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Green construction management towards certification processes. Comparative analysis between Canada and Mexico.

Case studies Canadians colleges and UNAM´s sustainability programs.

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"GREEN CONSTRUCTION MANAGEMENT TOWARD CERTIFICATION PROCESSES. COMPARATIVE ANALYSIS BETWEEN CANADA AND MEXICO. CASE STUDIES: CANADIANS COLLEGES AND UNAM'S SUSTAINABILITY PROGRAMS"

I. INTRODUCTION TO SUSTAINABLE DEVELOPMENT IN CONSTRUCTION
II. UNDERSTANDING AND IMPLEMENTING GREEN STANDARDS IN CONSTRUCTION PROJECTS
III. GREEN CONSTRUCTION IN CANADA AND MEXICO
IV. SUSTAINABILITY PROCEDURE IN CONSTRUCTION
V. CONCLUSIONS

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Abstract

The future of our planet is compromised by the progress of the way we do our activities, between them the construction of infrastructure and buildings involved in humankind development. For this process, it has become necessary that codes and construction regulations accompanying national economic and environmental policies from a local perspective, observing social, culture and nature aspects that made their community. The implementation of design, construction, maintenance and operation best practices mentioned throughout thesis serve to mitigate human development´s adverse effects to our planet.

The certification and assessment systems like LEED, BREEAM, GREEN GLOBES; STARS, CASBEE among others, are tools that can be used during the whole life of constructions, even without performing the certification process, the best way to implement them is combining with environment management, energy efficiency and corporate social responsibility systems like ISO´s type, bear in mind indicators mentioned in codes and standards like ASHRAE, IGCC, and Passive House. It´s important to remark that third-party body involvement is the best option to assess Project´s outcomes on both design and process implemented during life cycle of constructions.

New local policies in terms of regulations for construction are crucial to achieve the global goals set to environmental protection in COP 21 in Paris 2015. At this regard, the collaboration between countries is fundamental. Sharing the experiences gained in the development of technologies, construction process, environment-friendly materials are compulsory subjects to every country. Accordingly, Mexico has a lagging with NAFTA´s trading partners, for this reason it´s necessary a closer approximation with Canada and USA in similar projects like NAMAS´implementation developed with the UK and Germany. .

Public buildings along with living spaces are the change makers to reduce the environmental footprint of cities, given the impact during its construction and operation, as well as its role as a didactic space to generate the required sustainability culture for citizens, families and communities. The governments are the responsible to develop the policies, laws, and regulations the technical concepts mentioned in this thesis. However, are the people who have to appropriate them and implement in the everyday life and professional practice.

The systematisation of sustainability in corporate´s culture is an essential step towards initiate paradigm shift in the construction sector. The creation and implementation of sustainable practices, procedures and plans must be a pivotal point in corporate´s culture and professional ethics of public servants, engineers, architects, urbanists, urban developers, users, and every person committed with sustainable construction.

Resumen

El futuro de nuestro planeta está comprometido por el avance del modo en que hacemos nuestras actividades, entre ellas la construcción de la infraestructura y edificaciones involucradas en el desarrollo de la humanidad. En este proceso es necesario que los códigos y reglamentos de construcción acompañen a las políticas económicas y ambientales nacionales, desde una perspectiva local, respetando los aspectos sociales, culturales y naturales que generan a su comunidad. La implementación de las mejores prácticas de diseño, construcción, mantenimiento y operación mencionadas a lo largo de la presente tesis, sirve para mitigar los efectos nocivos del desarrollo humano a nuestro planeta.

Los sistemas de evaluación y certifación como LEED, BREEAM, GREEN GLOBES; STARS, CASBEE entre otros, son herramientas que pueden ser usadas durante el ciclo de vida de las construcciones, aun sin llevar a cabo el proceso de certificación, la mejor forma de implementarlos es combinarlos con un sistema de gestión ambiental, eficiencia energética, responsabilidad social tipo ISO, teniendo en cuenta indicadores mencionados en códigos y estándares como ASHRAE, IGCC y Passive House. Es importante remarcar que la participación de un organismo de certificación de tercera parte es la mejor opción para evaluar los resultados, tanto del diseño y procesos implementados durante la vida de las edificaciones.

Nuevas políticas regionales en materia de regulación en el sector de la construcción son indispensables para lograr las metas globales de protección al medio ambiente comprometidas en la COP 21 en Paris en 2015. A este respecto la colaboración entre países para adoptar estas medidas es fundamental. El compartir las experiencias en el desarrollo de tecnologías, procesos constructivos, desarrollo de materiales amigables con el medio ambiente son asignaturas obligatorias para todos los países. En este sentido México tiene un rezago significativo con sus socios comerciales del TLCAN, por lo que es necesario un mayor acercamiento con Canadá y Estados Unidos en programas similares para la implementación de las NAMAS realizados con Reino Unido y Alemania.

Los edificios públicos junto con los espacios habitacionales son los grandes jugadores para reducir la huella ambiental de las ciudades, dado el impacto que tienen tanto en su construcción y operación; así como un espacio didáctico para generar la cultura de sustentabilidad necesaria en los ciudadanos, en sus familias y la comunidad. Los gobiernos son los responsables de desarrollar las políticas, leyes y reglamentos que engloban los conceptos técnicos incluidos en el presente trabajo, pero son las personas quienes tienen que apropiarse de ellos y aplicarlos en el día a día de su vida personal y actividad profesional.

La sistematización de la sustentabilidad en el ámbito de las empresas es un paso indispensable para iniciar el cambio de paradigmas en el sector de la construcción. La generación e implementación de procedimientos y planes de sustentabilidad deben formar parte de la cultura empresarial y de la ética profesional de funcionarios públicos, ingenieros, arquitectos, urbanistas, desarrolladores, usuarios y todas las personas comprometidas con la construcción sustentable.

ACKNOWLEDGMENTS

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Introduction

I. Statement of the Problem

If you are not part of the solution, you are part of the problem. I start by introduce this quote to underline the responsibilities of all the people involved during the Life cycle of buildings, urban infrastructure, and construction in general. According to United Nations Habitat Program more than one half of the world population lives now in urban areas, this trend is expected to continue in the future. This is a global Phenomenon that is heavily affecting living conditions, the environment, and development (World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352), 2014). Energy conservation, water scarcity, natural resources depletion, and climate change are some of the elements that need to be taken into account. At this regard, it´s important to acknowledge that commercial buildings, dwellings, hospitals, hotels, and schools are the main sources of pollutants, and the larger consumers of natural resources, and thus the need to implement sustainability policies, codes and standards. (Philipp Rode et al, 2011). Nowadays, professional responsibility for design, construction, commissioning and operations, not only include structural, safety, and quality aspects, but also, green construction aspects mentioned in thesis.

As members of NAFTA, It is expected that Canada and Mexico have a strong network focused on sustainable development, and exchange information and experiences to bridge the gap between the countries. In this thesis, I include Canada and Mexico Cities´ highlights of several International reports in order to have information to contrast both cases. In order to have another element to contrast, I conduct a sustainability assessment under STAR rating system with three higher education institutions of both countries.

I also reviewed the main international rating systems in order to understand better the difference between them, and how to use some of their elements, tools, simulators, and related standards during the sustainability procedure included in chapter four.

II. Research Goal

Set parameters for Green construction under energy conservation and sustainability standards in the design, construction, and operation processes of a building according with current green regulations, construction codes and assessment´s certification ratings.

III. Research questions

Why is necessary for the constructions projects to be compromised and involved with Green certifications?

Which are the experience and benefits of Green building in Mexico and Canada?

How we can approach to green certification and green construction?

IV. Objectives

- Determine the importance of the energy efficiency and green construction concepts.
- Establishing a rapport between sustainability in the construction sector and the environment.
- Define the main concepts and principles involved in the Green certifications.
- Conduct a review in the main international green building standards.
- Analyze cost-benefit of achieving a Green certification
- Conduct a review of sustainable construction in Mexico and Canada
- Compare sustainability programs of Canadians Colleges and UNAM
- Develop a Sustainability Procedure for whole life cycle of a project.

V. Interviews & questionnaires sources

a) The **Commission for Environmental Cooperation** (CEC)
  - Former Executive Director Dr. Irasema Coronado

b) Mexico City´s Secretariat of the Environment (SEDEMA)
  - Self-regulated and Audit Program (PAAS in Spanish)
  -

c) Dawson College
  - Sustainable Dawson (Chris Adam, M. Ed.)

d) Niagara College
  - Sustainability Office (Taryn Wilkinson, Ept Sustainability Coordinator) Note: Questionnaire

e) The Autonomous National University of Mexico (UNAM)
  - The University Program for Sustainability Strategies (PUES) (Mireya Imaz, M. Sc.; Luis Gutiérrez P.Eng.)
  - The University Program for efficient Water Management (PUMAGUA) (Cecilia Lartigue, M Sc.)
  - General Management for General Services and Mobility (DGSG) (Ignacio Medina, General Manager)
  - (BICIPUMA(Isabel Barragán Isidro, Coordinator Program) – PUMABUS (. Agustín Óscar Valdés Barrón, Coordinator Program))
  - World Heritage Site “Central Campus” website

VI. Chapter Review

- Chapter 1 (Introduction to Sustainable Development in construction)

In this chapter, I introduce the problem, its elements and impacts to understand the complexity of the situation. I cover the sustainability timeline to show how environmental situation is interacting with the construction sector involving the following requirements (Energy efficiency, Water, Surface Water Run Off, Materials, LCA of Construction Materials, Waste, Pollution, Health & Wellbeing, Management, and Ecology)

Methodology: I reviewed Books, thesis, on-line reports and websites to describe the requirements mentioned.

- Chapter 2 (Understanding and implementing green standards in construction projects)

In this chapter I intended to introduce the most recognized rating systems: LEED STANDARDS, Passive, House Certification, BREAM, EnergyStar, Green Globes, HQE, Envirohome&BuiltGreen, National Green Building Standard, STARS, BOMA, CASBEE , and Eco-cycle pointing out pros and cons. I also include related ISO and ASHRAE standards and Software developed for green construction (METEONORm, RETSCREeN, Green Building Studio, ATHENA, BEES, e-Quest and CanQuest**,** EE4, EnergyPlus

Methodology: I reviewed Books, thesis, on-line reports and websites to know characteristics, and verify their incidence through the world and why they are the ones most commonly used. These secondary sources help me to introduce pros and cons for construction and design professionals, external opinions in related areas.

- Chapter 3 (Green construction in Canada and Mexico)

In order to know the state of the art of Green Building in Mexico and Canada I reviewed International reports (CEC, C40, Arcadis Sustainable Cities Index Report, CDP Cities 2012 Global Report, GCI REPORT, Latin American Green City Index, US and Canada Green City Index, World Green building trends 2013) to have elements to compare in a general context.

To continue the research, I reviewed barriers and triggers for Green building, emissions trends, policies, and certifications, Eco initiatives, and tools created in Mexico and Canada.

In order to have another element to compare I used the Talloires declaration, and ASHEE´s STARS assessment with three Canadian Colleges (Niagara College, Mohawk College, Dawson College and UNAM to compare them. I also include two cases of collaboration between colleges

Case study Methodology: After have reviewed which the status of current of Green Building is, an empirical study was carried out. Three different case studies were used to present how Higher Education Institutions implement sustainability programs in internal procedures. In order to make the comparison I elaborate a template with the main credits of STARS assessment, and use my experience as a student in these schools to include a SWOT analysis that aims to present exhibits. This template intends to work as a checklist to mark green facilities, institution information in regards of CO_2e emissions, sustainability programs and sustainability literacy. There are two other sections to enlist both sustainability highlights and express personal comments, including a self-assessment under STARS assessment credits. As part of the research I interviewed sustainability managers of Dawson college, and UNAM (see Interviews & questionnaires sources section) and sent a questionnaire to Niagara and Mohawk College. In 2008, the only one comparative study for green building between Mexico and Canada was presented by CEC, for this reason I interviewed former CEC´s Executive Director in Montreal to know the outcomes and follow-up of actions recommended in this report.

- Chapter 4 (Sustainability Procedure in Construction)

In order to establish sustainability practices in the construction process I linked Legislations, Policies, standards , and regulations to adopt a Sustainability Statement, and determine objectives and indicators for land use, energy, water and waste water, materials, waste management, purchasing, indoor quality, and community outreach.

As part of the implementation process, I proposed to make a Green Building - Cost benefit evaluation that include life-cycle factors and economics aspects.

The Procedure to achieve sustainability in a construction project include a punch list system by following the Sustainability Standard Operating Plan (**SSOP**) that provides different actions during the different stages in the construction process from design to decommissioning. The **SSOP is** linked with standards sections of this chapter, and the Sustainability procedure (**SP**).

Methodology: I used ISO model to elaborate the **SSOP** and **SP**, and introduce a **punch list** during the five phases of the life cycle of a construction (Predesign, design, construction, handover, and operation) Involving different activities such as set up of policies and objectives, set up of procedures and indicators, planning and design, procurement and traceability, commissioning, audit and continuous improvement, users engagement and public outreach, and decommissioning). This three elements are created to facilitate the sustainability adoption process under a continuous improvement scheme.

- Conclusions

In the conclusions section, I submit my conclusions under environment, economic, social factors that are already excelling in green building. I underline triggers and drivers in Mexico and Canada. Finally, I introduce my expectative for green construction in the future.

Notice to Readers:

1. All referenced websites information was retrieved from January 2015 to May 2016; at the time of thesis presentation (May 2016) all websites were available.
2. Hyperlinks have been incorporated into this document so that readers can move from the main text to examples and exhibits
3. All fees are refered in local currency and rate of exchange according with the date.

Chapter One

1.- Introduction to Sustainable Development in construction

In 2013, the approval announcement of two interesting projects in Canada and Mexico were released. Those projects are related for several reasons. Both intend to use water or wetlands surface, are focused to fill the demand of transportation systems of great metropolitan areas, and finally they rise a lot of questions related with sustainability policies.

In one hand in Canada, the cleanup of Randle Reef in Hamilton Harbour includes the treatment of a a huge mass of coal tar near the U.S. Steel Canada facility, Randle Reef spans about 60 hectares, or 120 football fields, in Hamilton Harbour, and contains about 675,000 cubic meters of heavily contaminated sedimentwith coal tar (polycyclic aromatic hydrocarbons).[1]The proposed clean-up project involves constructing an engineered containment facility (ECF) on top of a portion of the most contaminated sediment, then dredging and placing most of the remaining contaminated sediment in the facility.[2][3] According to Environment Canada "larger portion" of the contaminated sediment will be kept in using a process called "in situ capping,"[4] The project will provide a 5 Ha of the primary site for a marine terminal in Pier 15, and U.S. steel plant facilities.[5] The current project is in a re-tendering process due to project´s modifications.[6][7]

In the other hand Mexican government presented, the new International Mexico City Airport (AICM) will be located on an 11,400-acre site about six miles from Mexico City's existing Benito Juarez International Airport. In the final phase will have capacity for 120 million passengers per year and feature six runways, *quadrupling Juarez's capacity.* [8]Is scheduled to commence operations in 2020.The new airport will be one of the three largest airport infrastructure projects worldwide. This project will also include a subway line to connect with Mexico City, 24 water treatment plants; and 25 km of drains will be tubed. [9]The total amount of investment is estimated in USD 11.3 billion, the project developed by Norman Foster and partners, and and Netherlands Airport Consultants (NACO). intended to be certified as LEED PLATINUM.[10] Both projects had been questioned for environmental organizations, academics, and property owners.[11][12]

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[1]Samantha Craggs (Sep 30, 2013) Hamilton Harbour Randle Reef cleanup gets final go-ahead , CBC Newsretrieved from: http://www.cbc.ca/news/canada/hamilton/news/hamilton-harbour-randle-reef-cleanup-gets-final-go-ahead-1.1873366

[2] (Feb 13, 2015)'Game-changer' Randle Reef cleanup plan moving ahead, CBC News retrieved from: http://www.cbc.ca/news/canada/hamilton/news/game-changer-randle-reef-cleanup-plan-moving-ahead-1.2956258 CBC Newx

[3] http://www.randlereef.ca/

[4] http://ec.gc.ca/default.asp?lang=En&n=976258C6-1&news=491B73F8-2719-4B56-B632-5C1327F9350F

[5] (October 30, 2012) Comprehensive Study ReportRandle Reef Sediment Remediation Project http://www.ceaa-acee.gc.ca/050/documents/p80001/84290E.pdf

[6]Mark Scinocca, Commissioner, Finance and Regional Treasurer The Regional Municipality of Halton (June 10, 2015)FN-34-15 - Randle Reef Update – 2015 retrieved from: http://sirepub.halton.ca/councildocs/pm/18/Jun%2010%202015%20Administration%20and%20Finance%20FN3415%20%20Randle%20Reef%20Update%20%202015%20%20FN3415%20%20Randle%20Reef%20Update%20%202015doc%20185695.pdf

[7] http://m.insidehalton.com/news-story/5739007-hamilton-firm-wins-randle-reef-contract

[8] http://centreforaviation.com/profiles/newairports/new-mexico-city-international-airport

[9]NEW INTERNATIONAL AIRPORT Project Vision retrieved from: http://consulmex.sre.gob.mx/laredo/images/stories/docs/SCT/dan02416%20naicm-ingles.pdf

[10] http://www.airport-world.com/features/airport-design/4944-project-watch-new-mexico-city-international-airport.html

[11] Tema ambiental, la parte débil del nuevo AICMhttp://eleconomista.com.mx/industrias/2014/09/03/lado-ambientalista-parte-debil-nuevo-aeropuerto

[12] Construcción del nuevo AICM afectaría diversidad biológica que alimenta a aves migratoriashttp://diversidadambiental.org/medios/nota476.html

In 1987, the International Joint Commission declared Hamilton Harbour as an AOC.[13]During the XX century, this area was subjected to the impacts of intensive industrial and urban development including three wastewater treatment plants. In order to delisting Hamilton harbour from the 43 Areas of concern (AOC´s) a remedial action plan (RAP) was implemented by Federal, province, and local authorities in 1992[14]. This plan aimed to improve water quality, fish habitat and ecological health, the ECF form part of the RAP[15].

According to the report released in 2012 by Environment Canada: As a result of the programmed remediation actions Approximately 376 hectares of fish and wildlife habitat and 12 kilometres of shoreline habitat have been restored.Under the current schedule by 2025, Hamilton Harbour will be delisting. There are still remaining two major actions: The Randle Reef cleanup project, and the upgrading of the Woodward Avenue Wastewater TreatmentPlant.

In October 29, 2013. The Stelco Plant revealed that they were gone to stop steel-making operations in Hamilton, and continue coke production. That represented at least the lost of 47 non-union jobs, and several others, "In its heyday in the 1970s, the plant, then known as Stelco's Hilton Works, employed roughly 14,000 people"[16], the Marine terminal of containers expects to create only 60 permanent jobs.

In the case of the AICM, environmentalist claimed that a great environmental impact would be created in the surrounded area, stressing the habitat of natural organism such as migratory birds, and underline that authorities have demonstrated a lack of respect to the way of life of local communities.[17]

The new AICM is located in the middle of Lake Texcoco, approximately 23 km east of Mexico City. The myriad of small lakes spread through the highlands of central Mexico were and still are important stopover and wintering grounds for several species of waterfowl and wading birds, as well as the breeding ground for several permanent residents.[18]In the past the basin of Mexico valley was conformed by 3 lakes with salty water(Zumpango Lake, Xaltocan Lake, Texcoco Lake), and 2 lakes with fresh water (Xochimilco Lake, and finally Chalco Lake). [19]. It has been assessed that the original lake of the Valley of Mexico had an area of approximately 1,575 km^2[20]. According with (Zeevaert, 1952) the relative elevation of system lakes of the basin was. (Zumpango Lake + 6m, Xaltocan Lake + 3m, Xochimilco Lake + 3.5 m, Chalco Lake 3.5 m, Texcoco Lake 0 m), the average Mexico City elevation was +.85 m[21]

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[13]http://www2.hamilton.ca/NR/rdonlyres/CB2B6D55-614D-414E-9665-93780CDD1185/0/Apr19EDRMS_n86769_v1_8_1__PW10042.pdf
[14]http://www.hamiltonharbour.ca/index.php?page=index&p=about_the_rap
[15]http://www.marinedelivers.com/hamilton-harbour-remedial-action-plan
[16](October 29, 2013) http://www.cbc.ca/news/canada/hamilton/news/u-s-steel-closes-hamilton-blast-furnace-and-steel-making-1.2287483
[17](Sábado, 06 de Septiembre de 2014)http://www.bambapolitica.com.mx/nuevo/index.php?option=com_content&view=article&id=14395:pide-corte-internacional-de-arbitraje-ambiental-no-privilegiar-intereses-comerciales-en-nuevo-aicm&catid=34:noticias-del-dia&Itemid=58
[18]Alcantara& Escalante (March,2002) Current Threats to the Lake Texcoco Globally Important Bird Area
[19] Ing. Gerardo Cruickshank García (May, 1995) Proyecto Lago de Texcoco, Rescate Hidrológico
[20]Alvarez, J. R., editor. 1977. **Enciclopedia de México, tomo VIII.** Edit. México D.F.: Enciclopedia de México.
[21]John P Bradbury, Paleolimnology Of Lake Texcoco, Mexico (Evidencefromdiatoms)University of Minnesota

The continuous draining of the basin of the Valley, and the growth of the city, had represented engineering problems, the early dikes built in 1450 A.D. by Netzahualcoyotl to prevent floods and polluted by salty water of the Chinampas farms the main source of food of the city. In 1503, a 16 km dike “The Albarradon” was built from the north Sierra del Tepeyac to east Cerro de la Estrella . During the Colonial period, Mexico City suffered continuous floods for that reason several water and sewage works were developed in 1629 “El Tajo de Nochistongo”, in 1794 “The Castera Chanel, in 1895, the North channel and the Tequizquiac tunnel. In recent years due to the deficit of sewage, massive infrastructure projects start been building by Federal, and Local governments. The main projects are “The deep drainage “and the tunnel of the “Emisor Oriente”.[22]

Finally, after put in context the technical complexity of both projects, we can beg the question of how these projects can be sustainable, and how they can turn their environmental impacts into benefits to the local communities.

It´s important to define sustainability, why is very closely related with construction, and which are the impacts and challenges for the upcoming years.

In 1962, Rachel Carson published the Silent Spring[23], this book tried to demonstrated how pesticide use, was endangering species, and contaminated natural resources. In 1970´s, the Middle East conflict brings a new energy policy in Europe, USA, and Japan. Energy conservation stablished not only in the economical discourse, but also in construction standards, and design.
Although human concern to environmental impact grew during 1980´s, it wasn´t until the World Commission on Environment and Development (WCED) presented the 1987 report, by its Chair Gro Harlem Brundtland, at the time Norwegian Prime Minister, that sustainability concept was introduced into the environmental discourse, thereby transforming architectural discourse and establishing “Green Architecture”. (Baweja, 2008). Today sustainability is defined as “progress that meet[s] the needs ofthe present without compromising the ability of future generations to meet their own needs”. Understanding that“Sustainable”as used in “sustainable development “has come to connote a balancing of the relationships between environmental, social, and economic health. (Landman, 1999).

Every city, and it´s community have their own characteristics and dynamics. The population growth has been always linked to economic development, and the construction sector has been always involved in this process. From metropolitan areas to rural settlements, both urban development and infrastructure construction continue impact the environment. In 2007, for the first time in history, the global urban population exceeded the global rural population, and the worldpopulation has remained predominantly urban thereafter. Furthermore, in the U.S.A. in 2011, for the first time in nearly a hundred years, the rate of urban population growth outpaced suburban growth, reversing a trend that held steady for every decade since the invention of the automobile.24

[22]http://cuencavalledemexico.com/consejo-de-cuenca-del-valle-de-mexico/historia/
[23] http://www.biologicaldiversity.org/publications/papers/Silent_Spring_revisited.pdf
[24]http://ideas.time.com/2013/07/31/the-end-of-the-suburbs/

Today, 54 per cent of the world's population lives in urban areas, a proportion that is expected to increase to 66 per cent by 2050.[25] World´s urban population is expected to surpass 6 billion by 2045.

The 2014 world´s urban prospect report underlined that the biggest part of this growth is going to take place in developed countries, In order to meet the needs of their growing urban populations, it will be necessary to manage those urban areas., and provide them with housing, infrastructure, transportation, energy and employment, as well as for basic services such as education and health care. The report also states that by 2030, the world is projected to have 41 mega-cities with more than 10 million inhabitants, and affirms that:

"Accurate, consistent and timely data on global trends in urbanization and city growth are critical for assessing current and future needs with respect to urban growth and for setting policy priorities to promote inclusive and equitable urban and rural development."

As these trends are confirmed, Governments must implement policies to ensure that the benefits of urban growth are shared equitably and sustainably. As mentioned in the report in one hand **"the cities are important drivers of development and poverty reduction in both urban and rural areas, as they concentrate much of the national economic activity, government, commerce and, transportation, and provide crucial links with rural areas, between cities, and across international borders"**[26]. But, in the other hand rapid and unplanned urban growth, excessive centralization of economic and administrative functions threatens sustainable development.

In the policy implications section, the report manifest that the need of building institutional capacities most include: Accountability, Proficiency, and Responsibility, as well as integrated approach to attain urban sustainability and assessing current and future needs.

The future we want report of Rio + 20 Summit, sustained that ***"The respect for human rights underpins the attainment of development because if a person's human rights are not safeguarded and respected that person's well-being is undermined"***.[27]

One of the outcomes of the summit was The Agenda 21. In order to reaffirm the commitment of Unites Nations Organization and his members to protect the environment and human wellbeing. This document tried to establish a pattern for every country, as well serve as a tool to create programs focused in each activity of every sector.

The Chapter 7 of Agenda 21 specifically refers to the role of human settlements in sustainable development and the impact of the construction industry as main source of use substantial amount of global resources and waste emissions[28]. This document intends to complement the program of the United Nations Habitat. For 40 years, Habitat have developed and led several initiatives addressed to solve problems like climate change, safety, and planning.

[25]http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html
[26]http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html
[27]http://www.un.org/esa/population/publications/pop_challenges/Population_Challenges.pdf
[28]https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

1.1. Sustainability Timeline

In order to summarize the main global actions towards sustainability, I present the following table of events.

Year	Event	Proposals
1976	Habitat I (Vancouver)	• The first global meeting to link the environment and human settlement.[29] • Enforcement of human settlement policies • Creation of livable settlements • Integrate all people to the planning, building and management of the settlements
1992	UN Conference on Environment and Development (Rio)	• Two "Rio Conventions" are opened for signature: the Convention on Biological Diversity and the Framework Convention on Climate Change • Chapter 7 Agenda 21 "Promoting sustainable human settlement development" 7.4. The overall human settlement objective is to improve the social, economic and environmental quality of human settlements and the living and working environments of all people, in particular the urban and rural poor. 7.5. The programme areas included in this chapter are: a. Providing adequate shelter for all; b. Improving human settlement management; c. Promoting sustainable land-use planning and management; d. Promoting the integrated provision of environmental infrastructure: water, sanitation, drainage and solid-waste management; e. Promoting sustainable energy and transport systems in human settlements; f. Promoting human settlement planning and management in disaster-prone areas; g. Promoting sustainable construction industry activities; h. Promoting human resource development and capacity-building for human settlement development.
1996	Habitat II (Istanbul)	Conference statements: • We have considered, with a sense of urgency, the continuing deterioration of conditions of shelter and human settlements. • We reaffirm our commitment to better standards of living in larger freedom for all humankind. • Rural and urban development are interdependent. In addition to improving the urban habitat, we must

[29] unhabitat.org/?wpdmact=process&did...

		also work to extend adequate infrastructure, public services and employment opportunities to rural areas • We shall work to expand the supply of affordable housing by enabling markets to perform efficiently and in a socially and environmentally responsible manner, • In order to sustain our global environment and improve the quality of living in our human settlements, we commit ourselves to sustainable patterns of production, consumption, transportation and settlements development; pollution prevention; respect for the carrying capacity of ecosystems; and the preservation of opportunities for future generations.[30]
1997	Kyoto Protocol Agreed	The conference goal was to enable legally binding developed country parties to goals for greenhouse gas emission reductions, and establishing the Clean Development Mechanism for developing countries
2000	Millennium Goals	Conference´s statement: • Respect for nature. Prudence must be shown in the management of all living species and natural resources, in accordance with the precepts of sustainable development We resolve therefore: • to adopt in all our environmental actions a new ethic of conservation and stewardship and, as first steps, • to intensify our collective efforts for the management, conservation and sustainable development of all types of forests. • To stop the unsustainable exploitation of water resources by developing water management strategies at the regional, national and local levels, which promote both equitable access and adequate supplies.
2002	World Summit on Sustainable Development (Johannesburg)	The major innovation at Johannesburg were the so-called 'Type 2' agreements. These were informal agreements involving non-state parties, sometimes amongst themselves and sometimes with individual governments.[31]
2010	Nagoya Plan of Action on Cities and Biodiversity	This summit aimed to encourage national government actors to recognize the role of cities and local authorities in their national biodiversity strategies and action plans (NBSAP), facilitate the adoption by cities and local

[30] http://unhabitat.org/wp-content/uploads/2014/07/The-Habitat-Agenda-Istanbul-Declaration-on-Human-Settlements-20061.pdf
[31] http://www.eoearth.org/view/article/157161/

		authorities of practices that support the implementation of these strategies and action plans, and support the development of local biodiversity strategies and action plans, sustainable development plans and adaptation plans consistent with their national biodiversity strategies and action plans.[32]
2012	Rio +20 “The future we want”	The global community reconvenes in an effort to secure agreement on “greening” world economies through a range of smart measures for clean energy, decent jobs and more sustainable and fair use of resources. [33]
2016	Habitat III (Quito) “The new urban agenda”	The **Habitat III Conference** scheduled in 2016 will mark a critical moment and provide a concrete opportunity to strengthen cooperation mechanisms, partnership arrangements and other implementation tools, which will help implement the sustainable urbanization agenda. **Overall Goal:** *Promote cities that are environmentally sustainable, socially inclusive and economically productive* **Proposed Targets:** Social Cohesion and Equity - Livable Cities Urban Frameworks Spatial Development Urban Economy Urban Ecology and Environment Urban Housing and Basic Services[34]

Table 1.1 Sustainability timeline[35]

After 40 years of continuous international efforts to transform the design and construction processes, attempts to modify consumption trends, establish certification and evaluation mechanisms to achieve millennium goals, the problems persist[36].

Historically, Green building has been conceived as a tool to incorporate sustainable features to the design and construction. It also incorporates the four main goals of green development creating buildings that use less energy, cost less to operate and maintain, limit the impact on natural resources, and create places for people to work and live that promote health and productivity.[37]

In recent years, a new approach has tried to be incorporate, escalating the assessment methods to development plans, and master planning of neighborhoods, communities, and cities. Such as LEED-Neighborhood Design (ND) in 2009, that aims to integrate principles of smart growth, urbanism and

[32]http://www.uncsd2012.org/content/documents/Supporting%20Local%20Action%20for%20Biodiversity.pdf
[33]www.uncsd2012.org/rio20/
[34]https://www.habitat3.org/
[35] http://www.edu.gov.mb.ca/k12/cur/socstud/frame_found_sr2/tns/tn-43.pdf
[36] www.un.org/.../development/.../groupb_unhabitat_s...
[37] Inter-American Development Bank, (2012) GreenBuildings Workbook A guide for IDB practitioners (www10.iadb.org/intal/intalcdi/PE/2013/11799.pdf)

green building, and BREEAM Communities method that provides a way to improve measure and certify the social, environmental and economic sustainability.[38]

The world urbanization trends show us the following facts[39]:

Today, the most urbanized regions include Northern America (82 per cent living in urban areas in 2014), Latin America and the Caribbean (80 percent), and Europe (73 per cent). In contrast, Africa and Asia remain mostly rural, with 40 and 48 per cent of their respective populations living in urban areas. They represent the impacts demonstrated un figure 1.1, but also opportunities to accomplish sustainability goals in the future as showe in figure 1.2.

As the world continues to urbanize, sustainable development challenges will be increasingly concentrated in cities, particularly in the lower-middle-income countries where the pace of urbanization is fastest. Integrated policies to improve the lives of both urban and rural dwellers are needed.

Cities today occupy approximately only 2% of the total land, however they accounts for the:[40]

70% **Economy (GDP)**	over 60 % **Global Energy Consumption**	70% **Greenhouse Gas Emissions**	70% **Global Waste**

Figure 1.1. City impacts

Today's baseline

ENERGY USE 24%* -50%**	**CO2 EM ISSIONS 33%*** -39%****	**WATER USE 40%****	**SOLID WASTE 70%****

Figure 1.2. Green Building Performance (benefits) Source: United States Green Building Council (USGBC), www.usgbc.org[41]

[38] http://www.bre.co.uk/filelibrary/pdf/Brochures/BREEAM_Communities.pdf

[39] United Nations, Department of Economic and Social Affairs, Population Division (2014). *World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).*

[40] https://www.habitat3.org/the-new-urban-agenda

[41] Inter-American Development Bank, (2012) GreenBuildings Workbook A guide for IDB practitioners (www10.iadb.org/intal/intalcdi/PE/2013/11799.pdf)

Figure Notes:
* Turner C. & Frankel M, 2008 “Energy performance of LEED for New Construction Buildings: Final report”. Paper prepared for: U.S. Green Building Council. Washington DC, United States: U.S. Green Building Council.

** Kats G. 2003. “The Costs and Financial Benefits of Green Building: A Report to California´s Sustainable Building Task Force”. California, United States.

*** Kim M. Fowler and Emily M. Rauch. 2008. “Assessing green building performance: A post occupancy evaluation of 12 GSA buildings”. Prepared for the U.S.

General Services Administration (GSA) Public Buildings Service. Washington, United States.

It´s important star by defining the following concepts.

“Sustainable urban development can be defined as the spatial manifestation of urban development processes that creates a built environment with norms, institutions and governance systems enabling individuals, households and societies to maximize their potential, optimize a vast range of services so that homes and dynamic neighborhoods, cities and towns are planned, built, renewed and consolidated restraining adverse impacts on the environment while safeguarding the quality of life, needs and livelihood of its present and future populations.”[42]

“Sustainable housing means housing that takes into account the long-term environmental, social, cultural and economic balance of the housing stock and its occupants”[43]

These days, is very common to read news about climate change, and government projects addressing to this problem under the umbrella of international initiatives like Agenda 21[44,45]. Almost every country has developed internal policies, and created mechanism to detect and measure the main sources of pollution, because of those actions, several certification processes were developed since 1990, as showed in figure 1.3.

[42] http://www.un.org/en/development/desa/policy/untaskteam_undf/groupb_unhabitat_suscities.pdf
[43] unhabitat.org/?wpdmact=process&did=MjczLmhvdGxpbms=
[44] http://www.un.org/esa/agenda21/natlinfo/countr/canada/eco.htm
[45] http://www.un.org/esa/agenda21/natlinfo/countr/mexico/inst.htm

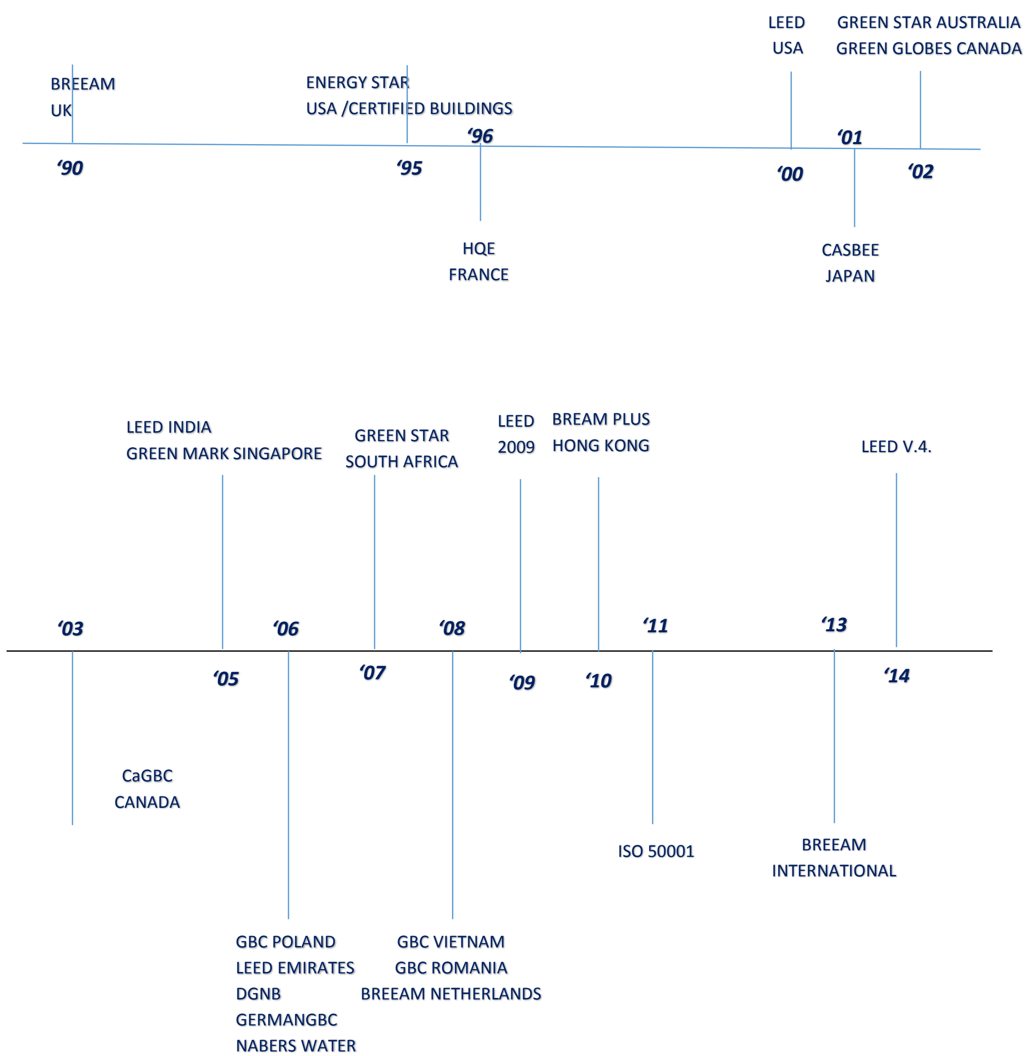

Figure 1.3. Time line of the development of rating tools

Note: Dates and countries indicate foundation of organization launch of the system Source: Reed; up to 2010 Note: Full disclosure of rating systems will be presented in chapter two.

1.2. Sustainability as a requirement

The report Code for Sustainable Homes: A step-change in sustainable home building practice (Communities and Local Government, 2006) defined a set of nine categories of environmental impact showed in the following table.[46]

Categories	Issue
Energy and CO2 Emissions	Dwelling emission rate (M) Fabric energy efficiency (M) Energy display devices Drying space Energy labelled white goods External lighting Low and zero carbon technologies Cycle storage Home office
Water	Indoor water use (M) External water use
Materials	Environmental impact of materials (M) Responsible sourcing of materials – basic building elements Responsible sourcing of materials – finishing elements
Surface Water Run-off	Management of surface water run-off from developments (M) Flood risk
Waste	Storage of non-recyclable waste and recyclable household waste (M) Construction site waste management Composting
Pollution	Global warming potential (GWP) of insulants NOX emissions
Health and Well-being	Daylighting Sound insulation Private space Lifetime Homes (M)
Management	Home user guide Considerate Constructors Scheme Construction site impacts Security
Ecology	Ecological value of site Ecological enhancement Protection of ecological features Change in ecological value of site Building footprint

Table 1.2: Summary of Environmental Categories and Issues

[46] Code for Sustainable Homes Technical Guide (November 2010)
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/5976/code_for_sustainable_homes_techguide.pdf

In the last section of this chapter I will try to explain how the construction impact the environment by providing information from different international sources like IPCC, and regulatory bodies from North America, and Europe.

1.2.1. Energy efficiency

Energy and CO2 Emissions

Quick stats [47]

According with the World Business Counsil for Sustainable Dvelopment (WBCSD):

- Buildings account for 40% of energy use worldwide.
- Energy used during its lifetime causes as much as 90% of environmental impacts from buildings (Journal of Green Building).

Building operations consume more than 2/3 of all electricity (BuildingScience.com)

Residential and commercial buildings consume 40% of the primary energy and 71% of the total electricity in the United States. (ASHRAE)

The following tables present the current electric rates in North America, It´s important to remark in all cases that the price per KwH are in local currency, and depends on seasonality, and the End-use of costumers. In all cases, government subsidies apply.

When	**How much electricity you use**	**Price (¢ per kWh)**
Residential (effective May 1, 2015)		
Summer (May 1 - Oct 31)	Up to 600 kWh	9.4
	More than 600 kWh	11.0
Winter (Nov 1 - Apr 30)	Up to 1,000 kWh	--
	More than 1,000 kWh	--
Non-residential (effective May 1, 2015)		
All seasons	Up to 750 kWh	9.4
	More than 750 kWh	11.0

Table 1.3. , Ontario, Canada Retrieved from: Ontario Energy Board website: http://www.ontarioenergyboard.ca/OEB/Consumers/Electricity/Electricity+Prices (September 2015)

	Residential		**Commercial**		**Industrial**		**Transportation**		**All Sectors**	
Census Division and State	**June 2015**	**June 2014**	**June 2015**	**June 2014**	**June 2015**	**June 2014**	**June 2015**	**June 2014**	**June 2015**	**June 2014**
U.S. TotalGraph	**12.93**	**12.98**	**10.87**	**10.98**	**6.98**	**7.27**	**10.20**	**10.45**	**10.64**	**10.76**

Table 1.4. Average Price of Electricity to Ultimate Customers by End-Use Sector, In U.S.A., June 2015 and 2014 (Cents per Kilowatthour)

Retrieved from: U.S. Energy Administration website:

http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a

[47] http://sustainabilityworkshop.autodesk.com/buildings/environmental-issues-building-design

Rate 2													
Price by cateory ($/kWh)													
Range	Dec/2014	Jan	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1 – 50	2.241	2.186	2.160	2.103	2.053	2.042	2.021	2.017	2.030	2.109			
51 – 100	2.706	2.640	2.609	2.540	2.479	2.466	2.440	2.435	2.450	2.545			
Add	2.980	2.907	2.873	2.797	2.730	2.716	2.688	2.683	2.700	2.804			
Fixed Charge ($)													
Monthly	53.31	53.27	54.06	54.31	54.55	54.89	55.08	55.26	55.53	56.02			

Rate 3												
Demand charge bases ($/kW)												
Dic./2014	Ene.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
242.01	241.84	245.42	246.57	247.68	249.24	250.11	250.91	252.11	254.35			
Energy Charge based ($/kWh)												
1.699	1.624	1.569	1.487	1.416	1.395	1.364	1.356	1.366	1.452			

Table 1.5.: CFE – Fees Mexico

The energy efficiency of buildings falls within the strategic framework of the two global challenges established by the International Council for Research and Innovation in Building and Construction (CIB) Task Group:

- climate change due to greenhouse gas emissions, CO_2 in particular, and
- provision of fossil fuels.[48]

The report remarks the following outcomes:

In developed countries, buildings represent approximately 40% of CO_2 emissions and 40% of energy consumption. These figures concern CO_2 emissions and energy consumption from using the buildings. [49]

Transport-related CO_2 emissions and energy consumption as a direct result of buildings, especially from private cars when blocks of flats or houses are not built on a public transport route, are placed under transport.

In all, buildings are directly or indirectly responsible for over half of total $C0_2$ emissions and energy consumption. The CO_2 emissions and energy consumption by buildings are rising sharply in high growth emerging countries, along with an improvement in comfort and rapid urban growth.

[48] The Implementation of Energy Efficient Buildings Policies: an International Comparison FINAL REPORT
English version Jean CARASSUS Professor Ecole Nationale des Ponts et Chaussées, Paris Institute of Technology Coordinator CIB Task Group 66 (2009-2012) August 2013

[49] CO2 emissions and energy consumption related to the construction, renovation and destruction of buildings are placed under industry.

The role of buildings is rising significantly in emerging countries along with rapid urban growth.

At this regard, three targets have been set in order to limit climate change and reduce dependence on fossil fuels:

- reduce greenhouse gas emissions, especially CO_2,
- increase energy efficiency, and even reduce energy consumption,
- step up the share of renewable energies.

As mentioned in the World Energy Outlook 2012, the main contributors of greenhouse effect gases had presented their own emissions programs, and goals:

- The United States has set a goal to double its energy efficiency by 2030
- The European Union has committed to a cut of a 20 percent in its 2020 energy demand
- China is targeting a 16 percent reduction in energy intensity by 2015
- Japan aims to cut 10 percent from electricity consumption by 2030[50]
- Mexico announced that it would reduce greenhouse gas emissions 22 percent below business-as-usual levels by 2030 and peak its emissions by 2026.[51]

In order to meet these goals local governments have set strategies and technologies to reduce energy consumption by buildings:[52]

- Optimize passive solar orientation, building massing and use of external shading devices such that the design of the building minimizes undesirable solar gains during the summer months while maximizing desirable solar gains during winter months.
- Optimize building orientation, massing, shape, design, and interior colors and finishes in order to maximize the use of controlled natural day lighting which significantly reduces artificial lighting energy use thereby reducing the buildings internal cooling load and energy use. Consider the use of light shelf technology.
- Use high performance low-e glazing, which can result in significant year round energy savings.
- Optimize the value of exterior insulation and the overall thermal performance of the exterior envelope assembly. Consider advanced/high performance envelope building systems such as structural insulated panel systems (SIPS) and insulated concrete form systems (ICF's) that can be applied to light commercial and institutional buildings.
- Use energy efficient T-8 and T-5 bulbs, high efficiency electronic ballasts, and lighting controls.
- Use state-of-the art, high efficiency, heating, ventilation and air conditioning (HVAC) and plumbing equipment, chillers, boilers, and water heaters, etc. Use variable speed drives on fan and pump motors. Use heat recovery ventilators and geothermal heat pump technology for up to 40% energy savings.
- Avoid the use of HCFC and Halon based refrigeration, cooling and fire suppression systems.
- Use Energy Star certified energy efficient appliances, office equipment, lighting and HVAC systems.

[50] U.S. Presidential State of the Union; International Energy Agency, World Energy Outlook 2012
[51] http://thinkprogress.org/climate/2015/03/28/3640220/mexico-emissions-cuts/
[52] Building Green in Penssylvania, Governors Green Building Council

- Consider on-site small-scale wind, solar, and/or fuel cell based energy generation and co-generation. Purchase environmentally preferable "green" power from certified renewable and sustainable sources.

Each project needs to design his own strategy towards energy consumption reduction, and stablish policies, and procedures. The figure 1.4 intends to stablish a pattern towards the implementation of Energy Management System, and sustainability measures during the construction process related to energy. As defined by (Barney L. Capehart, Ph.D., CEM, Wayne C. Turner, Ph.D. PE, CEM, William J. Kennedy, Ph. D., PE;, 2012) the energy management is the efficient and effective use of energy to maximize profits (Minimize costs) and enhance competitive positions, besides this definition is important to underline the Life Cycle Assessment in this process, and translate customer´s requirements to an Energy Management Program.

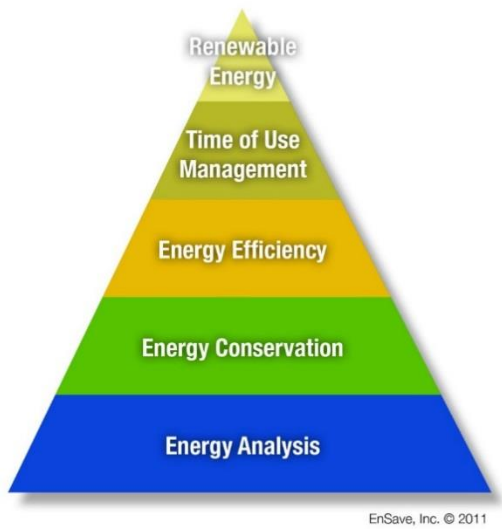

Figure 1.4. 'Energy Pyramid'
Retrieved from: http://www.ensave.com/wp-content/uploads/2012/06/The-Energy-Pyramid.pdf

The principle of the Energy Pyramid approach is based on the Time - Cost of the actions implemented. The longer we delay to implement the actions to the project, the more costly the corrective measures are.

Energy Analysis: This analysis often takes the form of an energy audit. Energy audits review the current energy consumption on a similar building, and recommend ways to save energy through more efficient behaviors and use of equipment. An energy audit is a valuable tool for making decisions about energy, because it determines the best energy choices, their cost, and the return on investment in years.

Once energy usage is known, potential energy conservation projects can be identified either in constructed buildings or in new projects.

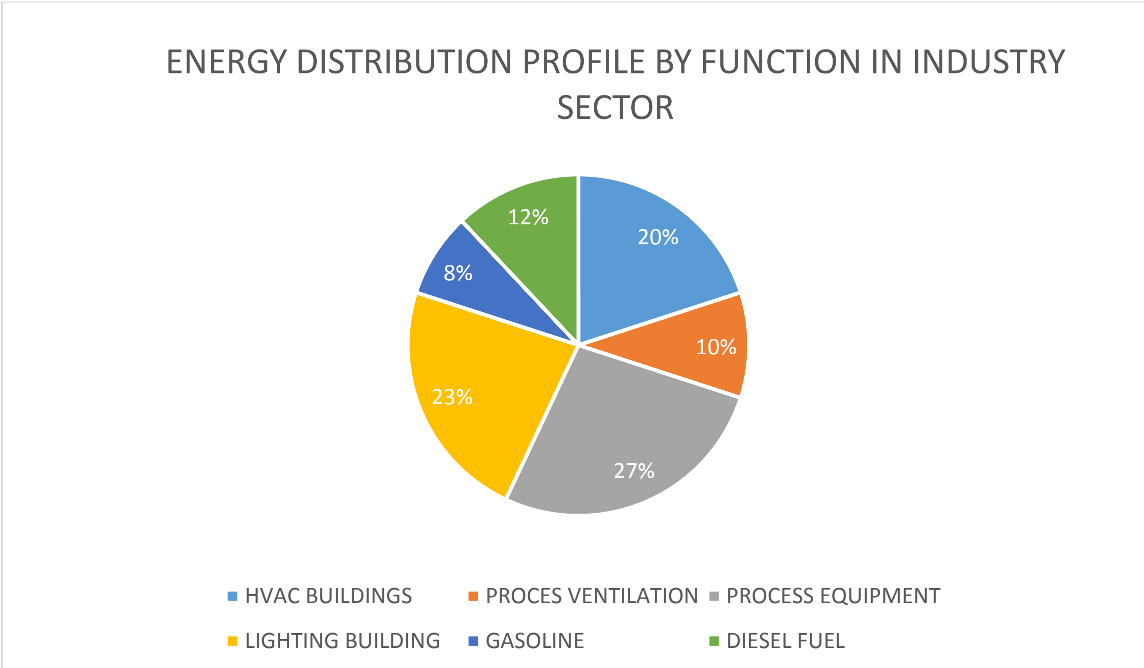

Figure 1.5.Energy distribution profile by function in industry sector
Retrieved from: Albert Thumann, P.E.,C.E.M., Scott Dunning, Ph.D.,P.E.,C.E.M.;2011. Plant Engineers and Managers Guide to Energy Conservation, 10thed.The Fairmont press Inc.

Figure 1.5 shows how much of the energy is used for each building function, and figure 1.6 demonstrates how energy is distributed in home buildings both in the United Kingdom.

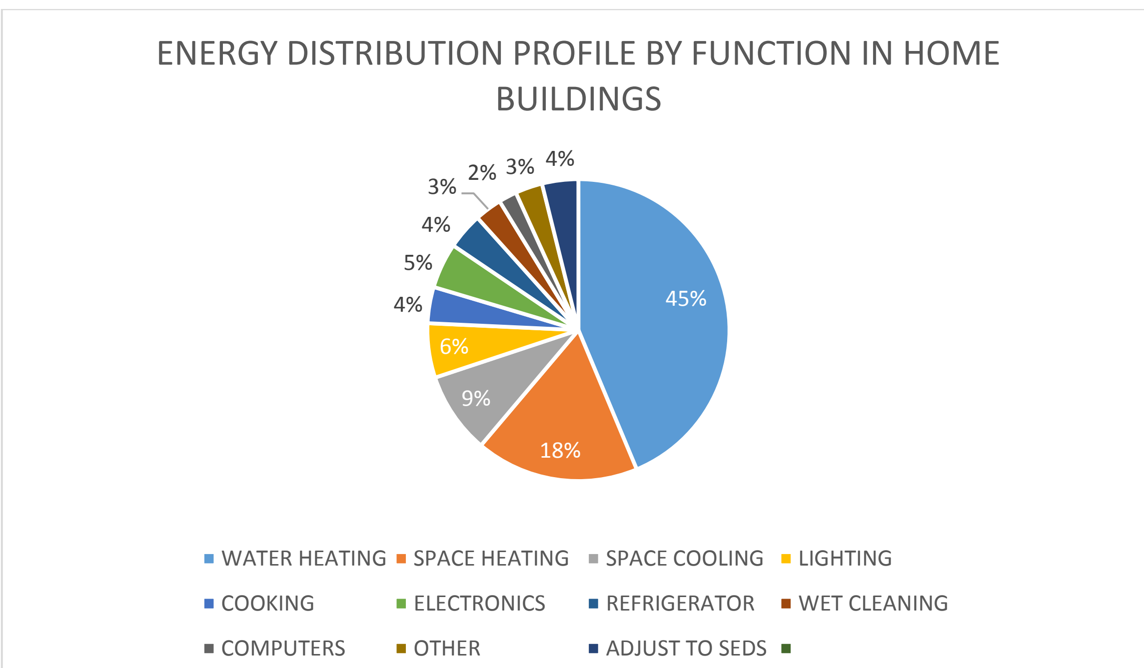

Figure 1.6 Energy distribution profile by function in home in buildings
Retrieved from: http://buildingsdatabook.eren.doe.gov/ChapterIntro2.aspx

"Energy conservation behavioral changes can be made for little or no cost. The cheapest kWh is the one you never use" [53]

Energy Conservation: focuses on changing people's behavior to use energy in a more efficient manner. Some simple examples of energy conservation that yield significant cost savings:

- turning off lights when not needed
- setting thermostats to lower settings in the winter and higher settings in the summer
- keeping windows shut and shades drawn during hot summer days
- making sure air conditioning and heating filters are cleaned regularly
- unplugging appliances and electronics when not in use

Energy Efficiency: involves purchasing and installing appliances and other household electronics with high energy efficiency. Some examples of energy efficiency include:

- using compact fluorescent lamps (cfl) rather than incandescent lamps (cfls use roughly ¼ of the energy of incandescent bulbs)
- buying energy star appliances (hot water heater, AC, stove, refrigerator, T.V., etc…)
- installing double-pane insulated windows rather than single-pane windows

In this context, comprehensive national development strategies to counter back the effects of climate change had been implemented in Mexico by the Mexico's National Housing Commission (CONAVI), and the Workers National Housing Fund Institute (INFONAVIT) like: the Green Mortgage (2010). The National Energy Savings Commission is also implementing new standards and programs to support green building construction.[54]

Canada have set specific standards for sustainability and energy efficiency throughout their federal building stocks. For example, the Energy Independence and Security Act, adopted in December 2007, aims to cut energy use in federal buildings. Ontario´s government has developed incentives, but is focusing in saving energy programs such as: Go Off peak, Evict your phantoms, and investment in Energy efficiency appliances certified by Energy Star.[55]

Energy Demand: can be more easily applied to commercial operations and "involves shifting energy usage when possible to periods with less demand on the energy distribution system. Energy demand considerations are most applicable to electricity and natural gas. For an electricity system, the challenge is to shift many of the energy-intensive operations to the times when off-peak rates are applicable.

[53] Building Green in Penssylvania, Governors Green Building Council
[54] Green Building in North America by American Agreement on Environmental Cooperation
[55] http://www.energy.gov.on.ca/en/saving-energy-for-home/

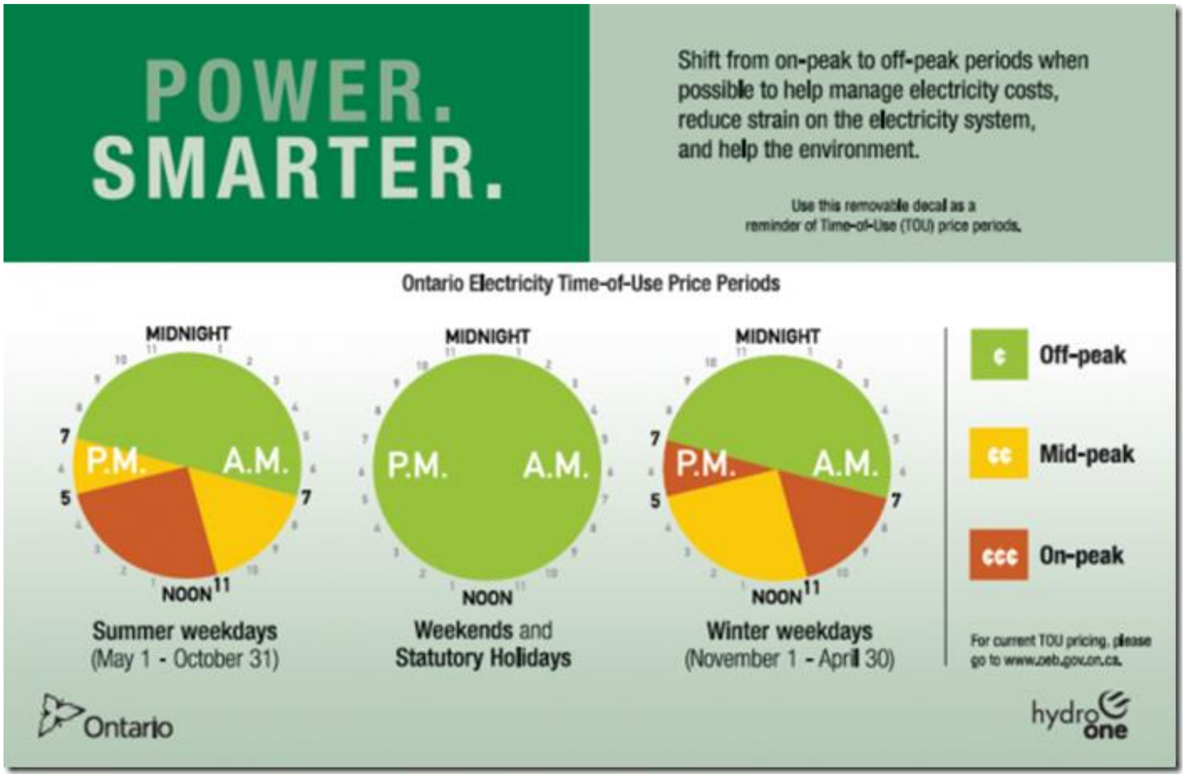

Figure 1.7 Ontario Electricity Time-of-Use Price Periods
Retrieved from: http://www.hydroone.com/MyHome/SaveEnergy/Pages/CostCalculators.aspx

Note: Niagara College has implemented an Demand Response Program[56]

As showed in figure 1.7 Ontario has three time-of-use periods:

Off-peak – when energy demand is low and less expensive sources of electricity are used
Mid-peak – when the cost of energy and demand are moderate
On-peak – when demand is highest and more expensive forms of electricity production are used.[57]
Renewable Energy is the peak of the pyramid and thus should be the last part of the pyramid to be built. Renewable energy technologies should be installed only after measures for energy conservation, energy efficiency and demand management have been fully implemented.[58]

Energy security: Implementation of mitigation measures in the buildings sector can play an important role in increasing the sufficiency of resources to meet national energy demand at competitive and stable prices and improving the resilience of the energy supply system. Specifically, mitigation actions result in: Strengthening power grid reliability, reducing cooling-related peak power demand and shifting demand to off-peak periods, and increasing the diversification of energy sources as well as the share of domestic energy sources used in a specific energy system

[56] http://sustainability.niagaracollege.ca/content/Projects/CampusProjects/Energy/DemandResponseProgram.aspx
[57] http://www.energy.gov.on.ca/en/smart-meters-and-tou-prices/
[58] http://www.danvers.govoffice.com/index.asp?Type=B_BASIC&SEC={847324FF-5997-45CB-BA9E-4FF3EB24E61B}&DE={E2F01AE5-762D-4468-9DFF-EB0E3C9165C1}

Before finish, this section I want to quote the 2009 UNEP´s report Greenhouse Gas Emission Baselines and Reduction Potentials from Buildings in Mexico elaborated by Odón de Buen that underlines as an issue that there are significant subsidies for the residential sector in México, particularly for electricity. ***"Just in the year 2006, more than 10 billion US$ were spent by the government to cover the costs no recovered through the power utility bill"***[59]. Of this total, more than 50 % goes to cover the difference in cost in the residential sector. ***"More specifically, more than half of residential electricity consumers pay about 0.05 US$ per kWh, which is about a fifth of real costs (which is paid by about 10% of all residential customers)"***. Finally, the report estates is an enormous barrier to energy efficiency measures by the end users. (Odón de Buen R., M.Sc. et al, 2009). This subsidiary polcy continues in Mexico, and continue to be submitted to strong criticism.

1.2.2. Water

Human demands for water are usually broken down in five water usage sectors:

- Food and agriculture
- Energy
- Industry
- Human Settlement
- Ecosystems

The United Nations World Water Development Report established that the main drivers and stressors for water are: demographic changes, technological developments, economic growth, prosperity, changing diets, and social and cultural values[60] At this regard, urban populations are projected to increase by 2.9 billion, from 3.4 billion in 2009 to 6.3 billion total in 2050, as mentioned in this report most of this growth is expected to develop in less developed areas. Asia's population is projected to increase by 1.7 billion; Africa has a projected urban population gain of 0.8 billion; and Latin American and the Caribbean urban populations are projected to grow by 0.2 billion. In addition, the climate change is also a major factor challenging the urban water supplies by changing water availability and the increasingly water-related number of disasters events.
The wastewater from urban settlements are also the main source of point-source pollution, and contributes to increase the eutrophication of oceans and freshwater resources. As proposed by the UN-report: urban planning, and integrated urban water management can contribute to ensure safety in human health and environment.

Besides this problem, the majors threats for human development related with water are water scarcity, erosion, and desertification.[61]Although, these problems are almost always related with developing countries, is important to mention the case of California´s current draught in the U.S.A[62]., and the continuos desertification in South Spain.[63]

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[59] Irastorza, V., *¿ Porqué se Necesita una Reforma a las Tarifas de Electricidad?* . 2006, Energía a Debate.
[60] The United Nations World Water Development Report 4 Volume 1, 2012 (http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/WWDR4%20Volume%201-Managing%20Water%20under%20Uncertainty%20and%20Risk.pdf)
[61] http://www.unccd.int/en/programmes/Event-and-campaigns/WDCD/WDCD2013/Pages/default.aspx
[62] INSIGHT TECHNICAL REPORT http://www.usgbc.org/sites/default/files/Water%20Conservation%20in%20Californias%20Green%20Buildings_GBIG%20Insight.pdf
[63] http://www.climateadaptation.eu/spain/desertification/

In this regard, the United Nations Department for Economic and Social Affairs (UNDESA) defines water scarcity as the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully.[64] Desertification at present is mainly due to forest fires, the loss of soil fertility of irrigated land by salinization, and erosion. Climate change will deteriorate soil fertility through a loss of carbon from the soil.[65]

Addressing to this issue the United Nations World Water Development Report 4 concludes that water management together with land-use planning for urban areas will need to become more efficient to meet current and growing demand through technology, investment, and comprehensive and integrated planning for multiple users.

"Beyond human demands for water in agriculture or in buildings, human development has many other impacts on hydrology that can be addressed and mitigated by green building practices. Typical development practices often disrupt the natural water balance and degrade the land's ability to clean rainwater and replenish groundwater resources. By quickly piping away water that falls on a building site and its many impervious surfaces, most buildings put additional strains on already stressed watersheds" [66]

The potential contribution of urban-scale actions in buildings and cities towards sustainability is undeniable. It is thus essential the adaptation of new policies in regional and national levels, by taking into account both climate weather changes, and new technologies. There are a number of strategies that can be employed to reduce the amount of water consumed at a facility. In general terms, these methods include:

System optimization

Water conservation measures
Water reuse/recycling systems

More specifically, a wide range of technologies and measures can be employed within each of these strategies to save water and associated energy consumption. Best practices include:

- Water efficiency limit the use of water inside and outside the building by considering water demand reduction like low-flow restroom fixtures and high-efficiency irrigation systems and supply like use of storm water or grey-water (water used from showers, wash basins, and laundry) recycling.[67]
- Rainwater Collection: Accumulating and storing of rainwater. Used to provide water for sanitary needs, livestock irrigation to refill aquifers in a process called groundwater recharge. (water-efficient irrigation systems, irrigation control systems, low-flow sprinkler heads, water-efficient scheduling practices, and Xeriscape[68])

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64 http://www.un.org/waterforlifedecade/scarcity.shtml
[65] http://www.greenfacts.org/en/desertification/index.htm
[66] http://unhabitat.org/urban-themes/water-and-sanitation-2/
http://www.unep.org/geo/geo5.asp
[67] Green Buildings Workbook INE/ECC February 2012 retrieved from: http://www10.iadb.org/intal/intalcdi/PE/2013/11799.pdf
[68] http://www.repsa.unam.mx/documentos/Camarena_2010_Xerojardineria-imprenta.pdf

- Grey Water Recycling Tanks: Greywater is wastewater generated from domestic activities such as laundry,dishwashing, and bathing which can be recycled on-site for uses such as landscape irrigation and constructed wetlands. The recycling tanks help to redistribute the water for useful purposes.
- Methods to reduce water use in HVAC systems.

Low-flow plumbing fixtures			
The low-flow commode flush rate options are: • 6 liter /flush • 4.8 liter/flush • 4-6 liter/flush (dual flush model) • 3,78 liter/flush (pressure assist) • 0.2 liter/flush (foam flush) • 0.0 liter/flush (waterless or composting toilet)	The low-flow urinal flush rate options are: • 3.78 liter/flush • 1.9 liter/flush • 0.47 liter/flush • 0.0 liter/flush (waterless)	The low-flow sink rate options are: • 3.78 liter/minute • 1.9 liter/minute • 0.94 liter /minute	The low-flow shower rate options are: • 9.5 liter/minute • 6.8 liter/minute
			

Figure 1.8. Low-flow plumbing fixtures Retrieved from: http://www.wbdg.org/resources/water_conservation.php

Water Saving Plumbing Fixtures: Sanitary fixtures and fittings with lower water consumptions like low flow shower heads and toilets, dual flush toilets, waterless urinals, faucets aerator.

The water consumption is directly linked to culture, the following tables demonstrates is not only about wealth and poverty, but it also include cultural and lifestyle behaviors. The U.S. and Canada have the major consumption per capita in the world 382 and 343 lt, respectively. [69]Mexico in comparison only has 135 Lts. As showed in figures 1.9.1 and 1.9.2 the price for municipal water[70] has a direct relation with per capita daily consumption in developed countries. In the case of Canada the main threat to water availability is in Ontario, is high (more than 40%) in the urbanized south-west part of the province. This is caused by large industrial and municipal water use and a low inland surface water supply.[71]in 2011, Mexico was in the sevetn place of the global groundwater

[69] http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=00EEE0E6-1
[70] http://proyectos2.iingen.unam.mx/LACClimateChange/docs/boletin/Nota15.pdf
[71] https://ec.gc.ca/eau-water/default.asp?lang=En&n=2DC058F1-1

abstraction list with 29 Km3/year.[72]In the last two decades water consumption doubled, producing water stress in dry seasons and semi-arid and arid regions. Water stress rises due to physical and economic stress.

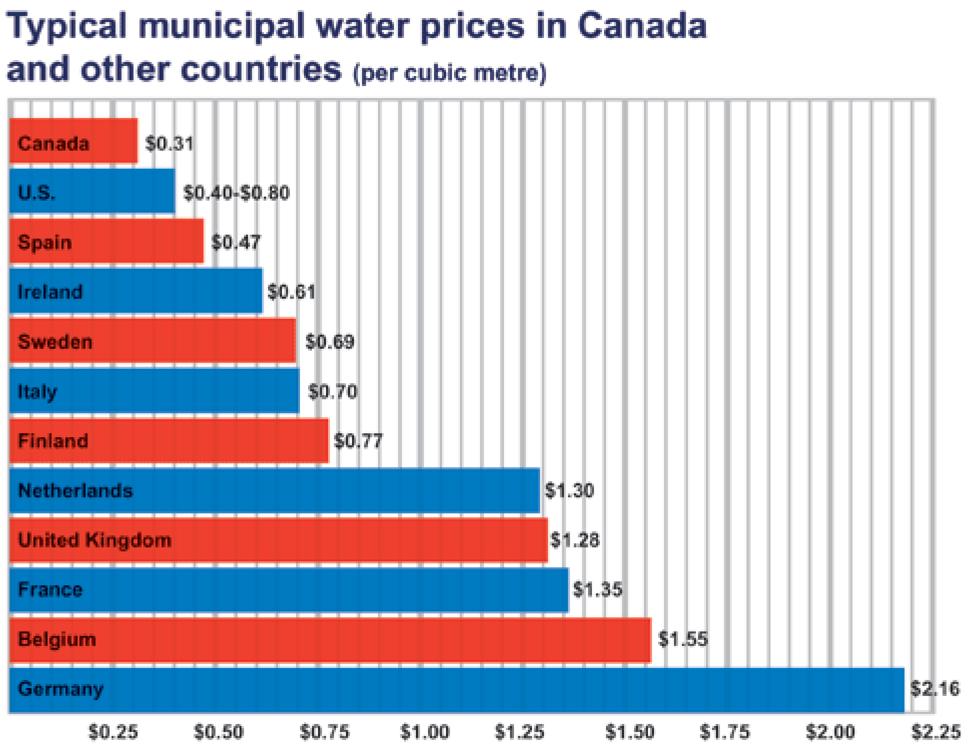

Figure 1.9.1 Water process in developed countries

[72] Source: Data from IGRAC (2010), AQUASTAT (2011) and EUROSTAT (2011).

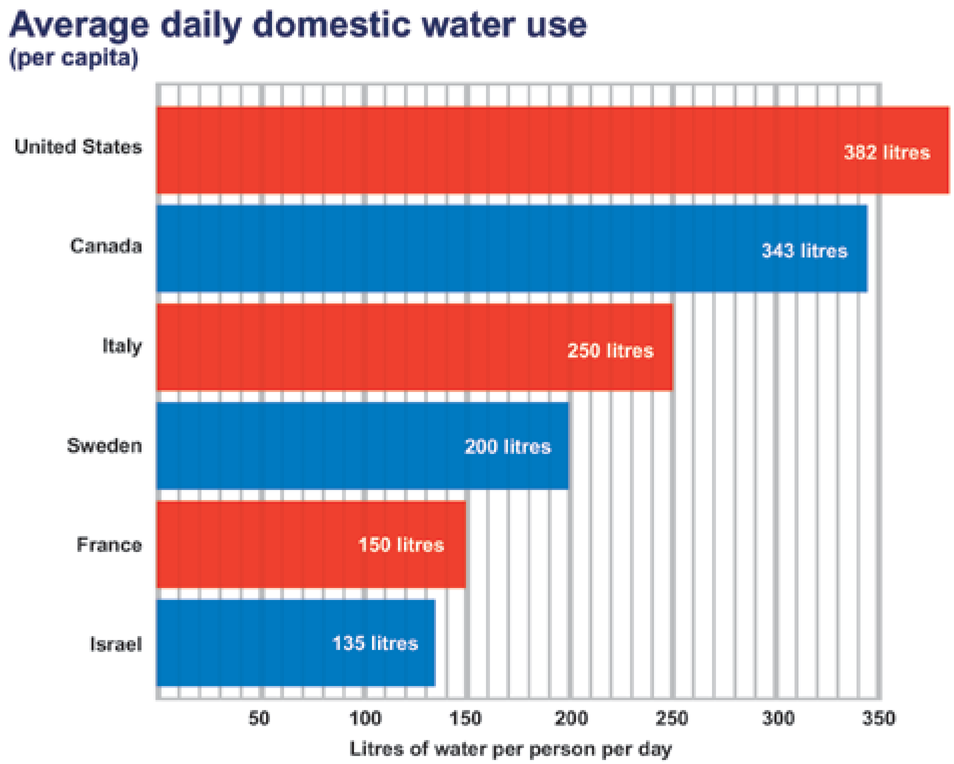

Figure 1.9.2 Average daily domestic water use

Note 1: Mexico 1441 (m3/person/year) Water footprint: the domestic consumption of water resources minus the virtual water exports plus the virtual water imports.[73]

Note 2: The statistic shows the per capita consumption of bottled water worldwide in 2009 and 2014, by leading countries. Mexico had the highest per capita consumption with 69.8 gallons in 2014. The per capita consumption of the United States was 34 gallons in that year.[74]

1.2.2.1. Surface Water Run-off

It´s mandatory that all existing features of ecological value surrounding the construction zone and site boundary area are adequately protected from damage during clearance, site preparation and construction activities as listed below as best practices:

- Trees of over 100 mm trunk diameter, and/or of significant ecological value, are protected by barriers. Barriers must prohibit construction works in the area between itself and the tree trunk.
- Minimum distance between tree trunk and barriers must be either the distance of branch spread or half tree height, whichever is the greater.
- Watercourses and wetland areas are to be protected by cut-off ditches and site drain-age to prevent silting or erosion induced by run-off to natural watercourses.

[73] http://www.conagua.gob.mx/english07/publications/statics2010.jpg
[74] http://www.statista.com/statistics/183388/per-capita-consumption-of-bottled-water-worldwide-in-2009/

SUDS (Sustainable drainage systems or sustainable urban drainage systems) are composed of a combination of management procedures and control structures designed to drain surface water. The successful drainage of surface water is achieved in a more sustainable way than conventional techniques(Figure 1.10 demonstrates SUDS benefits).[75]

Typical systems components are:

Permeable surfaces:.
Concrete block paving (laid dry or with sand)(See figure 1.11)
Specialist permeable paving blocks
Permeable pavements
Reinforced grass (See figure 1.11)
Gravelled areas
Filter strips
Swales
Filter and infiltration trenches (French drains)
Underground Storage Systems (Storm cells)
Basins and ponds

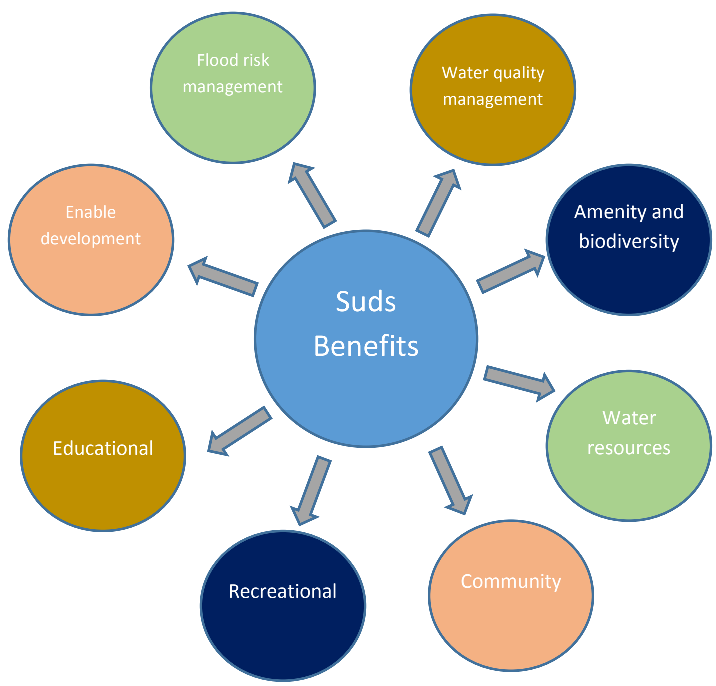

Figure 1.10. SUDS Benefits Retrieved from: http://www.susdrain.org/delivering-suds/using-suds/benefits-of-suds/SuDS-benefits.html

In developed countries, planning permission is now required to lay traditonal impermeable driveways that allow uncontrolled runoff of rainwater onto the roads becuase this can contribute to flooding and pollution of watercourses some paving solutions are required like **Driveline Priora Permeable Paving showed in figure 1.11.**

[75] http://www.theconstructioncentre.co.uk/sustainable-homes/sustainable-drainage-systems.html

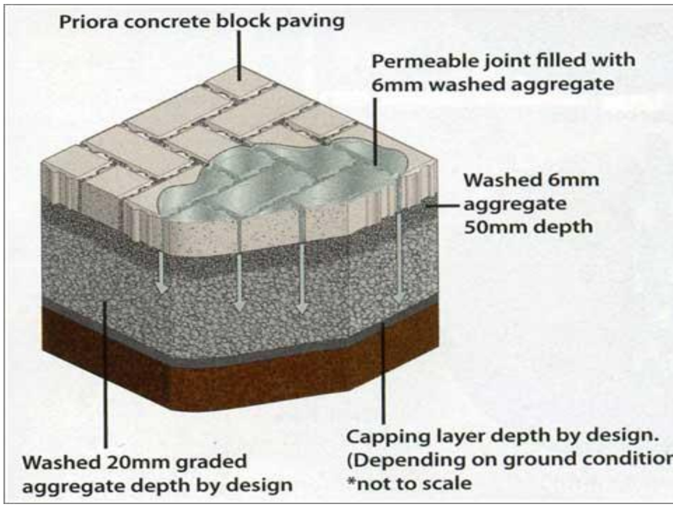

Figure 1.11. : Driveline Priora Permeable Paving Retrieved from: http://www.fangornlandscapes.co.uk/suds.html , http://www.cresswater.co.uk/media/cw-pic-suds-01.jpg

1.2.2.2. Water Quality and Conservation

Key Principles:
Preserve the existing natural water cycle and design site and building improvements such that they closely emulate the site's natural "pre-development" hydrological systems. Emphasis should be placed on retention of storm water and on-site infiltration and ground water recharge using methods that closely emulate natural systems. Minimize the unnecessary and inefficient use of potable water on the site while maximizing the recycling and reuse of water, including harvested rainwater, storm water, and gray water.

Key Strategies and Technologies:

- Recognize that the least costly, least time consuming and most environmentally preferable design for site and storm water management is often the one in which the design of buildings and site improvements respect the existing natural flows and features of the land, instead of designing the building and site improvements with total disregard for the site, which results in needless, extensive, disruptive, costly and time consuming excavation and earthmoving.

- Conduct a thorough site assessment and strategically locate buildings and site improvements to preserve key natural hydrological features. Special effort should be made to preserve areas of the site that serve as natural storm water retention and ground water infiltration and recharge systems. Preserve existing forest and mature vegetation that play a vital role in the natural water cycle by absorbing and disbursing up to 30% of a site's rainwater through evapo-transpiration.

- Minimize the building's footprint, site improvements and construction area, and minimize excavation, soil disturbance and compaction of existing topsoil as this soil in its natural uncompacted state serves a vital role in absorbing and storing up to 80% of natural rainfall until it can be absorbed by vegetation or enter the site's natural sub-surface ground water system.

- Design and locate buildings and site improvements to optimize use of low-impact storm water technologies such as bio-retention, rain gardens, open grassy swales, pervious bituminous paving, pervious concrete paving and walkways, constructed wetlands, living/vegetated roofs, and other technologies that support on-site retention and ground water recharge or evapotranspiration. Stormwater that leaves the site should be filtered and processed naturally or mechanically to remove trash and debris, oil, grit and suspended solids. Use "hold and release" technologies such as dry retention ponds only as a last resort as these technologies do not preserve the natural water cycle, have little or no benefit in terms of ground water recharge and result in needless additional site disturbance.

- Establish a water budget for the building and implement a design that minimizes the use of potable water by using low-flow plumbing fixtures and toilets and waterless urinals. Harvest, process and recycle rainwater, site storm water, and building gray water and identify appropriate uses within the building and site. Use on-site treatment systems that enable use of rain water for hand washing, graywate for toilet flushing, rain and storm water for site irrigation, cooling tower make-up and other uses.

- Conserve water and preserve site and ground water quality by using only indigenous, drought resistant and hardy trees, shrubs, plants and turf that require no irrigation, fertilizers, pesticides or herbicides.

The building's design also considered four urban waters: mains-, storm-, waste- and natural-. To minimise its impact on natural waters, it was designed to minimise demand for mains water and discharges of stormwater and sewage.[76]

1.2.3. Materials and Resources

In the article, **"Construction materials and the environment"** presented in 2004 by Arpad Horvath to the Annual Review of Environment and Resources, the author raises the following questions, that help us to demonstrate different approaches to environmental impacts generated by construction sector from a conservation material perspective. (Horvath, 2004)

What are the materials flows and uses of all construction materials worldwide/by Country/by region/ by city?
How much resource consumption is associated with construction when the supply chains are analyzed?
What is the demand for nonconstruction materials and services when construction materials and services are purchased? What is the water demand of the construction sector?

[76] WATER BALANCE OF A GREEN BUILDING SAM TROWSDALE, JEREMY GABE, ROBERT VALE
http://www.branz.co.nz/cms_show_download.php?id=5f70c27162a425bf44d9a614fa247c3f53581b5a

How much emissions and wastes are associated with construction materials and processes in all life-cycle phases?
What are the environmental impacts of construction materials?
How do the environmental effects of construction products vary from one geographic region to another?
How long does infrastructure last?
How will shorter service life spans and increased need for reconstruction and renovation affect the environmental performance of the construction industry?
What are societal trends of importance to the built environment, and what challenges do they pose for environmental performance?
What are the societal costs of construction materials?

In this section, I´ll try to answer back some of them, since the objective of this thesis is to enlist the main factors of sustainability process.

There are also an important factor to take into account, the resource depletion of some construction materials such as aluminum, and plastics. At the regional level, construction material shortages are already a concern, and transporting these materials to construction sites from large distances will not only make them more expensive but will increase their environmental footprint as well. For this reasons, in recent years a new culture of recycling and reuse of construction materials have been implemented not only by the governments, but also by the private sector.[77]

Although, is impossible to determine accurately the flows since there are not statistics that encompasses all the constructions sectors. It´ll be possible to determine the amount of new home, buildings, roads, dams, etc. and project them to calculate the burden of materials used. As part of total quality and corporate responsibility, processes implemented by private companies, allow us to have emissions inventories for establish the baseline for greenhouse gases, pollutants and toxic chemicals.

The efficiency of the life cycle of infrastructure is a matter of concern for designers, users, and owners. A poor operation performance of buildings, render them functionally obsolete, and can be translated in human health issues as well as negative environmental impacts.

The following tables demonstrate the size of global resources consumption, and how all this matter is transformed in pollutants. The last table underline the participation by region in the world.

Resource	Resource (%)
Energy	45–50
Water	50
Materials for buildings and roads (by bulk)	60
Agricultural land loss to buildings	80
Timber products for construction	(90% of hardwoods)
Coral reef destruction	50 (indirect)
Rainforest destruction 25	25 (indirect)

Table 1.6 Estimate of global resources used in buildings[78]

[77] http://www.oldcastlematerials.com/docs/crh-social-responsibility-annual-reports/2009.pdf?sfvrsn=4
[78] Hawken, P., Lovins, E and Lovins, H, Natural, Capitalism – Creating the next Industrial Revolution, Little Brown and Co., 1999 369pp.

Pollution	(%)
Air quality (cities)	23
Climate change gases	50
Drinking water pollution	40
Landfill waste	50
Ozone depletion	50

Table 1.7.Estimate of global pollution that can be attributed to buildings[79]

	High-growth scenario (A1)	Low-growth scenario (B2)
CO2 emissions (in GtCO2)	8.6 → 15.6 (2004) (2030)	8.6 → 11.4 (2004) (2030)
Largest share from	Developing Asia, Middle East/North Africa, Latin America, sub-Saharan Africa	North America and developing Asia
Average annual CO2 emissions growth rate (2004-2030)	2.4%	1.5%

Table 1.8. Projected CO2 emissions from buildings to 2030[80] Source: IPCC (2007)

Since public awareness of nature resources depletion have become a trending topic in the last twenty years in the whole world, public examination to construction industry has increased. As per, of new environmental regulations, and economic constrains, almost every economic sector has been striving for green design. As a result, vehicle, chemical manufacturing, and electronics have reduced environmental footprint. (Horvath, 2004).

´

It´s important to define that materials flows signify the magnitude of renewable and non-renewable materials production and consumption, the energy needed to extract, transport, and prepare them for further use, the corresponding emissions and wastes and the potential depletion of viable stocks.

"Standards both within Canada and internationally have begun to reflect the growing priority of environmental protection and reducing the effects of global climate change. Social and consumer awareness of green lifestyle and consumption practices have also increased rapidly in recent years."[81]

Green building materials are composed of renewable, rather than non-renewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product **Fuente especificada no válida.**

Buildings materials are one of the elements in a sustainable building that can have the greatest environmental impact as well as directly affecting the quality of both the building's interior and exterior appearance. They directly and indirectly impact the wider ecological context through the processes used to extract, manufacture, transport and ultimately reuse or dispose them. Building

[79] Brown MT, Bardi E. Handbook of energy evaluation. A compendium of data for energy computation issued in a series of folios. Folio #3: Energy of ecosystems. Center for Environmental Policy, Environmental Engineering Sciences, University of Florida, Gainesville; 2001. Available at http://www.emergysystems.org/folios.php [accessed 02.06.09.

[80] Source: IPCC (2007)

[81] National Geographic Society and GlobeScan. 2010. *Greendex 2010: Consumer Choice and the Environment – A Worldwide Tracking Survey*.Retrieved from http://environment.nationalgeographic.com/environment/greendex/.

materials must also be chosen with a consideration of the context in which the building will be placed and the desired quality of building spaces. Many design decisions have an influence on a building's environmental footprint[82].

Ecological awareness has a strong cultural component in societies, in developed countries such as European Union, Canada, U.S.A.; a preventing approach is part of new policies. Figure 1.12 show us how environmental targets are included in safe management plans, as wells as the use of priority substances, and directives involving atmosphere, water resources, disposal of mine and construction´s waste to landfills.

In opposite to this, developing countries fail to stablish and implement regulations that meet international standards; for instance, Mexico despite to has a Law for Solid Waste since 2009, and several integral waste management plans, the diversion rate of waste was less than 12 % in 2004.[83]In comparison the waste diversion rate of major Canadian cities are. Edmonton: 60%; Halifax 57%; Metro Vancouver 55%; Toronto 67%; Winnipeg 17%[84]

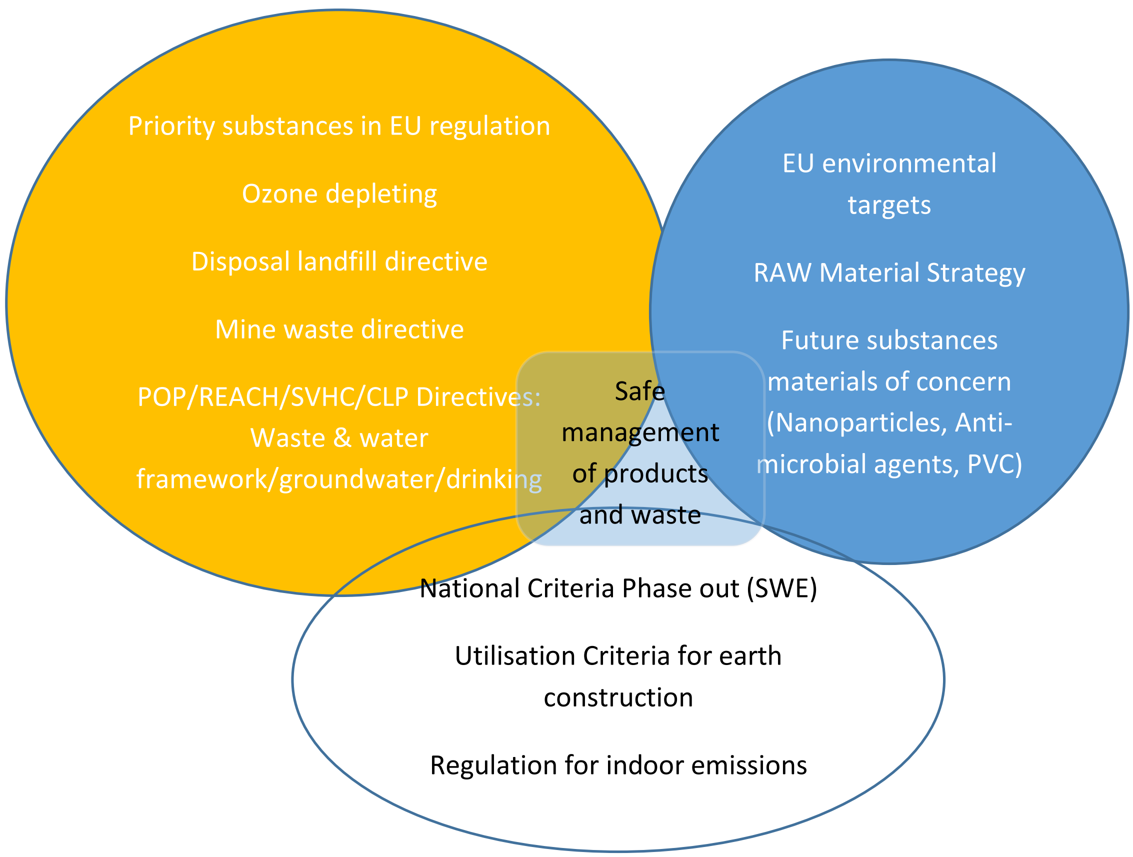

Figure 1.12. ***Legislation and future drivers (strategies) affecting the use of substances and materials in construction Products from:***[85]
Source: http://www.gdrc.org/uem/waste/material-efficiency.html

[82] **Sustainability and Life Cycle Analysis for Residential Buildings, I N T E R N A T I O N A L Buildingseries N°4 http://www.canadawood.cn/downloads/pdf/sustainability/sustainability_english.pdf**
[83] http://www2.inecc.gob.mx/publicaciones/libros/495/residuos.html
[84] http://garbage.speakupwinnipeg.com/2010/11/17-diversion-%E2%80%93-what-does-this-mean/
[85] Environmentally Sustainable Construction Products and Materials – Assessment of NORDIC INNOVATION REPORT 2014:03 // MARCH 2014 release

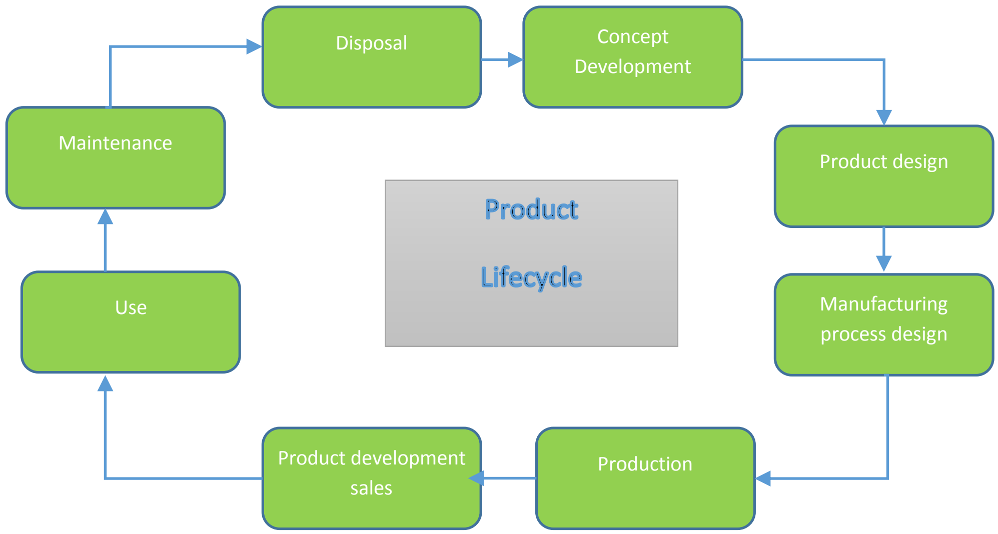

Figure 1.13 Product lifecycle retrieved from: http://www.umich.edu/~nppcpub/resources/compendia/ARCHpdfs/ARCHsbmIntro.pdf

1.2.3.1. Life-Cycle Assessment of Construction Materials

The principles of Life Cycle Design provide important guidelines for the selection of building materials. Each step of the manufacturing process, from gathering raw materials, manufacturing, distribution, and installation, to ultimate reuse or disposal, is examined for its environmental impact.

A material's life cycle can be organized into three phases: Pre-Building; Building; and Post-Building. These stages parallel the life cycle phases of the building itself. The evaluation of building materials' environmental impact (direct and indirect) at each stage allows for a cost-benefit analysis over the lifetime of a building, rather than simply an accounting of initial construction costs. Direct effects relate to the energy and material use in the materials production stage, whereas indirect effects reveal the contributions of the supply chains.[86]

The ecological damage related to the gathering of natural resources and their conversion into building materials includes loss of wildlife habitat, erosion, and water and air pollution.

The main approaches to LCA are Process-based LCA uses process flow analysis to model life-cycle activities and stages under the guidance of ISO 14040 to develop LCAs. The other LCA approach, EIO-LCA, solves this problem by using the economic input-output data to quantify both direct and supply chain effects.

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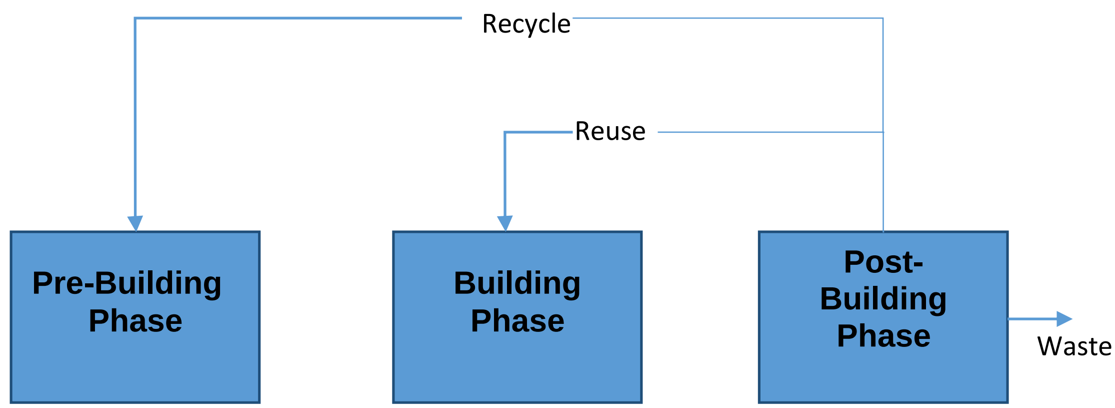
[86]**Sustainable Architecture Module: Qualities, Use, and Examples of Sustainable Building Materials**Jong-Jin Kim, Assistant Professor of Architecture,and Brenda Rigdon, Project Intern; (December 1998) retrieved from **http://www.umich.edu/~nppcpub/resources/compendia/ARCHpdfs/ARCHsbmIntro.pdf**



Manufacture	**Use**	**Disposal**
• Extraction	• Construction	• Recycling
• Processing	• Installation	• Reuse
• Packaging	• Operation	
• Shipping	• Maintenance	

Figure 1.14 Three phases of the building material life cycle. Retrieved from: http://www.umich.edu/~nppcpub/resources/compendia/ARCHpdfs/ARCHsbmIntro.pdf [87]

	Green Features	
Manufacturing Process (MP)	**Building Operations (BO)**	**Waste Mgmt. (WM)**
Waste Reduction (**WR**)	Energy Efficiency (**EE**)	Biodegradable (**B**)
Pollution Prevention (**P2**)	Water Treatment & Conservation (**WTC**)	Recyclable (**R**)
Recycled (**RC**)	Nontoxic (**NT**)	Reusable (**RU**)
Embodied Energy Reduction (**EER**)	Renewable Energy Source (**RES**)	Others (**O**)
Natural Materials (**NM**)	Longer Life (**LL**)	

Figure 1.15: Key to the green features of sustainable building materials.

MP	**BO**	**WM**
WR		
	WTC	R
RC	NT	RU
EER		
	LL	

Figure 1.16. Green features of plastic lumber and pavers.

[87] **Sustainable Architecture Module: Qualities, Use, and Examples of Sustainable Building Materials (**Jong-Jin Kim, Brenda Rigdon, 11998)

MP	BO	WM
WR		
		R
RC		
EER		O
	LL	

Figure 1.17 Green features of recycled asphalt.

Figures 1.15, 1.16, 1nd 1.17 show how to present materials features from manufacturing, building, and waste management for plastic lumber and recycled asphalt.

Pre-Building Phase

The **Pre-Building Phase** describes the production and delivery process of a material up to, but not including, the point of installation. This includes discovering raw materials in nature as well as extracting, manufacturing, packaging, and transportation to a building site. This phase has the most potential for causing environmental damage. Understanding the environmental impacts in the pre-building phase will lead to the wise selection of building materials. Raw material procurement methods, the manufacturing process itself, and the distance from the manufacturing location to the building site all have environmental consequences. An awareness of the origins of building materials is crucial to an understanding of their collective environmental impact when expressed in the form of a building. (See figures 1.16 and 1.17)

Using a **"cradle-to-cradle"** approach, the "waste" from one generation can become the "raw material" of the next. The recycling and reuse of construction and demolition (C&D) materials offsets impacts associated with the input of virgin material into construction and renovation of buildings and infrastructure.

Building Phase

The **Building Phase** refers to a building material’s useful life. This phase begins at the point of the material’s assembly into a structure, includes the maintenance and repair of the material, and extends throughout the life of the material within or as part of the building. *Construction*: The material waste generated on a building construction site can be considerable.

The selection of building materials for reduced construction waste, and waste that can be recycled, is critical in this phase of the building life cycle.

Use/Maintenance: Long-term exposure to certain building materials may be hazardous to the health of a building’s occupants. **“Even with a growing awareness of the environmental health issues concerning exposure to certain products, there is little emphasis in practice or schools on choosing materials based on their potential for outgassing hazardous chemicals, requiring frequent maintenance with such chemicals, or requiring frequent replacements that perpetuate the exposure cycle”**.

Post-Building Phase

The **Post-Building Phase** refers to the building materials when their usefulness in a building has expired. At this point, a material may be reused in its entirety, have its components recycled back into other products, or be discarded. From the perspective of the designer, perhaps the least considered and least understood phase of the building life cycle occurs when the building or material's useful life has been exhausted. The demolition of buildings and disposal of the resulting waste has a high environmental cost. Degradable materials may produce toxic waste, alone or in combination with other materials. Inert materials consume increasingly scarce landfill space. The adaptive reuse of an existing structure conserves the energy that went into its materials and construction. The energy embodied in the construction of the building itself and the production of these materials will be wasted if these "resources" are not properly utilized.

The Living Building Challenge Red List

The LBC Red List is a list of materials prohibited for use on a building project seeking to achieve Living Building Challenge certification, due to concerns about toxicity and human health impacts. The list is updated as new scientific research is published. Recognizing the complexity of the manufacturing process, there is an exception for small components on complex products made from ten or more constituent parts. The small component must be less than 10 per cent of the total project by both weight and volume and be discrete and contained in the form it is introduced to the product. Another exception is made for materials on the Red List that are required by local building codes.[88]

The life-cycle of a product includes sourcing of raw materials, manufacturing, packaging, transportation, distribution, retailing, installation, use of the product, and management of the product when it is no longer needed (through reuse, repair, upgrading, recycling, or safe disposal). To capture the benefits of reuse, repair, upgrading and/or recycling, quantify the impact offsets that can be accomplished when the product is used in place of a virgin material in another building or infrastructure.

Where there are certain life-cycle stages or attributes that dominate the opportunity for environmental improvement, those key impact areas (or "hot spots") should be given greater emphasis in a material specification.

Consider trade-offs among multiple environmental impacts (e.g., global warming, resource depletion, indoor air quality, waste streams) when determining environmental preferability. That is, look at the "big picture" rather than simply shifting problems from one impact to another.(see section 4.2)

Employing LCA Tools like ATHENA and BEES can simplify the process and give more credible results.[89] (See section 2.4)

[88]CIRS TECHNICAL MANUAL retrieved from: http://cirs.ubc.ca/building
[89]Retrieved from: https://www.wbdg.org/design/env_preferable_products.php

ATHENA: EcoCalculator for Assemblies. LCA—which allows the impartial comparison of building designs based on measures such as global warming potential[90]

BEES: BEES measures the environmental performance of building products by using the life-cycle assessment approach specified in the ISO 14040 series of standards.[91]

Key Principles:
Minimize the use of non-renewable construction materials and other resources such as energy and water through efficient engineering, design, planning and construction and effective recycling of construction debris.

Maximize the use of recycled content materials, modern resource efficient engineered materials, and resource efficient composite type structural systems wherever possible.

Maximize the use of re-usable, renewable, sustainably managed, bio-based materials. Remember that human creativity and our abundant labor force is perhaps our most valuable renewable resource. The best solution is not necessarily the one that requires the least amount of physical work.

Key Strategies and Technologies:

- Optimize the use of engineered materials which make use of proven engineering principles such as engineered trusses, composite materials and structural systems (concrete/steel, other…), structural insulated panels (stress skin panels), insulated concrete forms, and frost protected shallow foundations which have been proven to provide high strength and durability with the least amount of material.

- Identify ways to reduce the amount of materials used and reduce the amount of waste generated through the implementation of a construction waste reduction plan. Adopt a policy of "waste equals food"whereby 75% or more of all construction waste is separated for recycling and used as feedstock for some future product rather than being landfilled. Implement an aggressive construction waste recycling program and provide separate, clearly labeled dumpsters for each recycled material. Train all crews and subcontractors on the policy and enforce compliance.

- Identify ways to use high-recycled content materials in the building structure and finishes. Consider everything from blended concrete using fly ash, slag, recycled concrete aggregate, or other admixtures to recycled content materials such as structural steel, ceiling and floor tiles, carpeting, carpet padding, sheathing, and gypsum wallboard. Consider remanufactured office furniture and office partition systems, chairs and furniture with recycled content or parts.

- Explore the use of bio-based materials and finishes such as various types of agriboard (sheathing and or insulation board made from agricultural waste and by-products, including straw, wheat, barley, soy, sunflower shells, peanut shells, and other materials). Some structural insulated panels are now made from bio-based materials. Use lumber and wood products from certified

[90] Retrieved from: https://wbdg.org/tools/athena_ec.php?a=1
[91] Retrieved from: https://wbdg.org/tools/bees.php?a=1

forests where the forest is managed and lumber is harvested using sustainable practices. Use resource efficient engineered wood products in lieu of full dimension lumber which comes from older growth forests.

- Evaluate all products and systems used for their ability to be recycled when they reach the end of their useful life. Preference should be given to products and systems that facilitate easy, non-energy intensive separation and recycling with minimal contamination by foreign debris.

- Recognize that transportation becomes part of a product or building materials embodied energy. Where practical, specify and use locally harvested, mined and manufactured materials and products to support the regional economy and to reduce transportation, energy use and emissions.

		Btu per ton			
	%by weight	**Materials**	**Hauling**	**Btu/yd3 concrete**	**% energy**
Cement	12	5,792,000	504,000	1,574,000	94a
Sand	34	5,000b	37,000b	29,000	1.7
Crushed Stone	48	46,670	53,000	100,000	5.9
Water	6	0	0	0	0
Concrete	100	817,600		1,700,000	100

Table 1.9 Embodied energy for cement and concrete production
retrieved from:
http://www.annualreviews.org/doi/abs/10.1146/annurev.energy.29.062403.102215

[a] Energy requirements for cement production are provided using 1990 numbers from the Portland Cement Association.[92]

[b] Energy requirements for aggregate (sand and stone) and hauling are computed using data from the Portland CementAssociation and assuming (*a*) the cement is hauled 50 miles to ready-mix plant; (*b*) the aggregate is hauled 10 miles to plant; (*c*) the concrete mix is hauled 5 miles to building site; and (*d*) the concrete mix is 500 lbs. cement, 1400 lbs. sand, 2000 lbs. crushed stone, and 260 lbs. water per yd3.[93]

1.2.3.2. Waste

Waste is anything that goes into a skip and ends up in landfill. For example, unused materials and off-cuts Damaged materials and products, demolition waste. Industry measures show that 13% of waste is new, unused material take steps to reduce this waste by finding a supplier who accepts returns or exchanges.[94]

Construction and demolition (C&D) materials consist of the debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. C&D materials often

[92] Wilson A. 1993. Cement and concrete: environmental considerations. *Environ. Build. News* 2(2):7–12
[93] ibidim
[94] Sustainable construction Simple ways to make it happen

contain bulky, heavy materials, such as concrete, wood, metals, glass, and salvaged building components.[95]

Exchange material what might appear of no value to you may be of value to someone else. There are many exchange schemes available

As mentioned in the East of England´s brochure, the reduction of waste can benefit local environment and economy, and even company business by:

- Reducing waste saves your business money in three ways:
    - Decreased removal and landfill taxes every tonne of waste is taxed
    - Reduced materials
    - Reduced labour costs for sorting and transporting the waste.
- Minimising waste going to landfill benefits the environment
- Efficient waste disposal and segregation helps keep your site tidy and organised and reduces the costs of mixed waste
- Transporting your own waste requires a waste carrier's licence. Sorting your waste Identify waste or demolition products, which can be reused or recycled Find local waste collection and recycling services.

Better waste management and resource efficiency

There are many important economic, environmental and legislative reasons for reducing waste and making the best use of materials that might otherwise go to landfill. These apply to every facet of the built environment - from clearing the site for a new development, to drawing up an organisation's waste management strategy.

REDUCING WASTE

Reducing waste through better product design, recycling, and re-use of materials will result in tremendous reductions in both raw material usage and also in associated environmental impacts, as well as the cost to the private sector and local governments of disposing of these materials. Building-related construction and demolition debris totals approximately 136 million tons per year in the United States, accounting for nearly 60 percent of the total non-industrial waste generation there. An estimated 20 to 30 percent of building-related construction and demolition debris is recovered for processing and recycling.

In Canada, construction, renovation, and demolition waste accounts for about 17 to 21 percent of the total mass of waste landfi lled annually.12 The volume of demolition waste in Mexico City is estimated between 3,500 and 5,000 tons a day.13 Reducing construction waste and creating reusable and recyclable building components are key strategies in addressing these environmental impacts.[96]

[95]U.S. EPA http://www3.epa.gov/epawaste/conserve/imr/cdm/index.htm

[96] 11 See <www.epa.gov/greenbuilding/pubs/gbstats.pdf>.

12 See <www3.gov.ab.ca/env/waste/aow/crd/publications/CRD_Report_All.pdf>, citing information from Statistics Canada.

13 *Soluciones para Residuos de la Construcción* <http://www.guanajuato.gob.mx/iee/expo-pdf/soluciones.pdf>.
Instituto de Ecología del Estado de Guanajuato

A regulatory framework in France

Since 2000, waste management plans have been implemented in construction and public works sector, which has made possible waste traceability in sustainable construction projects. These plans have helped improve waste sorting, traceability and permitted the implementation of "clean construction site" charters, which are gathering various stakeholders of building and civil engineering works. Based on the "Grenelle de l'Environnement and the Waste Framework Directive of 2008, ADEME (french public Agency of Environment and Energy) and ECOBATP LR have published a guide for the development and the monitoring of waste prevention and management plans in construction and public works sectors, to help County Councils, which are in charge of this question. The lack of treatment sites for non-hazardous waste and the estrangement of existing ones are a real problem for construction sites management .[97]

The figure 1.18 demonstrates how actual process works; in the base are all the materials that diverted from the landfills in the next levels, environmental technologies are implemented to control methane emissions and energy generation, in the following levels anaerobic and aerobic composting of organic waste. Finally, recycling and waste reduction best practices are marked as the most preferred.

Figure 1.18 The Hierarchy of Sustainable Waste Management developed by the Earth Engineering Center, Columbia University[98]

1.2.4. Pollution

The IEA 2010 report affirms that the main resources used to generate electricity and heat energy worldwide are non-renewable fossil fuels such as coal, gas, and oil, as well as non-renewable nuclear materials. In OECD countries, electricity generation consists of 62% generation from fossil fuels and 21% generation from nuclear materials. Heat energy is generated using 55% fossil fuels. (see figures 1.19, and 1.20)

[97] http://blog.mountee.eu/2014/04/02/waste-management-in-sustainable-renovation-projects-by-cecile-copigny/

[98] http://www.seas.columbia.edu/earth/wtert/sofos/GWMS_paper_Themelis_Oct2008.pdf

As a consequence, most communities in the developed world receive most of their electrical and heat energy from non-renewable sources. The pressing need for society to move towards sustainable energy solutions is highlighted by the fact that:

- Most electricity and heat is generated from non-renewable sources,many of which are anticipated to reach a peak of production in the next 10-90 years;
- Energy generation accounts for 26% of global anthropogenic greenhouse gas emissions,the single largest source of emissions from human activity and a major contribution to human-induced climate change;
- Energy systems are centralized and designed around non-renewable resource use, disconnecting people from their energy generation;
- Energy demand is rising globally; and
- A quarter of the world's population ,1.6 billion people currently have no access to electricity, which impacts the fulfilment of their basic human needs, and is likely to swell future energy demand.

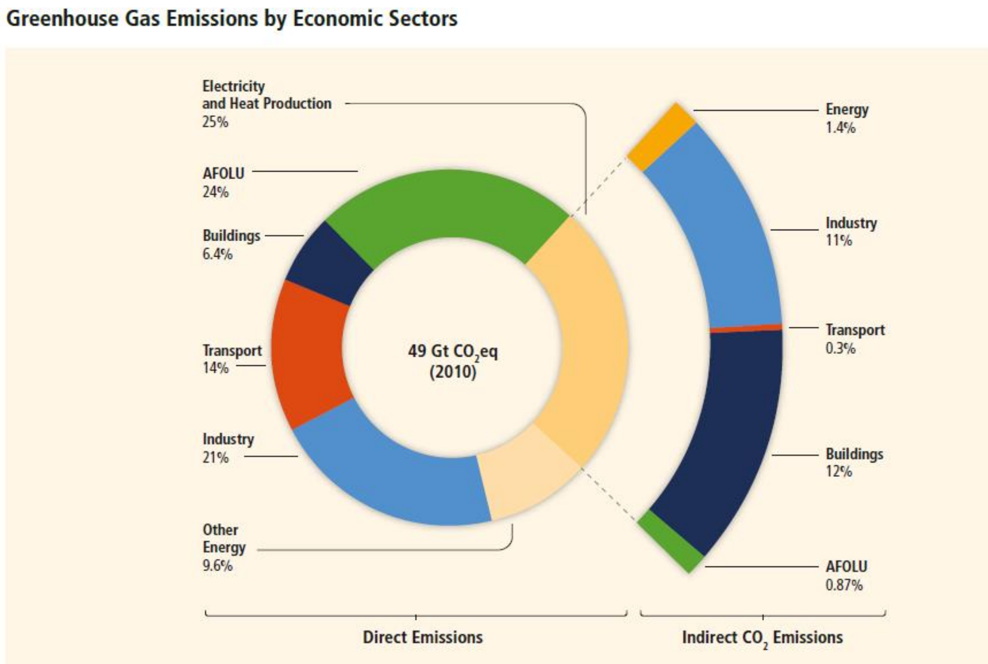


Figure 1.19 Greenhouse Gas Emissions by Economic Sectors

Total anthropogenic GHG emissions (GtCO2eq / yr) by economic sectors. Inner circle shows direct GHG emission shares (in % of total anthropogenic GHG emissions) of five economic sectors in 2010.[99]

[99] PCC, 2014: Climate Change 2014: Mitigation of Climate Change. *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: http://mitigation2014.org/report/publication/

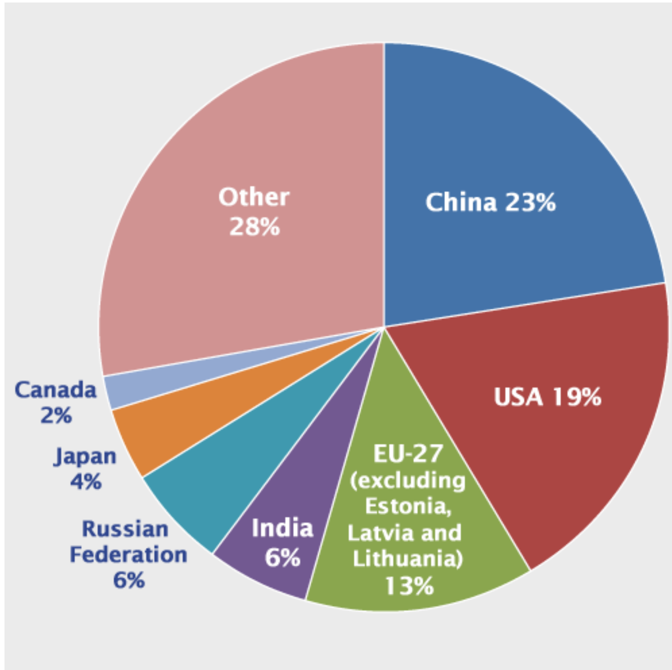


Figure 1.20 Greenhouse Gas Emissions by Country
Source: National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2008.[100]

In 2010, buildings accounted for 32 % of total global final energy use, 19 % of energy-related GHG emissions (including electricity-related), approximately one-third of black carbon emissions, and an eighth to a third of F-gases (medium evidence,medium agreement). This energy use and related emissions may double or potentially even triple by mid-century due to several key trends. A very important trend is the increased access for billions of people in developing countries to adequate housing, electricity, and improved cooking facilities. The ways in which these energy-related needs will be provided will significantly determine trends in building energy use and related emissions. In addition, population growth, migration to cities, household size changes, and increasing levels of wealth and lifestyle changes globally will all contribute to significant increases in building energy use. The substantial new construction that is taking place in developing countries represents both a significant risk and opportunity from a mitigation perspective.

Recent developments in technology and know-how enable construction and retrofitof very low and zero-energy buildings, often at little marginal investment cost, typically paying back well within the building lifetime.

In existing buildings, 50 to 90 % energy savings have been achieved throughout the world through deep retrofits. Energy efficient appliances, lighting, information communication (ICT), and media technologies can reduce the substantial increases in electricity use that are expected due to the proliferation of equipment types used and their increased ownership and use.

[100] Source: National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2008.

In developed countries, evidence indicates that behaviours informed by awareness of energy and climate issues can reduce demand by up to 20 % in the short term and 50 % of present levels by 2050.

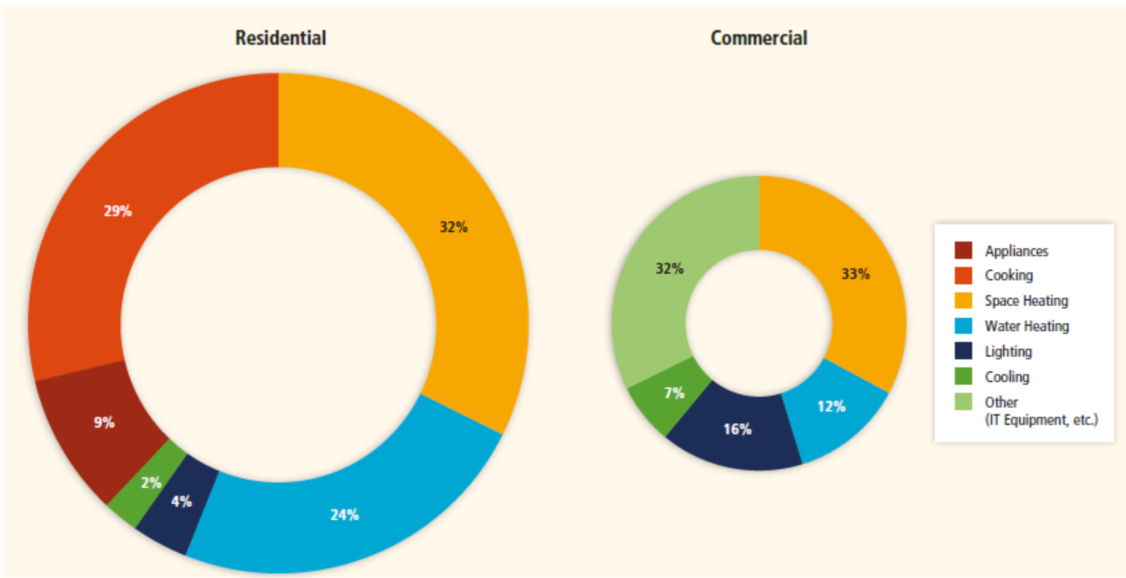


Figure 1.21 World building final energy consumption by end-use in 2010, source IEA (2013)

Buildings are sensitive to climate change, which influences energy demand and its profile. As climate warms, cooling demand increases and heating demand decreases (Day A. R., P. G. Jones, and G. G. Maidment, 2009), (Hunt A., and P. Watkiss, 2011)while passive cooling approaches become less effective (Hunt A., and P. Watkiss, 2011), (Artmann N., D. Gyalistras, H. Manz, and P. Heiselberg, 2008), (Chow D. H., and G. J. Levermore, 2010). Under a +3.7 °C scenario by 2100, the worldwide reduction in heating energy demand due to climate change may reach 34 % in 2100, while cooling demand may increase by ≥ 70 %; net energy demand could reach 6 % by 2050 and + 5 % by 2100; with significant regional differences, e. g., ≥ 20 % absolute reductions in heating demand in temperate Canada and Russia; cooling increasing by ≥ 50 % in warmer regions and even higher increases in cold regions. (Isaac M., and D. P. Van Vuuren , 2009)

Essential steps in the design of low-energy buildings are:

- Building orientation, thermal mass, and shape;
- High-performance envelope specification;
- Maximization of passive features (daylighting, heating, cooling, and ventilation);
- Efficient systems meeting remaining loads;
- Highest possible efficiencies and adequate sizing of individual energy-using devices; and
- Proper commissioning of systems and devices.

Cost savings can substantially offset additional high-performance envelope and higher-efficiency equipment costs, of around 35 - 50 % compared to standard practices of new commercial buildings (or 50 - 80 % with more advanced approaches). Retrofits can routinely achieve 25 – 70 % savings in total energy use . (Levine M., et al, 2007). (L. D. D., 2009)

Land use planning influences greenhouse gas emissions in several ways, including through the energy consumption of buildings. More compact urban form tends to reduce consumption due to lower per capita floor areas, reduced building surface to volume ratio, increased shading, and more opportunities for district heating and cooling systems (Urge-Vorsatz et al., 2012a) (Ürge-Vorsatz D., et al, 2012). Greater compactness often has tradeoffs in regions with significant cooling demand, as it tends to increase the urban heat island effect. However, the overall impact of increased compactness is to reduce GHG emissions.[101]

How much could the building sector contribute to ambitious climate change mitigation goals, and what would be the costs of such efforts?

According to the GEA "efficiency" pathway, by 2050 global heating and cooling energy use could decrease by as much as 46 % as compared to 2005, if today's best practices in construction and retrofit know-how are broadly deployed (Urge-Vorsatz et al, 2012) (Ürge-Vorsatz , Danila et al, 2012). This is despite the over 150 % increase in floor area during the same period, as well as significant increase in thermal comfort, as well as the eradication of fuel poverty (Urge-Vorsatz et al, 2012). The costs of such scenarios are also significant, but according to most models, the savings in energy costs typically more than exceed the investment costs. For instance, GEA (2012) projects an approximately 24 billion USD2010 in cumulative additional investment needs for realizing these advanced scenarios, but estimates an over 65 billion USD2010 in cumulative energy cost savings until 2050.

1.2.5. Health and Wellbeing

In 2013, WorldGBC reported on "The Business Case for Green Building". Chapter one, that stimulated a high degree of interest, highlighted some of the research which demonstrated that green buildings could enhance health, wellbeing and productivity for their occupants.[102]

"Design can deal with complex requirements in simple ways. It can create sustainable places that enhance people's health and well-being and improve service delivery."[103]

The Venn diagram below in figure 1.22 shows the interrelationship between health, well-being and sustainability, and how quality design to address one can benefit the others. Green infrastructure, planting and well thought-out public space can:

- Encourage physical activity and well-being, through exercise and growing food
- Help mitigate carbon emissions and urban heat islands
- Increase local pride, sense of safety and identification with an area.

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[101] http://unhabitat.org/on-compact-integrated-connected-cities-raf-tuts-un-habitat/
[102] Health, Wellbeing &Productivity in Offices The next chapter for green building WGBC report 2013 retrieved from: http://www.worldgbc.org/files/6314/1152/0821/WorldGBC__Health_Wellbeing__productivity_Full_Report.pdf
[103] http://webarchive.nationalarchives.gov.uk/20110118095356/http:/www.cabe.org.uk/files/future-health.pdf

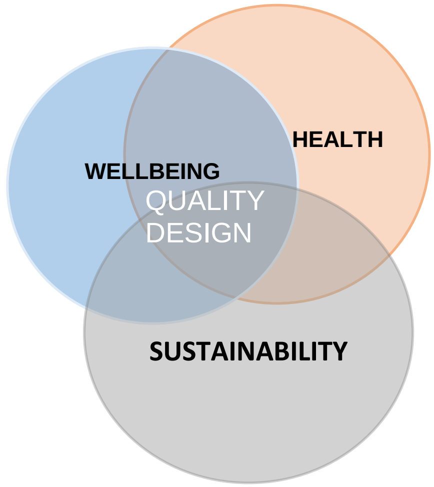

Figure 1.22. Sustainability Venn diagram
Retrieved from: http:/www.cabe.org.uk/files/future-health.pdf

"A healthy, happy workforce is a vital component of a productive, successful business in the long-term."[104]

Indoor Environmental Quality
Key Principles:
Provide a healthy, comfortable and productive indoor environment for building occupants and visitors. Provide a building design, which affords the best possible conditions in terms of indoor air quality, ventilation, and thermal comfort, access to natural ventilation and daylighting, and effective control of the acoustical environment.

Key Strategies and Technologies:

- Use building materials, adhesives, sealants, finishes and furnishings which do not contain, harbor, generate or release any particulate or gaseous contaminants including volatile organic compounds.
- Maximize the use of natural daylighting.
- Maximize the use of operable windows and natural ventilation
- Provide a smoke free building
- Design building envelope and environmental systems that not only treat air temperature and provide adequate ventilation, but which respect all of the environmental conditions which affect human thermal comfort and health, including the mean radiant temperature of interior surfaces, indoor air humidity, indoor air velocity, and indoor air temperature
- Maximize occupant health, comfort and performance by providing occupants with individual space/zone control of heat, ventilation, cooling, day-lighting and artificial lighting whenever possible.

[104] Health, Wellbeing & Productivity in Offices, World Green Building Council, 2013

- Prevent contamination of the building during construction from spreading of construction dust and dirt.
- Provide a clean and healthy building. Use biodegradable and environmentally friendly cleaning agents that do not release VOCs or other harmful agents and residue.
- Prior to occupancy install new air filters and clean any contaminated ductwork and ventilation equipment.

As showed in figure 1.23 a quality indoor environment created by implementation of physical improvements in buildings can enhance productivity, and work attitude. A healthy and safe work environment reduce cost and at the end this represents financial benefits.

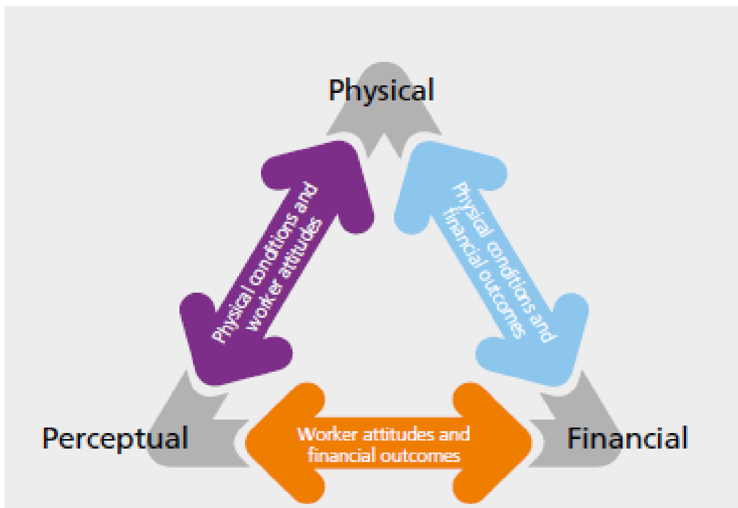

Figure 1.23 Summary of metrics framework and key relationships
Retrieved from:
http://www.worldgbc.org/files/6314/1152/0821/WorldGBC__Health_Wellbeing__productivity_Full_Report.pdf

1.2.6. Management

Setting Green Goals and Objectives…

It is important to set specific measurable goals for things like energy efficiency, water conservation, on-site treatment of rain water and storm water, material and resource management, construction waste management, and to assign responsibility for meeting these goals to specific members of the design team.

If the building is to be built in accordance with green construction standard, it will be helpful to review the requirements of that standard, and establish firm criteria for meeting those goals.

Integrated Design Process…

As stated by several authors "***Building a green building is not just a matter of assembling a collection of the latest green technologies or materials. Rather, it is a process in which every element of the design is first optimized and then the impact and interrelationship of various different elements and systems within the building and site are re-evaluated, integrated, and optimized as part of a whole building solution"***

The emphasis on integrated and optimized design is inherent in nearly every aspect of the building from site planning and use of on-site storm water management strategies to envelope design and detailing and provisions for natural ventilation of the building.

Unlike residential buildings, high-performance commercial buildings can cost less to build than standard buildings, even without simplifying the design, because the cost savings from the downsizing in mechanical and electricity equipment that is possible with a high-performance envelope can offset the extra cost of the envelope.

Benefits related to workplace productivity

Investment in low-carbon technologies related to air conditioning and wall thermal properties during construction or renovation improves workplace productivity, as evidenced by a meta-analysis of several studies (Fisk, 2002) (Kats et al, 2003) (Miller et al , 2009)). On average, energy efficient buildings may result in increased productivity by 1 – 9 % or even higher for specific activities or case studies.

The productivity gains can be attributed to:

- Reduced working days lost due to asthma and respiratory allergies
- Fewer work hours affected by flu, respiratory illnesses, depression, and stress; and
- Improved worker performance from changes in thermal comfort and lighting.
- Productivity gains can rank among the highest value co-benefits when these are monetized, especially in countries with high labour costs (GEA, 2012).

1.2.7. Ecology

Sustainable Site Design

Key Principles:

Minimize urban sprawl and needless destruction of valuable land, habitat and green space, which results from inefficient low-density development. Encourage higher density urban development, urban re-development and urban renewal, and **brownfield** development as a means to preserve valuable green space.

Preserve key environmental assets through careful examination of each site, which values, preserves and actually restores or regenerates valuable habitat, green space and associated eco-systems that are vital to sustaining life.

Key Strategies and Technologies:

- Make more efficient use of space in existing occupied buildings, renovate and re-use existing vacant buildings, sites, and associated infrastructure and consider re-development of **brownfield** sites.
- When new development is unavoidable, identify and protect valuable **Greenfield** and wetland sites from development.
- Recognize that allowing higher density development in urban areas helps to preserve green space and reduce urban sprawl.
- Evaluate each site in terms of the location and orientation of buildings and improvements in order to optimize the use of passive solar energy, natural daylighting, and natural breezes and ventilation.
- Make best use of existing mass transit systems and make buildings and sites pedestrian and bike friendly, including provisions for safe storage of bicycles. (See figure 1.25)
- Develop programs and incentives that promote car-pooling including preferred parking for commuters who carpool. Consider making provisions for re-fueling or recharging **alternative fuel vehicles**. (See figure 1.21)
- Help reduce the urban heat island effect by reducing the building and site development footprint, maximizing the use of pervious surfaces, and using light colored roofs, paving, and walkways. Provide natural shading of buildings and paved areas with trees and other landscape features.
- Reduce impervious areas by carefully evaluating parking and roadway design. Pursue variances or waivers where local ordinances may unintentionally result in the over-design of roadways or parking.
- Optimize the use of on-site storm water treatment and ground water recharge.
- Minimize the boundaries of the construction area, avoid needless compaction of existing topsoil, and provide effective sedimentation and silt control during all phases of site development and construction.
- Use landscape design to preserve and restore the region’s natural habitat and heritage while emphasizing the use of indigenous, hardy, drought resistant trees, shrubs, plants and turf.
- Reduce night-time light pollution by avoiding over-illumination.

Figure 1.24 Picture of parking lots for electric vehicles in IKEA store in Hamilton Canada (October 2015)

Figure 1.25 Bicycles in Montreal Canada (October 2015)

"Vision without action is a daydream, Action without vision is a nightmare"
(Japanese saying)

Chapter 2

2.- Understanding and implementing green standards in construction projects

2.1. Introduction to building standards

The objective of this chapter is to introduce the top green building standards that are currently been implemented around the world, as well as the software used during the designing and assessment processes.

According to the Office of the Federal Environmental Executive, "green building" is defined as:

"Increasing the efficiency with which buildings and their sites use energy, water and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal the complete building life cycle."[105]

Before we start listing the standards, it´s important to explain that given the approach of each standard to sustainability, and how these standards address to the points mentioned in chapter one in table 1.1.

First, in order to continue we need to the following classification for green building rating systems

As stated by Ali and al Nsairat Green building certification tools are based on two methodologies the multi-criteria approach and the LCA approach.

The multi-criteria tools are structured in different hierarchical groups, which have different weights on the final evaluation, based on a scoring system. Among them, the most known are the British BREEAM (Building Research Establishmemt Environmental Assessment Method) and the American LEED (Leadership in Energy and Environmental Design) .[106] (Ali and al Nsairat, 2009).

The LCA systems including issues dealing with energy and material flow regarding to the inventory-oriented and/or impact oriented results of an analysis of energy and mass flows within building´s life cycle, including an examination of risks for the environment.

Other Authors classified them according to the approach in the following groups:[107]

1. Cumulative energy demand (CED) systems, which focus on energy consumption
2. Life cycle analysis (LCA) systems, which focus on environmental aspects
3. Total quality assessment (TQA) systems, which evaluate ecological, economic and social aspects (Berardi U. , 2011).[108]

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[105] Evaluating the Diffusion of GreenBuilding Practices, Benjamin Cryer, Jeffrey Felder,200&(http://www.worldcat.org/title/evaluating-the-diffusion-of-green-building-practices/oclc/86705809)
[106] http://www.mdpi.com/2071-1050/7/8/10324/htm
[107] Philipp Redl Master Thesis Sustainable Building Certification –The Case of Hotel Buildings (2013)
[108] http://onlinelibrary.wiley.com/doi/10.1002/sd.532/epdf

According to regional regulations, each regulation either can be Voluntary, or Mandatory and a mix of both[109]

Second, we need to define to define the following concepts:

Codes are laws that outline legal requirements that must be met and are made up of mandatory provisions that become enforceable when adopted by statute or ordinance. **Building codes** are regulations, technical provisions, and referenced standards establishing minimum requirements for the construction, alteration, maintenance and demolition of buildings.[110]

Codes are typically enacted by ordinances or laws adopted by local, regional, state, or tribal governments. Most of building codes were designed to protect human health and safety primarily from physical hazards, as well as to protect property and structures from fire, weather, and seismic events.[111]

Common **standards** related to building practices are created through consensus processes by organizations such as ANSI, ASTM, or ASHRAE. ISO defines a **standard** as ***"A document, established by consensus, approved by a recognized body that provides for common and repeated use as rules, guidelines, or characteristics for activities or their results."***[112]

A **certification** is a confirmation that a product meets defined criteria of a standard. ISO defines **certification** as ***"Any activity concerned with determining directly or indirectly that relevant requirements are fulfilled."***[113]

Perhaps, start working with Green building rating systems can even modify the design-construction process of companies, at this regard it will be important to determine all factors and risks that are involved in each of the phases of construction project, and how the staff of the company and specialists interact during the life cycle of the building as showed in figure 2.1.

[109] See Toronto Green Standard in Chapter three http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f85552cc66061410VgnVCM10000071d60f89RCRD
[110] http://www3.epa.gov/region9/greenbuilding/codes/contents.html
[111] IDEM
[112] http://www.etsi.org/standards/what-are-standards
[113] https://www.wbdg.org/resources/gbs.php

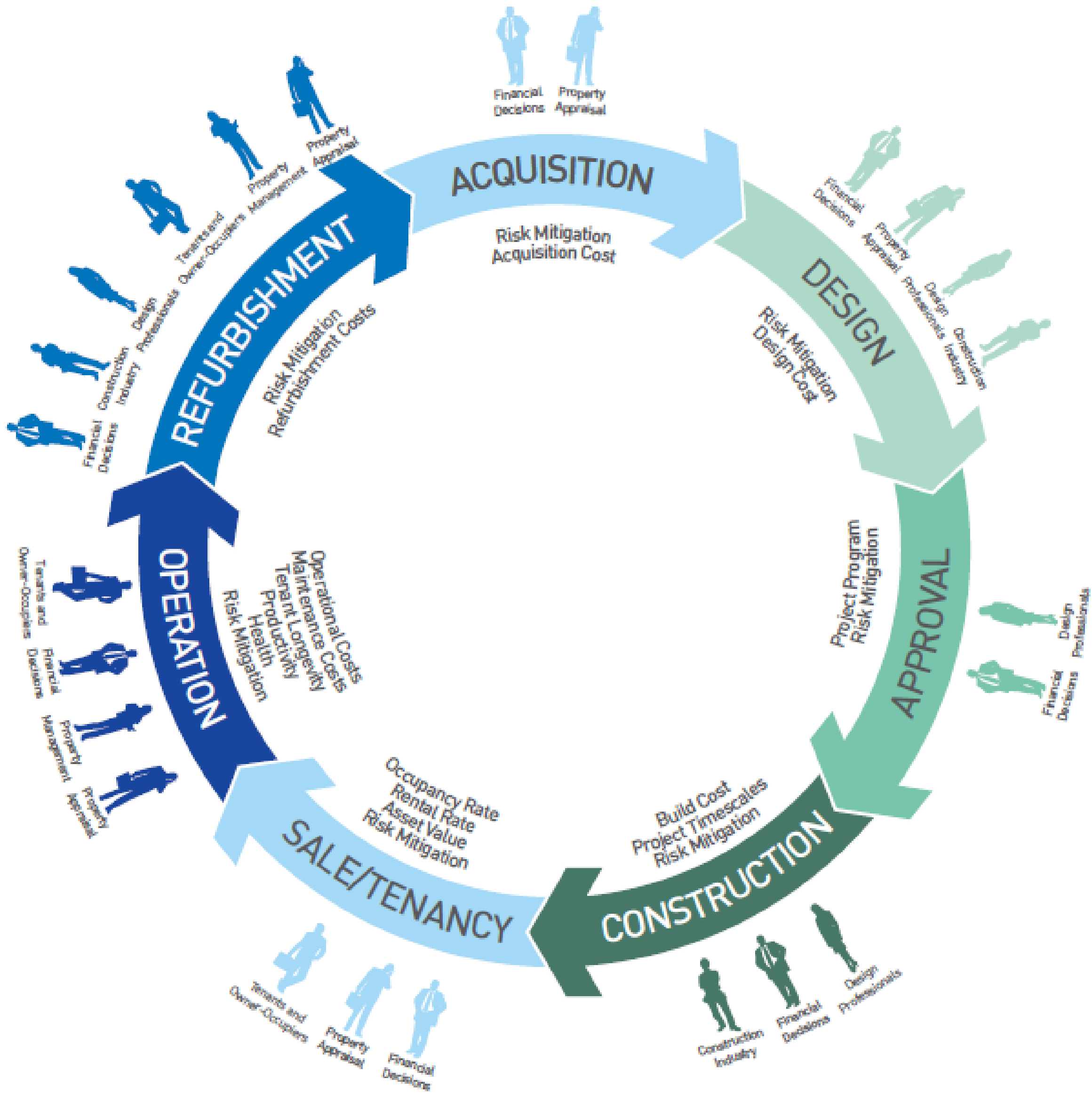

Figure 2.1. The business case for green Building council, A Review of the Costs and Benefits for Developers, Investors and Occupants (2013).[114]

In the past, projects used to be limited from Designing to Construction phases, the cost –benefit assessment, and hardly evaluated the operation and maintenance fees. Today, it is not only important to incorporate both to the assessment equation, but also include environmental and risk aspects.

Over the years, there has been a particular focus on the development of environmental assessment tools for the construction sector, catering either for different building types or generic developments. Most are designated for particular countries as showed in table 2.1 all of them mix environmental criteria, and socio-economic impacts. (Appleby, 2011)

[114] http://www.worldgbc.org/files/1513/6608/0674/Business_Case_For_Green_Building_Report_WEB_2013-04-11.pdf

Rating system	Country	Launch date	Personal Comments and official websites
BREEAM (England) Building Research Establishment Environmental Assessment Method	UK	1990	The ratings aim to demonstrate how environmentally sustainable a building is. and stimulate the demand of sustainable buildings, now a voluntary initiative in the private sector and compulsory in the public sector. http://www.breeam.com/new-construction
Breeam Communities	UK	2012	This standard was developed to find sustainable ways of addressing 21st century challenges urbanisation, climate change etc.- and it covers economic, social and environmental sustainability, assessing all the components of a community (An introduction for international use BREEAM Communities 2012, 2012) http://www.breeam.com/masterplanning
LEED or Leadership in Energy and Environmental Design	USA	1993	It is a voluntary point-based sustainability assessment program for building projects. http://www.usgbc.org/leed LEED V4 (Last version) http://www.usgbc.org/v4
National Green Building Standard™ (NGBS)	USA	2008	It´s a tool that includes home building guidelines and green scoring calculator to rate the design of new and refurbished dwellings. http://www.nahb.org/en/research/nahb-priorities/green-building-remodeling-and-development.aspx
Plan Bâtiment Durable /HQE or Haute Qualité Environnementale (High Quality Standard)	France	1996/2005.	This rating system is focused on: Manage the impacts on the outdoor environmental impact Create a pleasant indoor environment http://www.planbatimentdurable.fr/la-valeur-verte-dans-l-immobilier-a757.html
DGNB (Deutsche Gesellschaft für Nachaltiges Bauen or German Sustainable Building Council)	Germany	2009	This tool focuses on around 50 criteria ranging from environmental, economic, technological and work process aspects to sociocultural and functional dimensions.[115] http://www.dgnb-system.de/en/system/certification_system/

[115] http://www.knaufinsulation.com/en/sustainable-buildings-and-green-building-rating-systems

National Association of Home Builders	USA	2008	The ICC 700 National Green Building Standard™ (NGBS) is the first residential green building standard to undergo the full consensus process and receive approval from the American National Standards Institute (ANSI). http://www.nahb.org/en/research/nahb-priorities/green-building-remodeling-and-development/green-home-satisfaction-survey-report.aspx
Green Globes	Canada /USA		Green Globes grew out of a version of BREEAM that was developed for existing buildings in Canada by BRE, and now is controlled by the Green Building Initiative, including a version for new buildings. http://www.thegbi.org/green-globes-certification/
BOMA Best (Building Owners and Managers Association)	Canada /USA	2005	The Green Globes for existing buildings transformed to BOMA, and BOMA standards are available for office buildings, shopping centres, open retail and light industrial units. http://www.bomabest.com/
PassiveHouse Certification (Germany)	Germany	1992	Passive design is architectural design that eliminates the need for mechanical heating and cooling of a building through the use of smart, time-tested heating and cooling strategies such as natural ventilation, solar heat gain and solar shading and efficient insulation. http://www.passiv.de/en/03_certification/03_certification.htm http://www.passivhaushomes.co.uk/passivhaushistory.html
EnergyStar	USA	1992	First established in 1992 as a voluntary labeling program, Energy Star is a widely recognized government-run product certification label for energy efficient products. Energy Star-certified products include appliances, heating and cooling equipment, lighting, home electronics, commercial roofing, and office equipment. http://www.energystar.gov/

CASBEE Comprenhensive Assessment System for Built Environmental Efficiency	Japan	2001	The family of assessment tools is based on the building's life cycle: pre-design, new construction, existing buildings, and renovation. CASBEE presents a new concept for assessment that distinguishes environmental load from quality of building performance. CASBEE results are presented as a measure of eco-efficiency or Building Environmental http://www.ibec.or.jp/CASBEE/english/
STARS (Academic Institutions)	USA / CANADA	2001	The Sustainability Tracking, Assessment & Rating System (STARS) is a transparent, self-reporting framework for colleges and universities to measure their sustainability performance. STARS was developed by the Association for the Advancement of Sustainability in Higher Education (AASHE) with broad participation from the higher education community. https://stars.aashe.org/
Eco-cycle	(Sweden)	1995	It is an approach to urban design focused in three areas water, energy, and waste. https://sweden.se/nature/sustainable-living/ http://cal.abe.kth.se/uploads/Reports/Eco-cyclemodel2.0.pdf
NABERS ((National Australian Built Environment Rating System))	Australia	1998	It´s a permance-based rating system for existing offices, homes hotels, and retail buildings using measured operational parameters. http://www.nabers.gov.au/public/WebPages/Home.aspx

Table 2.1 World green building rating systems review

According to the World Green Building Trend´s Report of 2013 it was expected that in 2015 more than 60% of construction firms will have certain level of green building activity; the figures 2.2 and 2.3 show some outcomes from this report. The report also states that green building is no longer a niche part of construction around the world. It has become a way in an ever-increasing number of firms are designing, constructing, and improving buildings around the world[116]

[116] World Green Building Trend´s Report of 2013 retrieved from: http://www.worldgbc.org/files/8613/6295/6420/World_Green_Building_Trends_SmartMarket_Report_2013.pdf

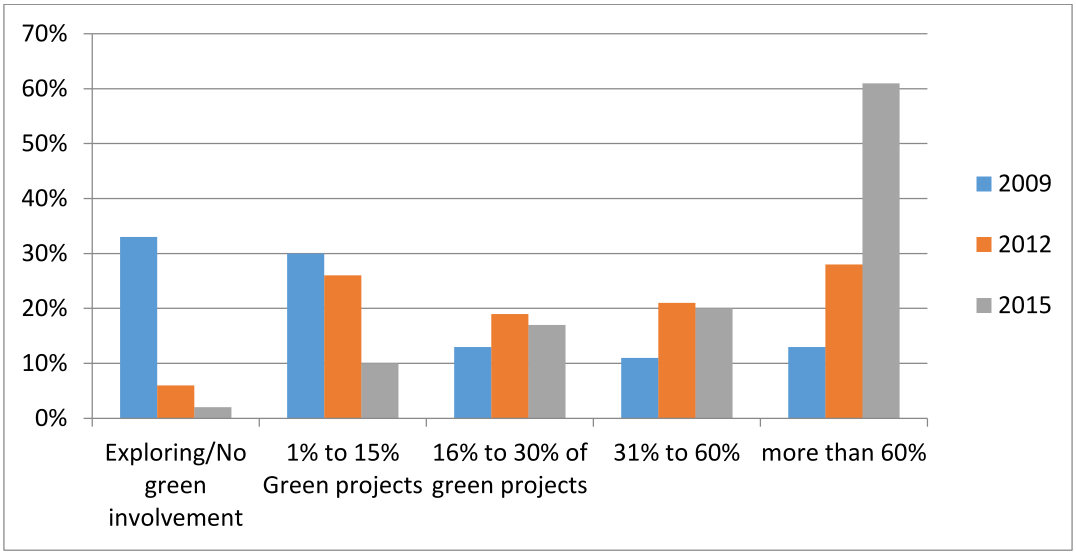

Figure 2.2 Levels of Green Building Activity by firms around the world Source : Smart Market Repor McGrawhill Construction, 2013[117]

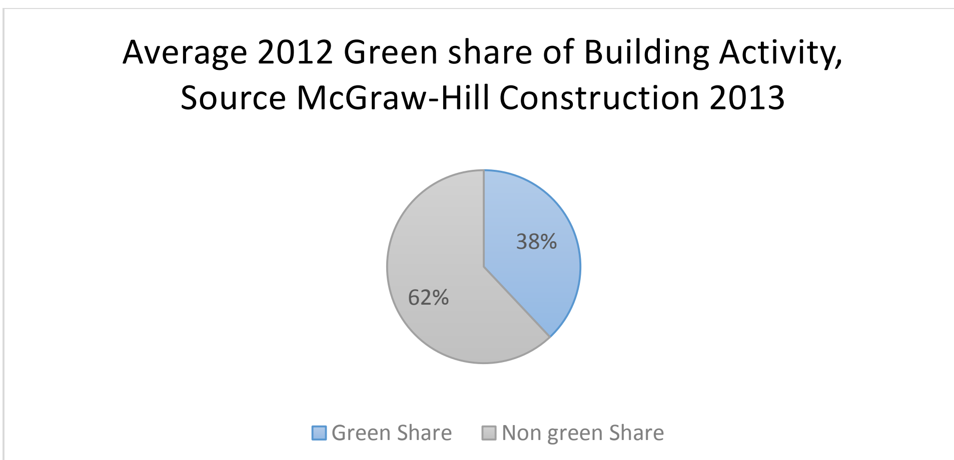

Figure 2.3 Green share of building construction
Source : Smart Market Repor McGrawhill Construction, 2013

Project types can be divided as follows:[118]

- New Construction
- Reconstruction
- Renovation
- Alteration

[117] idem
[118] Source: NJ Green Buildings Manual

Screening Analysis of Rating Systems

Although, most of rating systems pursuit the same objectives and have similar categories, many of them cannot fit the sustainable building needs. For this reason is important to evaluate each, before taking a decision.

First, it is important to create a questionnaire in order to fulfill the criteria of client's requirements, and local regulations.

The screening criteria can include:

- Relevance: Does the rating system provide a "whole building evaluation "rather than an evaluation of an individual design feature?
- Measurable: Does the rating system use measurable characteristics to demonstrate the extent of sustainable design incorporated into the building?
- Applicability: Can the rating system be used in the project?
- Availability: Is the rating system easily adaptable to the project?

There are so many factors to take into account in the decision making process. In order to achieve all the projects requirements, it will be possible that more than one rating system will be follow for the same project to accomplish all of them.

The drivers for Green Building certifications are: [119]

Legislative Requirements
There are a number of policies at national/federal, provincial/state and municipal levels around the world that mandate minimum certification requirements for new construction, significant renovations or additions.

Federal or regional mandatory disclosure requirements for estimated energy and/or water consumption.
Municipal requirements of a minimum standard of achievement for Building Permit application.

Eco-districts where building permits or site plans will not be approved without a commitment to achieve a particular rating or its equivalent.

Investor, Owner or Tenant Requirements
Several investors, property owners and developers have corporate sustainability mandates to only build or hold as equity sustainable buildings. Similarly, many tenants have corporate sustainability mandates or Green Lease policies to only move into certified space. These mandates often set project requirements high above any legislated minimum requirements.

[119] INTERNATIONAL SUSTAINABILITY SYSTEMS COMPARISON Key International Sustainability Systems: Energy and Water Conservation Requirements , Prepared for CoreNet Global by Ove Arup & Partners Ltd. | March 2014

Building Economics
The economic driver is particularly strong and it is critical to understand how the selection of an appropriate certification target can decrease the life cycle cost of the building in several ways, including the following:

- Reduced energy consumption from improved efficiency of equipment and systems and overall space planning to minimize dependence on artificial lighting and mechanical ventilation, heating and cooling
- Reduced water consumption (particularly hot water, which further reduces energy through the use of low-flow fixtures and decreased irrigation and non-potable uses
- Improved system performance confirmed through a rigorous commissioning process
- Improved controls to minimize the use of equipment when not required, decreasing both energy and water consumption while also increasing the equipment life
- Improved system documentation and monitoring to allow trending of data to quickly identify equipment failure, leaks or other sources of waste

Market Dynamics
There are commercial benefits to achieving certification in several real estate markets. These certifications facilitate a common language in the industry for marketing and competitive advantage recognition purposes. Further, in many markets, increased certification above the norm commonly results in improved absorption and increased rental rates.

Incentives
There are many of incentive programs available globally and each building will be eligible for a particular subset of these incentives based on its location, size, context and type. Typically, incentives are offered by federal or provincial/state government agencies, utility providers and municipal bodies. Some examples of each:

- Zoning exemptions. For example, Hong Kong and Singapore both grant permission to developers to build additional gross floor area beyond that which is allowed by zoning by-laws if a minimum certification level is achieved.

- Rebates on energy-efficient or water-conserving equipment or fixtures. For example, Austin Energy (Texas) provides a rebate for new chillers and other equipment based on both peak demand and first-year annual energy savings compared with the code baseline.

- Tax benefits. For example, the Government of Canada has created a specific depreciation class for renewable power generation equipment to improve payback periods.

Risk Management (see figure 2.1)

Sustainability rating system credits are earned by providing several features that decrease risk for the building owner/landlord. These include:

- Fundamental and enhanced commissioning requirements that insure that the building is in working order at handover

- Handover documentation requirements to provide the facility manager with all documentation required to properly operate and maintain the building (often included in commissioning)
- Monitoring and verification systems to allow real-time tracking of energy and water consumption and alert the facility manager to equipment malfunction, leaks or sources of waste
- Decreased reliance on conventional energy sources through on-site generation, which improves resilience of the facility in case of power outages
- Incorporation of passive design elements to reduce energy consumption and limit the impact of future energy cost increases

2.2. International Rating Systems

The goal of most of the certification schemes is to ensure safety or quality, help those who do not have the skills or knowledge to assess this. It can also be to make things more efficient: due to certification it is not necessary to do the same assessment for everybody again and again. Certification systems can ensure that materials etc. have the necessary qualities, and people have the skills needed. But this is only guaranteed if the system is focused on what is the most important, and is able to measure and evaluate this in an efficient way. There is a tendency to focus on factors that are easy to measure, and they are not necessarily the most important.[120]

As mentioned in chapter one, today no one can deny the important role of green building construction figures 2.4, and 2.5 demonstrates the prevalence of these types of certifications around the world.

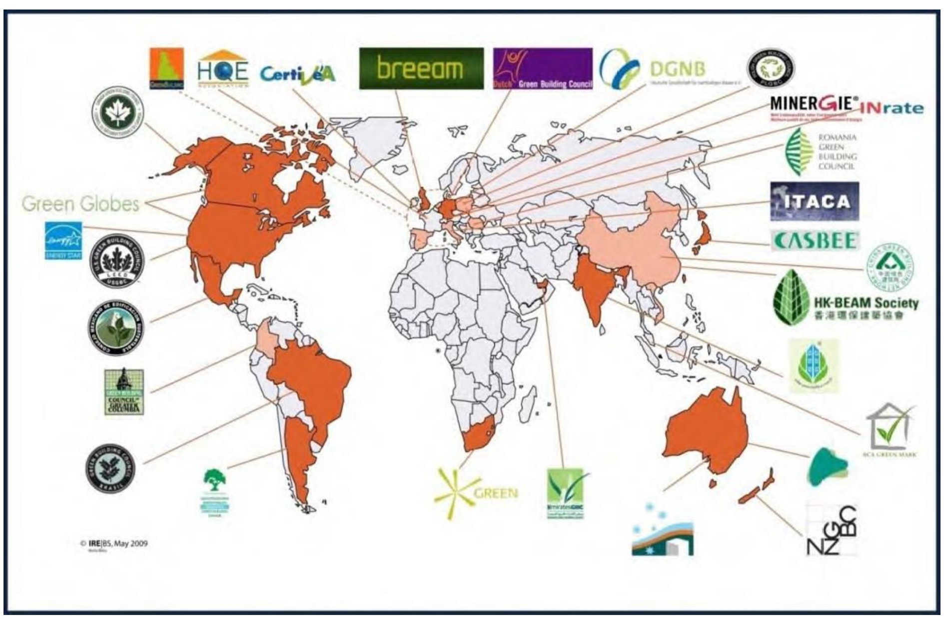

Figure 2.4 World rating programs retrieved from:
http://www.prres.net/Proceedings/..%5CPapers%5CReed_International_Rating_Tools.pdf

[120] https://www.ntnu.no/wiki/download/attachments/39650028/GetFileVeg.pdf?version=1&modificationDate=1324451439000

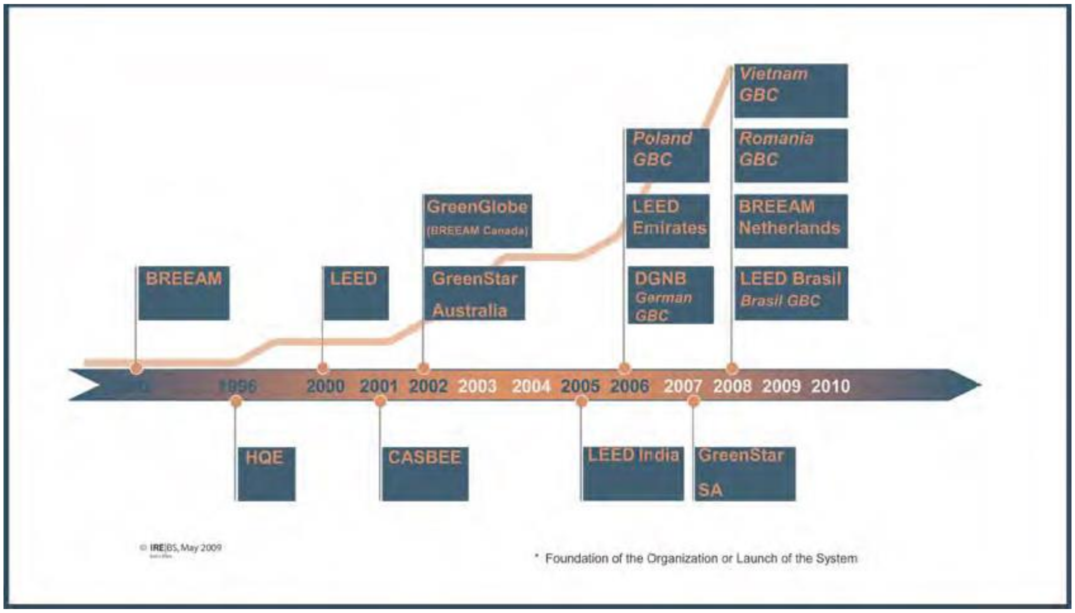

Figure 2.5 Timeline of the Development of Rating Tools [121]

2.2.1. LEED STANDARDS

LEED stands for Leadership in Energy and Environmental Design. It´s an independent, third party verification rating system that provides a method of standardization and oversight for environmental performance designed for new and existing commercial, institutional and residential buildings. Performance focuses on human and environmental health in five key areas including sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality.[122]

Historical highlights:

1998: USGBC launched first pilot - LEED version 1.0 in August
2000: USGBC launched LEED Green Building Rating System version 2.0
2007: LEED rating system release of version 3.0
2009: USGBC launches LEED-Neighborhood Design (ND) integrating principles of smart growth, urbanism and green building
2014: LEED rating system release of version 4.0

LEED is global. Today, LEED is used in more than 135 countries.[123]

[121] http://www.prres.net/Proceedings/..%5CPapers%5CReed_International_Rating_Tools.pdf
[122] Please consult with the USGBC (https://new.usgbc.org/) for further information.
[123] LEED V4 GUIDE PDF

LEED has become the dominant sustainability ratings system globally and is the most commonly used system in the USA, Canada, Mexico, Central and South America and India. It is widely used in China and the Gulf region as well as most of Europe (particularly Western Europe).[124]***In the past LEED has been subject to criticism over the years for the lack of greater integration of LCA , and that a building did not necessarily have to be energy efficient to receive certification.*** (Reeder, 2010)

Rating awarded:
Certified: 40 to 49 points, Silver: 50 to 59 points, Gold: 60 to 79 points, Platinum: 80 to 110

LEED v4 consists of 21 rating systems designed to address a diverse range of building types. Related rating systems are grouped together under the umbrellas of four LEED categories: [125][126]

Building Design and Construction (BD+C)
Interior Design and Construction (ID+C)
Building Operations and Maintenance (O+M)
Homes Design and Construction (Homes and Multifamily Lowrise/ Multifamily Midrise)

2.2.1.1. **Building Design and Construction (BD+C)**

LEED for New Construction and Major Renovations is a rating system for buildings that was designed to guide and distinguish high performance buildings that have less of an impact on the environment, are healthier for those who work and/or live in the building, and are more profitable than their conventional counterparts are. Buildings that are new construction or major renovation. In addition, at least 60% of the project's gross floor area must be complete by the time of certification (except for LEED BD+C: Core and Shell).

LEED BD+C: New Construction
New construction or major renovation of buildings that do not primarily serve K-12 educational, retail, data centers, warehouses and distribution centers, hospitality, or healthcare uses. New construction also includes high-rise residential buildings 9 stories or more.
LEED BD+C: Core and Shell

Buildings that are new construction or major renovation for the exterior shell and core mechanical, electrical, and plumbing units, but not a complete interior fit-out. LEED BD+C: Core and Shell is the appropriate rating system to use if more than 40% of the gross floor area is incomplete at the time of certification

As a marketing tool LEED for Core & Shell offers a precertification designation to registered projects to recognize the developer´s intent to construct a certified building. (Reeder, 2010)

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[124] INTERNATIONAL SUSTAINABILITY SYSTEMS COMPARISON Key International Sustainability Systems: Energy and Water Conservation Requirements , Prepared for CoreNet Global by Ove Arup & Partners Ltd. | March 2014
125 SUPPLEMENTAL REVIEW OF USGBC'S LEED V4 SYSTEMS: BD+C: NC, O+M: EB AND ID+C: CI
PREPARED FOR: THE U.S. GENERAL SERVICES ADMINISTRATION OFFICE OF GOVERNMENT-WIDE POLICY OFFICE OF FEDERAL HIGH-PERFORMANCE GREEN BUILDINGS . |August 2014
[126] http://www.cabrillo.edu/~msoik/3/LEED%20v4%20guide.pdf

LEED BD+C: Schools
Buildings made up of core and ancillary learning spaces on K- 12 school grounds. LEED BD+C: Schools may optionally be used for higher education and non-academic buildings on school campuses.

LEED BD+C: Retail
Buildings used to conduct the retail sale of consumer product goods. Includes both direct customer service areas (showroom) and preparation or storage areas that support customer service.

LEED BD+C: Data Centers
Buildings specifically designed and equipped to meet the needs of high-density computing equipment such as server racks, used for data storage and processing. LEED BD+C: Data Centers only addresses whole building data centers (greater than 60%).

LEED BD+C: Warehouses and Distribution Centers
Buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings, such as self-storage

LEED BD+C: Hospitality
Buildings dedicated to hotels, motels, inns, or other businesses within the service industry that provide transitional or short-term lodging with or without food.

LEED BD+C: Healthcare
Buildings that serve individuals who seek medical treatment, including licensed and federal inpatient care facilities, licensed and federal outpatient care facilities, and licensed and federal long-term care facilities. May optionally be used for buildings with other kinds of medically-related uses, such as unlicensed outpatient facilities, medical, dental and veterinary offices and clinics, assisted living facilities and medical education & research centers

LEED BD+C: Homes and Multifamily Lowrise.
Single-family homes and multifamily residential buildings of 1 to 3 stories. Projects 3 to 5 stories may choose the Homes rating system that corresponds to the ENERGY STAR program in which they are participating.

LEED BD+C: Multifamily Midrise.
Multi-family residential buildings of 4 to 8 occupiable stories above grade. The building must have 50% or more residential space. Buildings near 8 stories can inquire with USGBC about using Midrise or New Construction, if appropriate.

2.2.1.2. **Green Interior Design and Construction**

Interior spaces that are a complete interior fit-out. In addition, at least 60% of the project’s gross floor area must be complete by the time of certification.

LEED ID+C: Commercial Interiors Interior spaces dedicated to functions other than retail or hospitality.

LEED ID+C: Retail Interior spaces used to conduct the retail sale of consumer product goods. Includes both direct customer service areas (showroom) and preparation or storage areas that support customer service.

LEED ID+C: Hospitality Interior spaces dedicated to hotels, motels, inns, or other businesses within the service industry that provide transitional or short-term lodging with or without food.

2.2.1.3. **Green Building Operations and Maintenance** [127]

Existing buildings that are undergoing improvement work or little to no construction.

The Credit structure of LEED for building Operations and Maintenance

For existing buildings pursuing LEED certification, the establishment period is the time when building infrastructure is assessed, policies are drafted, and programs and processes are put in place to enable ongoing performance measurement. The performance period is the continuous implementation of the strategies set during the establishment period.

Establishment requirements fall into two categories of credits, those based on building components and site infrastructure and those based on policies and plans:

- Building components and site infrastructure are the characteristics and systems of the building.
- Policies and plans are statements that set goals and outline the implementation of operational management strategies.

Buildings that are fully operational and occupied for at least one year. The project may be undergoing improvement work or little to no construction. Must include the entire building's gross floor area in the project.

LEED O+M: Existing Buildings. Existing buildings that do not primarily serve K-12 educational, retail, data centers, warehouses and distribution centers, or hospitality uses.

LEED O+M: Retail. Existing buildings used to conduct the retail sale of consumer product goods. Includes both direct customer service areas (showroom) and preparation or storage areas that support customer service.

LEED O+M: Schools. Existing buildings made up of core and ancillary learning spaces on K-12 school grounds. May also be used for higher education and nonacademic buildings on school campuses.

LEED O+M: Hospitality. Existing buildings dedicated to hotels, motels, inns, or other businesses within the service industry that provide transitional or short-term lodging with or without food.

LEED O+M: **Data Centers.** Existing buildings specifically designed and equipped to meet the needs of high density computing equipment such as server racks, used for data storage and processing. LEED O+M: Data Centers only addresses whole building data centers.

LEED O+M: **Warehouses & Distribution Centers.** Existing buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as self-storage).

[127] http://www.usgbc.org/articles/rating-system-selection-guidance

2.2.1.4. **LEED for Neighborhood Development**

New land development projects or redevelopment projects containing residential uses, nonresidential uses, or a mix. Projects may be at any stage of the development process, from conceptual planning through construction. It is recommended that at least 50% of total building floor area be new construction or major renovation. Buildings within the project and features in the public realm are evaluated.

- **LEED ND: Plan**. Projects in conceptual planning or master planning phases, or under construction.
- **LEED ND: Built Project.** Completed development projects.

LEED-ND was developed primarily for application insituations where private developers pursuing environmentally principles to obtain a green stamp for their projects. This standard can be useful for land development, urban and community planning. It can be used to integrate several urban topics like:[128]

Smart Growth Housing and affordability Transportation
Sustainable and livable cities Environmental Advocacy Natural resource Protection
Climate Change and action Equity
Social Justice Public Health Land use

LEED-ND rating System is organized into three basic sections:

- **Smart Location and Linkage (SLL)** Where to build?

Elements:

Location, Ecosystems and open spaces, contaminated sites, Transit-Accesible locations, Ciclyng Facilities, Jobs and Housing Proximity.

- **Neighborhood Pattern and Design (NPD)** What to build?

Elements:

Walkable Streets, Compact Development, Neighborhood Connections, Mixed Uses, Affordable and Diverse Housing, Parking and Transportation Demand, Parks and Recreation, Universal Design, Community Participation, Local Food, School Access and Design.

- **Green Infrastructure and Building (GIB)** How to manage environmental impacts?

Elements:

Construction Techniques, Energy Efficiency and Conservation, Energy Production and Distribution, Water Efficiciency and Conservation, Stormwater and Wastewater, Green Building Proces, Historic and Existing Building Reuse, Heat Islands, Recycling and Reuse, Light Pollution

[128] https://www.nrdc.org/sites/default/files/citizens_guide_LEED-ND.pdf

2.2.1.5. **LEED in Motion Residential**[129][130]

The LEED in Motion report series provides a holistic snapshot of the green building movement, equipping readers with the numbers and insight they need to build a strong case for sustainability. The first of three reports, LEED in Motion: People and Progress examines the USGBC and green building communities: the individuals who are driving green building, practicing it and benefitting from it. The remaining two LEED in Motion reports: Places and Policies and Impacts and Innovation. LEED in Motion: Canada, a report that highlights the strong growth and innovation that is taking place in Canada's green building sector. As the first country to adopt LEED outside of the United States, the Canadian building industry embraced the LEED rating system early on and created what is now a strong base of over 2,200 LEED certified projects across the country.

The LEED V4 guide propose a rule for choosing between rating systems

The 40/60 rule provides guidance for making a decision when several rating systems appear to be appropriate for a project. To use this rule, first assign a rating system to each square foot or square meter of the building. Then, choose the most appropriate rating system based on the resulting percentages.

It´s important to take into account that the entire gross floor area of a LEED project must be certified under a single rating system and is subject to all prerequisites and attempted credits in that rating system, regardless of mixed construction or space usage type.[131]

40 % **(Should not use the rating system)**	**60 %** (Project team´s choice)	**100 %** **(Should use the rating system)**

Table 2.2 Percentage of floor area appropriate for a particular rating system

As mentioned in the beginning of this section, one of the critics of LEED was that in the past LCA wasn´t included. In this version LEED V4 include in the Material and Resources the following credits to encompass this topic:

Building Life Cycle Impact Reduction that cover the following points:[132]

Credit is a combination of “Building Reuse—Maintain Existing Walls, Floors, and Roof” and “Building Reuse—Maintain Interior Nonstructural Elements”.

- Added options for the reuse of historic and blighted buildings.
- Added option for a whole building life-cycle assessment of the project’s structure and enclosure.
- Building Product Disclosure and Optimization—Environmental Product Declarations

[129] LEED in Motion report from the U.S. Green Building Council (USGBC)
[130] http://issuu.com/usgbc/docs/leed_in_canada
[131] IDEM 19
[132] IDEM 19

- Addresses transparency in environmental life-cycle impacts and selecting products with improved life-cycles.
- Structured into disclosure and optimization options.
- Rewards the use of products with Environmental Product Declarations.
- Rewards products that meet the local products criteria.

Building Product Disclosure and Optimization—Material Ingredient Reporting

- Addresses transparency in material ingredients and selecting products with optimized ingredients.
- Structured into disclosure and optimization options.
- Rewards the use of products with ingredient reporting in programs like Health Product Declaration, Cradle 2 Cradle, and others.
- Rewards products that meet the local products criteria.
- Third option for supply chain optimization.

Fees [133]

During the beta period, previously registered LEED projects can switch to LEED v4 at no additional cost. For newly registering projects, please refer to Certification Fees for rates, shown below. Once enrollment form is submitted and registration fee paid, beta projects will be assigned a designated project support staff member from USGBC. LEED v4 beta projects will be expected to remit certification fee prior submitting for certification.(See table 2.3)

	Project Gross Floor Area in Sq Ft (excluding all parking areas)		
Registration	Less than 50,000	50,000- 500,000	More than 500,000
USGBC members	$900		
Non-members	$1,200		

Table 2.3 LEED for BD+C, ID+C, and O+M Registration Rates in the USA
retrieved from: http://www.usgbc.org/cert-guide/fees

"But LEED and green building so far have very little in common. In fact anyone who uses LEED as proof of their green building kudos is either a newbie wannabe or a marketing agent wanting to sell you something (and it aint green building)" [134]

I would like to conclude this section by introducing the following comments.

The point system awarded the same number of points for a simple bike rack as it gave for an advanced heating/cooling system. Naturally, developers went for the cheaper bike rack, and gamed the system to earn just enough points to win LEED certification. This is a limitation of point systems, since them don´t have a follow up to confirm the expecteded environmental impacts reduction.

Finally, quote Frank Gehry, the Pritzker Prize-winning architect at this regard **"Maybe you need the point system to energize this type of building, but I'm not sure it's necessary. The best way would be a political initiative that requires people to address these issues in order to get a building permit. Then the government can incentivize sustainable building through subsidies and various other things. But this is a global issue, so you need programs that not only we agree on but also that the Russians and the Chinese agree on"**[135]

[133] http://www.usgbc.org/cert-guide/fees
[134] http://ecobrooklyn.com/review-critique-leed/
[135] http://www.pbs.org/wnet/need-to-know/culture/architect-frank-gehry-talks-leed-and-the-future-of-green-building/1458/

2.2.2. Passive House Certification (Germany)/(England)

The Passivhaus standard originated from collaboration in 1988 between Professors Bo Adamson of Lund University, Sweden and Wolfgang Feist of the Institute for Housing and the Environment, Germany. The first Passivhaus home was built in Darmstadt in 1991, and a period of monitoring and evaluation, validated the standard, which was designed to achieve an energy consumption of only 10% of the standard house of the day. The Passivhaus Institut (PHI) was founded in 1996 to promote and control the standard, and to develop and distribute the PHPP spreadsheet. The Passivhaus Institut also defines and controls the associated quality assurance process.

"Passive Houses" were defined as buildings which have an extremely small heating energy demand even in the Central European climate and therefore need no active heating. Such houses can be kept warm "passively", solely by using the existing internal heat sources and the solar energy entering through the windows as well as by the minimal heating of incoming fresh air.[136]

The pioneering products that had been used in the Darmstadt house (See figures 2.6 and 2.7) , notably triple glazed windows and high-efficiency mechanical ventilation systems, started a new supply chain of Passivhaus compliant components.[137][138]

In 2006, the UK Government announced that from 2016 all new build dwellings would have zero in-use carbon dioxide emissions, with non-domestic buildings following from 2019. Today house builders, developers and social housing providers continue exploring ways of reducing the energy consumption in their projects.[139]

"The principle behind a Passive House is based on the concept by Amory Lovins[140][141] ***of reducing investment through energy efficient design. By dramatically increasing the energy efficiency of a building, the HVAC systems can be radically simplified upon reaching a certain level of efficiency. Consider the example of building a house for a cold climate. The heat demand for heating the house in the cold season is the major energy consuming service. If the heat demand is reduced by means of insulation, heat recovery, super windows, passive solar gains and other measures, the heating system can be simplified step-by-step. But the most significant threshold appears when the peak heating load reaches 10 W/m². When the peak heating load is less than 10 W/m², independent of climate, the ventilation system can easily be used for space heating, and a separate heating system is no longer required."*** (Feist D. W., 2010)

Passive Houses are buildings in which comfortable indoor conditions can be achieved throughout the year with minimum energy input. Passive Houses must meet very stringent requirements regarding both their design and construction. Passive Houses are certified based on a thorough quality check of their design. The certification criteria that apply for non-residential buildings are described below in table 2.4 : [142][143]

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136 http://www.passipedia.org/examples/residential_buildings/single_-_family_houses/central_europe/the_world_s_first_passive_house_darmstadt-kranichstein_germany
137 See www.cepheus.de/eng
138 http://www.zerocarbonhub.org/sites/default/files/resources/reports/Lessons_from_Germanys_Passivhaus_Experience(NF47).pdf
139 Idem 27
140 http://www.treehugger.com/green-architecture/passivhaus-precedents-zero-energy-house-1970s-recognized-award.html
141 http://gse.cat.org.uk/downloads/passive_house.pdf
142 http://www.passiv.de/downloads/03_certification_criteria_residential_en.pdf
143 Criteria for residential buildings can be found at www.passivehouse.com

Additional Passivhaus guidelines	UK building regulations characteristics
Insulation	
U-values of walls, floors and roofs	U-values of walls, floors and roofs around
≤ 0.15 W/m2K	0.15 to 0.25 W/m2K
Glazing	
Triple-pane windows with insulated frames	Double-pane windows
U-values (including doors) ≤ 0.8 W/m2K	U-values (including doors) around 1.20 to
	2.00 W/m2K
Solar orientation	
Windows largely south-facing	No particular requirement for solar orientation
Thermal bridging	
Minimal (ideally non-existent)	psi-(Ψ) values typically 0.05 to 0.24 (or even
psi-(Ψ) values ≤ 0.01 W/mK	0.50 at steel lintels) W/mK
Ventilation	
High-efficiency MVHR system	Background ventilators and intermittent
Heat recovery efficiency ≥ 75%,	extract fans
specific fan power ≤ 1.62 W/(l/s)	
Appliances	
Low-energy lights and appliances	Low-energy lights in 75% of internal fittings
Throughout	
Overheating	
Special care to avoid summertime	Likelihood of summertime overheating must
Overheating	be calculated

Table 2.4 Comparison of additional Passivhaus guidelines with UK building regulations[144]
Retrieved from:
http://www.zerocarbonhub.org/sites/default/files/resources/reports/Lessons_from_Germanys_Passivhaus_Experience(NF47).pdf

Critical reviews

"Passive House has been criticized for only addressing energy performance, while ignoring the broader categories that LEED covers with their rating system. Keep in mind however that Passive House was developed in Germany, where the construction industry is much more strictly regulated than in Canada, so a lot of sustainability practices are already commonplace there. It was suggested that LEED could benefit from inserting the Passive House performance standards into the energy category as on average LEED buildings reduce energy consumption by 20-30% where passive house is 80-90%."[145]

[144] Idem 27
[145] http://www.gotad.ca/leed-vs-passive-house/

This designing method is also criticized for a lack of follow up through the lifecycle of the building, and for not ensure that the building performs and continues to perform as it was designed during the operation of the building.

Cost –Benefit

There's no question that the upfront cost to build a passive home is higher than the cost to build a conventional home, but over time, the higher initial price of materials, design and construction will be offset by savings on utility bills and home maintenance.

The Passive House Institute US estimates that an additional upfront investment of around 10 percent of the construction budget is required to achieve passive house standards, as compared to regular energy code-compliant 2x4 construction (source: Passive House Institute US). In practice, the cost difference is often greater, but the price per square foot to build a passive house may be partially offset by the relatively small footprint of the home.[146]

Figure 2.6 and 2.7 Demonstrate the main techniques implemented in the first Passivhaus home that was was built in Darmstadt, Germany.

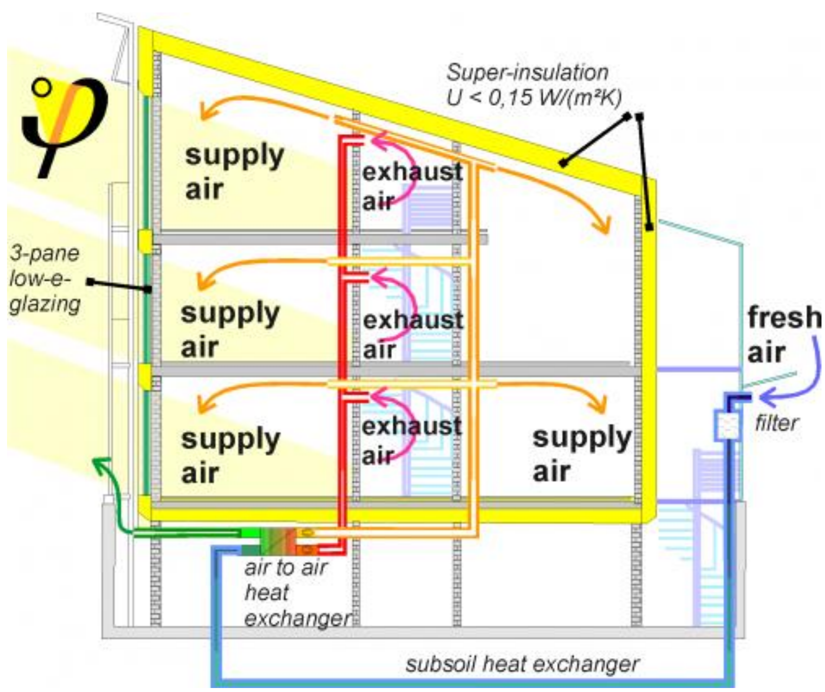

Figure 2.6 Cross section of the the first Passivhaus home was built in Darmstadt
Retrieved from:
http://www.passipedia.org/examples/residential_buildings/single__family_houses/central_europe/the_world_s_first_passive_house_darmstadtkranichstein_germany

146 http://home.howstuffworks.com/home-improvement/construction/green/10-benefits-of-a-passive-house9.htm

Building component	Description	Phototgraph of site	U-value W/(m²K)
Roof	Grass roof: Humus, non-woven filter, root protective membrane, 50 mm formaldehyde-free chip board; Wooden light-weight beam (I-beam of wood, stud link of hardboard), counter lathing, sealing with polyethylene sheeting bonded without jointing, gypsum plasterboard 12.5 mm, wood-chip wallpaper, emulsion paint coating, entire cavity (445 mm) filled with **blown-in mineral wool insulation**.		0.1
Exterior wall	Fabric reinforced mineral render; 275 mm of expanded polystyrene insulation (EPS) (installed in two layers at that time, 150+125 mm); 175 mm sand-lime brick masonry; 15 mm continuous interior gypsum plastering; wood-chip wallpaper, emulsion paint coating		0.14
Basement ceiling	Surface finish on fibreglass fabric; 250 mm polystyrene insulation boards; 160 mm concrete; 40 mm polystyrene acoustic insulation; 50 mm cement floor finish; 8-15 mm of parquet, adhesive; sealing solvent-free		0.13
Windows	Triple-pane low-e glazing with Krypton filling: U_g-value 0.7 W/(m²K). Wooden window with polyurethane foam insulated framework (CO2-foamed, HCFC free, handcrafted)		0.7
Heat recover y ventilation	Counterflow air-to-air heat exchanger;Located in the cellar (approx. 9°C in the winter), carefully sealed and thermally insulated, the first one to use electronically commutated DC fans.		heat recovery rate approx. 80%

Figure 2.7 Design features of the Passive House in Darmstadt-Kranichstein retrieved from: http://www.passipedia.org/examples/residential_buildings/single_-_family_houses/central_europe/the_world_s_first_passive_house_darmstadt-kranichstein_germany

Note: The Passive House Institute, in cooperation with GIZ (German International Cooperation Agency) and various Mexican institutions, has worked on a NAMA (Nationally Appropriate Mitigation Actions) document, which was presented by the Mexican government at the United Nations Climate Change Conference at Durban in December 2011. Applying the whole house approach, this study on social housing projects in Mexico used the Passive House Planning Package (PHPP) for a comparison of various energy efficiency standards including Passive House in different Mexican climate zones and for different social housing building typologies. **The investment costs for a current and future scenario (when Passive House components will be readily available on the Mexican market) were gathered and assessed. In all cases, the Passive House case proved to be the most economical option when looking at lifecycle costs.**[147] This subject will be further discuss in chapter three section 3.4.2.1.

Recommended method for investigating a Passive House solution[148]

1. Attempt to use passive technologies to reduce the peak load demand of the service in question. Possible approaches include insulation, shading, use of subsoil heat exchangers and reduction of internal heat loads by using high efficiency appliances.

2. If comfortable indoor climate conditions differ greatly from outdoor conditions, it is always recommendable to use a ventilation system with heat recovery (or vice versa with cold recovery) to maintain a high indoor air quality without the need of huge heating or cooling demands. ISO 7730 defines comfortable indoor climate as

3. There will be a certain point in the cooling/dehumidification demand so that with lower demands, there will be an appreciable simplification of the active technology needed.

2.2.3. BREEAM (England)

Before the UK Building Research Establishment (BRE) launched its Environmental Assessment Method (BREEAM) in 1990 the only methods available for predicting the performance of building were those designed to calculate specific criteria such as thermal loads, energy or water consumption or life cycle impacts of product manufacture. (Appleby, 2011)

BREEAM aims to improve the environmental performance of buildings, and internal environment for occupants. It´s a voluntary program focused on customer requirements under a holistic approach

Development history:
1990: Launch of BREEAM Offices
1991: Launch of BREEAM Industrial
1993: Launch of version for retail superstores
1998: Launch of BREEAM 98 – Major overhaul of the schemes (current layout, weightings etc)
2002 – **2006**: – Annual update process – Development of Bespoke BREEAM process Development of more schemes
2008: – Major update – Introduction of new schemes – International development

[147] http://www.passiv.de/en/05_service/03_literature/0302_cost-effectiveness/030202_energy-efficiency_sustainable-housing_Mexico.htm
[148] http://gse.cat.org.uk/downloads/passive_house.pdf

Notes: [149]

- BREEAM is maybe the most widely spread rating system around the world, according with the **BREEAM New construction manual by 2011 there were 200 000 certified buildings around the world.**
- **Recent studies have shown that BREEAM has helped save 4.5 million tonnes of CO2 since its inception.**

Objectives:

- Reduce environmental impacts of buildings
- Provide a credible environmental label
- Allow a transparent comparison of buildings
- Set criteria and standards over and above those required by legislation
- Challenge the market for more innovative solutions
- Stimulate the demand for sustainable buildings
- Allow organisations to demonstrate their progress towards achieving their CSR objectives

The BREEAM priciples are:

1. Ensure environmental quality
2. Provide a common framework of assessment
3. Use quantified measures
4. Integrate construction professionals
5. Adopt a flexible approach
6. Adopts third party certification
7. Use best available science and best practice
8. Adopts existing industry tools, practices and other standards
9. Reflect the social and economic benefits of meeting the environmental objectives
10. Stakeholder consultation to inform ongoing development

BREEAM sets the standard for best practice in sustainable design and claims to have become the de facto measure used to describe a building's environmental performance. BREEAM is an ever evolving assessment tool that seeks to quantify sustainability in order to measure it[150]

BREEAM awards an environmental label after assessing buildings against a range of environmental issues covering impacts on the environment at global, local and indoor levels. For each category,

[149] BREEAM New construction manual(http://www.breeam.com/breeamGeneralPrint/breeam_non_dom_manual_3_0.pdf)
[150]https://www.google.com.mx/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&ved=0ahUKEwjc7a7Vi4DKAhWEaD4KHSmkDW8QFgg0MAM&url=http%3A%2F%2Fdx.doi.org%2F10.4236%2Fce.2012.37b001&usg=AFQjCNGpjrAoyAqVZ6f7pB_sFCfTyncmYQ&bvm=bv.110151844,d.cWw

there are a number of 'credits' available. Where buildings have attained or exceeded various benchmarks of performance, an appropriate number of credits are awarded. The relative importance of the credits awarded under each category is taken into account in the final score, which is interpreted in the form of an overall rating of pass, good, very good, excellent and outstanding (introduced in August 2008 revision).

The following table outlines the the weigthingsof the nine environmental sections included in BREEAM UK New Construction.The certification covers the following areas showed in Table 2.5:

Section	**Assessment issues**
Energy	**Water**
Reduction of CO2 emissions	Water consumption
Energy monitoring	Water monitoring
Energy efficient external lighting	Water leak detection and prevention
Low or zero carbon technologies	Water efficient equipment (process)
Energy efficient cold storage	**Waste**
Energy efficient transportation systems	Construction waste management
Energy efficient laboratory systems	Recycled aggregates
Energy efficient equipment (process)	Operational waste
Drying space	Speculative floor and ceiling finishes
Transport	**Materials**
Public transport accessibility	Life cycle impacts
Proximity to amenities	Hard landscaping and boundary protection
Cyclist amenities	Responsible sourcing of materials
Maximum car parking capacity	Insulation
Travel plan	Designing for robustness
Land use and ecology	**Pollution**
Site selection	Impact of refrigerants
Ecological value of site/protection of eco-logical features	NOx emissions
Mitigating ecological impact	Surface water run-off
Enhancing site ecology	Reduction of night time light pollution
Long term impact on biodiversity	Noise attenuation
Health and wellbeing	**Managemen**t
Visual confort	Sustainable procurement
Indoor air quality	Responsible construction practices
Thermal confort	Construction site impacts
Water quality	Stakeholder participation
Acoustic performance	Service life planning and costing
Safety and security	**Innovation**
	New technology, process and practices

Table 2.5 BREEAM 2011 New Construction environmental sections and assessment issues[151]

Note: BREEAM credits are awarded where a building demonstrates that it meets the best practice performance levels defined for that issue.

[151] IDEM 38

Environmental section	Weighting
Management	12%
Health & Wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Materials	12.5%
Waste	7.5%
Land Use & Ecology	10%
Pollution	10%
Total	100%
Innovation (additional)	10%

Table 2.6 Sample of weightings
(Section of BREEAM Environmental)

Standard types of BREEAM assessment scheme exist for common building types:[152] [153]
Courts

- EcoHomes (used for refurbished homes; for assessment of new homes Code for Sustainable
- Homes replaced EcoHomes in April 2007)
- Education – introduced from August 2008 (replaces the existing BREEAM Schools
- assessment but will expand to include BREEAM Further Education)
- Healthcare – introduced from August 2008 (replaces the NHS Environmental Assessment Tool)
- Industrial
- Multi-residential
- Offices
- Prisons
- Retail

Life cycle stages of a building:

Design stage

Based on specifications and pre-development information
Options for shell & core or fit-out assessments

Construction stage

Pre-construction
Construction
Post construction review
As built' review and verification of design stage assessment*

Note: Full assessment may be carried out post construction

[152]http://www.islington.gov.uk/publicrecords/library/Environmentalprotection/Information/Guidance/2011-2012/%282012-03-03%29Introduction_to_BREEAM_and_CSH.pdf
[153] www.bre.co.uk

Figure 2.8 shows the General BREEAM process

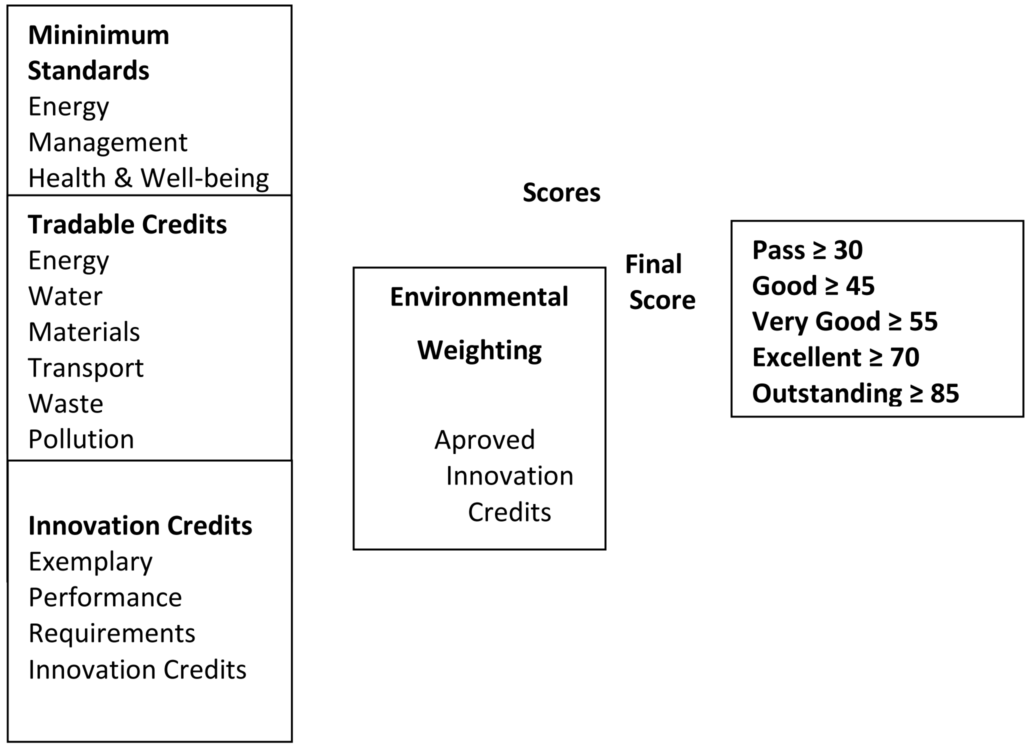

Figure2.8 BREEAM Rating system process

As showed in figure 2.8 **BREEAM the rating benchmarks (final certificates only) are:**

- Unclassified (<30)
- Pass(≥30)
- Good (≥45)
- Very Good (≥55)
- Excellent (≥70)
- Outstanding (≥85)

The Code assessment process

Similar to the new BREEAM approach, Code assessments are carried out by an accredited assessor in two phases:

Design Stage Review - Based on design drawings, specifications and commitments; results in an interim certificate of compliance

Post Construction Review - Based on the design stage review; confirmation of compliance including site records and visual inspection.

BREEAM assessment protocols[154]

[154] http://www.breeam.com/technical-standards

Master planning
Integrating sustainable design into the masterplanning of new communities or regeneration projects

The standard is applied during the early planning and design stages of a development. It offers a holistic framework with key target benchmarks that assists decision makers to better understand and improve upon the impact their decisions will have upon the longer-term environmental, social and economic aspects of the development.

This technical standard is suitable for Medium to large-scale developments, including new communities and regeneration projects.

New construction of buildings (For all newly constructed buildings and extensions of all types)
BREEAM New Construction assesses the design, construction, intended use and future-proofing of developments, including the local, natural or manmade environment surrounding the building. It uses a common framework that is adaptable, depending upon the building's type and location.
The assessment criteria and process focuses on the design of the building from concept stage right through to a fully constructed building. It requires evidence to support the design and construction decisions, agreed during the development of the project, and ensures they have been fully implemented.

Refurbishment & fit
The standard allows investors, developers and owners to assess an existing building's fabric, structure, core, local services, or interior design and fit out. Its performance benchmarks reward improvements to the poorest performing buildings, while also recognising those that perform well.

For the refurbishment of existing buildings

The assessment criteria and process recognise the split between tenant and landlord responsibilities. It focuses on particular factors where the landlord has control.

In-use buildings (For existing non-residential buildings)
BREEAM In-Use International is an assessment method which assists property investors, owners, managers and occupiers to drive sustainable improvements through operational efficiency, including how to continually manage the operation of their building effectively.
BREEAM In-Use International is an online rating tool that allows users to register buildings, assess and certify the building performance. A dynamic scoring platform and reporting section allows the user to track and improve the performance of their building or portfolio of buildings.

2.2.4. BREEAM Communities

As mentioned in chapter one the number of population living in urban areas increase rapidly, that can be translated as more harmful impacts to the environment. For this reason, as a potential solution, several cities around the world started to develop process tools like BREEAM Communities, LEED for Neighbourhood Development and CASBEE for Urban Development. Although rating tools for the sustainability assessment of buildings exist for more than two decades, it proves that the focus and attention to green buildings is insufficient to guarantee the sustainability of the built environment (Berardi U. , 2013)

There is the belief that the use of sustainable indicators early in the urban planning process would help advance the integration of sustainability goals during the process which will eventually lead into sustainable cities by design (Rosales in (Venou, 2014)

Building on the high level aims and objectives of the various standards in the BREEAM family, BREEAM Communities is an independent, third party assessment and certification standard based on the established BREEAM methodology..[155]

Purpose
Helps planners and developers to improve, measure and independently certify the sustainability of development proposals at the planning stage.
Measure and certify the overall potential sustainability of masterplan proposal during the planning stage of the Development control process
Dialogue tool

There are three steps involved in the assessment of sustainability at the masterplanning level:[156]

- Following site selection there is a process whereby the developer must show the suitability and need for specific types of developments on the site as part of a planning application
- The next step in the masterplanning process determines the layout of the development.
- Designing the details involves more detailed design of the development including: the design and specification of landscaping, sustainable drainage solutions, transport facilities and the detailed design of the built environment.

The categories in BREEAM Communities

Governance adresses community involvement in decision and long-term, stewardship of the development, consulting and engagement, design review, community management and facilities

Social and economic wellbeing (health, Local economy, social weellbeing) addresses societal and economic factors affecting health and wellbeing:

1. Housing provison
2. Economic Impact
3. Labour and skills
4. Public realm

12. Low impact materials
13. Resource efficiency
14. Alternative sustainable transport

[155] BREEAM Communities Technical Manual: SD202 Version: 2012 Issue: 0.0 Issue Date: 23/08/2012
[156] IDEM 45

5. Green infrastructure
6. Noise and light pollution
7. Adapting to climate change
8. Resources and energy Adresses the sustainable use of natural resources and the reduction of carbon emissions
9. Energy strategy
10. Existing Building and infrastructura
11. Sustainable buildings
15. Land use and ecology Adresses sustainable land use and ecological enhacement
16. Ecology Strategy
17. Land Use
18. Enhacement ecological values
19. Landscape
20. Flood risk management
21. Water pollution
22. Rainwater haervesting

Transport and movement address the design and provision of transport and movement infrastructure to encourage the use of sustainable modes of transport.
Transport Assessment

- Safe and appealing streets
- Cycling network
- Access to public transport
- Cycling facilities
- Public transport facilities
- Innovation

BREEAM Communities addresses the long-term economic success of a development through the assessment of a number of issues, including:

'**SE 01** - Economic viability';
'**SE 02** - Demographic needs and priorities'; and
'**SE 17** - Labour and skills'.

To ensure that performance against fundamental sustainability issues is not overlooked in pursuit of a particular rating, BREEAM sets mandatory standards of performance across the five categories in BREEAM Communities (see Table 2.7)[157]

Step	Identifier	Assessment issue	Criteria
Step 1	GO 01	Consultation plan	1– 3
	SE 01	Economic impact	1
	SE 02	Demographic needs and priorities	1– 2
	SE 03	Flood risk assessment	1– 3
	SE 04	Noise pollution	1
	RE 01	Energy strategy	1
	RE 02	Existing buildings and infrastructure	1– 2
	RE 03	Water strategy	1– 2
	LE 01	Ecology strategy	1– 6
	LE 02	Land use	1– 2
	TM 01	Transport assessment	1– 3
Step 2	GO 02	Consultation and engagement	1– 3
Step 3		None	

Table 2.7 Mandatory BREEAM Communities standards

Source: Technical Manual: SD202 Version: 2012 Issue: 0.0 Issue Date: 23/08/2012

Type and Size of Developments

• Residential, Mixed Use, Commercial

[157] IDEM 45

- New, Regeneration
- Small (2- 10 units)
- Medium (11-500 units)
- Large (up to 5999 units)
- Bespoke – above 5999 units

Critical reviews

"The results revealed that BREEAM is perceived as a very useful tool when addressing the environmental performance of buildings; however it is perceived that it does not address the whole concept of sustainability and sustainable development. A chief focus of sustainable development is on society, as it aims to include environmental considerations in the steering of societal change at the interface between the social, the economic and the ecological aspects. BREEAM fails to include sufficient social and economic components to address the whole of concept of sustainability and sustainable development." [158]

"Widespread it may be, but BREEAM has also been the subject of criticism. The two most common complaints are firstly that the privatisation of the BRE may have skewed it towards an unhelpful commercial standpoint. Secondly, and more importantly, some have complained that BREEAM can give far too much credit given to peripheral or even useless environmental aspects of building design. In the past these have included such as the addition of bike racks and recycling systems, diverting focus from more important elements such as lighting, building controls and water consumption." [159]

"It could be argued that a building that is not pleasant and comfortable to work in is not sustainable because it may result in low productivity and become unpopular with occupants and even unusable. BREEAM and its offshoots reward good design through a series of credits dealing with health, well-being and comfort" (Appleby, 2011)

2.2.5. EnergyStar

The ENERGY STAR voluntary program was established in 1992 by the U.S. Environmental Protection Agency (EPA) focused on save money and protect our climate through superior energy efficiency, this program operates under the authority of the Clean Air Act Section 103(g) EPA conducted a basic engineering research to develop, evaluate, and demonstrate non–regulatory strategies and technologies for reducing air pollution. In 2005, the U.S. Congress enacted the Energy Policy Act. Section 131, and establishing a voluntary program to identify and promote energy–efficient products and buildings in order to reduce energy consumption, improve energy security, and reduce pollution through voluntary labeling of or other forms of communication about products and buildings that meet the highest energy efficiency standards.[160]

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[158] How Accurately Does Breeam Measure Sustainability? Sarah Aspinall1, Begum Sertyesilisik2,3, Amr Sourani3, Ashley Tunstall4 2012

[159] Weighing up the pros and cons of the BREEAM environmental standard Posted on September 15, 2015 by Charles Marks **Retrieved from:** http://www.freshworkspace.com/blog/2015/09/weighing-up-the-pros-and-cons-of-the-breeam-environmental-standard/

[160] http://www.energystar.gov/about

Third-party certification requirements and testing from Energy Star included:

For Products
For New Homes
For Commercial Buildings
For Industrial Plants

Linda Reeder underlines that Cost-effectiveness is a core principle of Energy Star programs, and it is the intent of the EPA that the cost of requirements for an Energy Star qualified home be offset by the resulting savings in reduced energy costs. (Reeder, 2010).

"All program requirements must result in an incremental monthly mortgage cost that is the same or less than the projected monthly savings. Homes earning the ENERGY STAR label u*se *20-30 percent less energy than typical new homes, and even more when compared to most resale homes on the market today."[161]

Home Performance with ENERGY STAR® (HPwES) is a public-private voluntary partnership program designed to turn building science-based recommendations into solutions for improved, energy efficient homes. This program enhance home performance for healthier and more comfortable living environments, enhanced durability of the homes' structures and systems, and improved energy savings for the homeowners.[162]

The Energy Star process differentiate from others rating systems for the following aspects:

Third-party verification process in two phases of the project as showed in figure 2.9, this process allow, either, designers, and o owners to set energy goals, and redefine them before construction stage.

This program underlines the economy aspect of sustainable construction, while it evaluates, and compares the project investment with energy savings. (To qualify, a plan is independently reviewed and verified to include energy-saving features and construction practices that will result in a home that is 20–30 percent more energy efficient than a standard home). See Table 2.8
Though the process, the home may be evaluated either via the performance path, whereby the rater uses a software model to verify the home meets the energy target, or the prescriptive path, whereby the designer and builder follow a prescribed set of construction specifications. The rater must perform construction inspections and performance testing to verify that the home qualifies.

[161] http://www.energystar.gov/index.cfm?c=new_homes.nh_proven_value
[162] https://www.energystar.gov/ia/home_improvement/HPwES_Program_Plan_Template.pdf

Design process using Energy Star

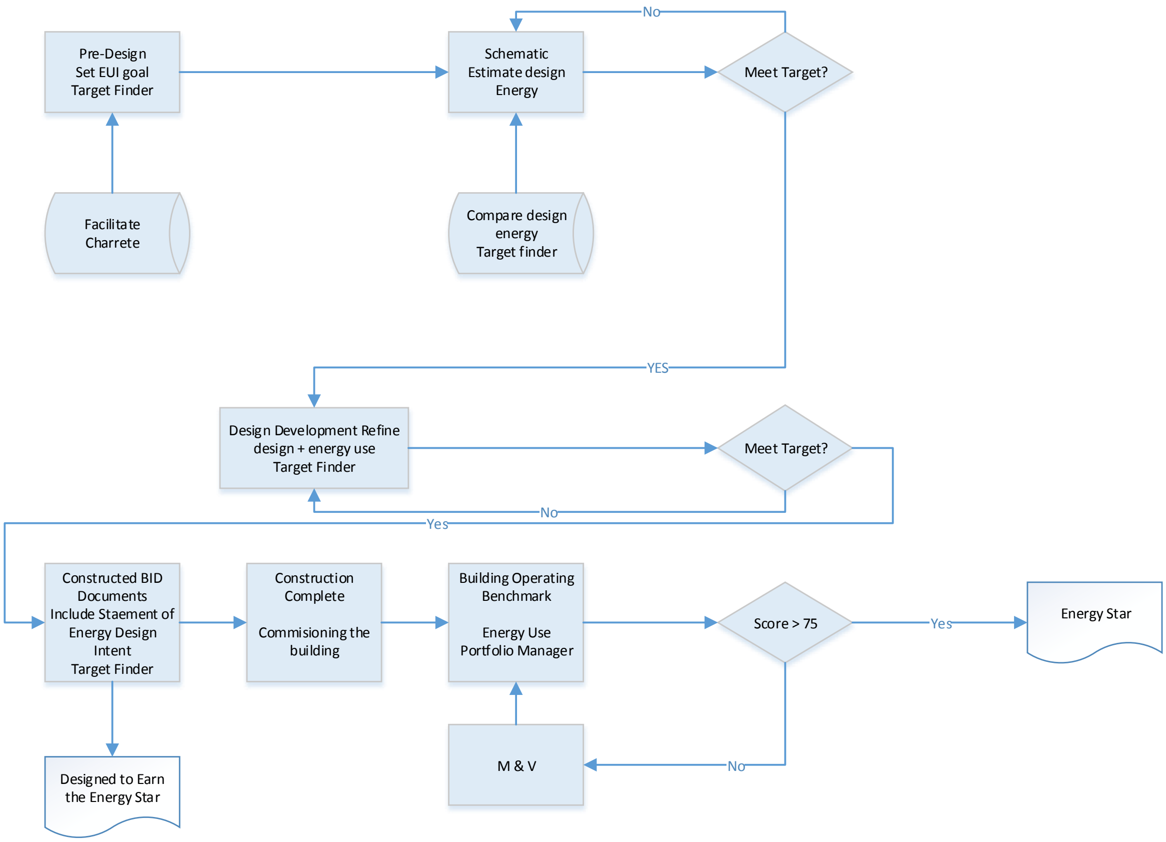

Figure 2.9 Energy Star Process
Modified from: U.S. Environmental Protection Agency

The **ENERGY STAR** benefits are:

Lower Utility Bills
Enhanced Performance
Environmental Protection

Criteria for earning the Energy Star for Homes are:[163]

1. Effective insulation, inspected to ensure proper installation
2. High-performance window
3. Tight construction of the building envelope
4. Sealed ductwork
5. Efficient heating and cooling equipment
6. Efficient products such as Energy star qualified appliances, lighting, and hot water heaters

[163] WWW.energystar.gov/homes

7. Third-party verification to confirm energy-efficient measures are properly installed and performing as expected
8. Reduced thermal flow, with new requirements for proper insulation installation, reduced thermal bridging, and increased duct insulation
9. Reduced airflow, through pressure-balancing and sealing sheetrock at top plates
10. Required whole-house mechanical ventilation; spot local exhaust; and water-managed roofs, walls, and foundations

Boilers: 14% energy savings	Furnaces: 20% energy savings	Televisions: 56% energy savings
Central AC and Air Source Heat Pumps (including ductless): 20-30% energy savings	Geothermal Heat Pumps: 20-40% energy savings	Ventilating Fans: 50% energy savings
Clothes Washers: 28% energy savings and 30% water savings (for front load models)	Monitors: 35% energy savings	Windows: Savings vary by climate, house construction, and number and type of windows replaced.
Ceiling Fans: 60% energy savings	Refrigerators: 15% energy savings	Dishwashers: 22% energy savings and 36% water savings *(Proposed)*

Table 2.8 Estimated Savings for ENERGY STAR Most Efficient 2015 Products by Category

Retrieved from:

http://www.energystar.gov/ia/partners/downloads/most_efficient/2015/EPA_Memo_ENERGY%20_STAR_Most_Efficient_2015_Final.pdf?3642-58e8

For Products

In order to earn the label, ENERGY STAR products must be third-party certified based on testing in EPA-recognized laboratories. In addition to up-front testing, a percentage of all ENERGY STAR products are subject to "off–the–shelf" verification testing each year. The goal of this testing is to ensure that changes or variations in the manufacturing process do not undermine a product's qualification with ENERGY STAR requirements.

For Commercial Buildings

Buildings achieving a score of 75 or higher using Portfolio Manager must be verified by a Licensed Professional (Professional Engineer or Registered Architect) to be eligible to apply for the ENERGY STAR. The Licensed Professional must verify that all energy use is accounted for accurately, that the building characteristics have been properly reported (including the square footage of the building), that the building is fully functional in accordance with industry standards, and that each of the indoor environment criteria has been met.

For Industrial Plants

A Professional Engineer must certify that the information used to calculate the plant's 75 or higher energy performance score is correct. In addition, the plant must satisfy EPA environmental compliance criteria screen

Critical Reviews

In Economics, a "Jevons Paradox" has two parts. First, improvements in a technology (say, an engine) cause that technology to use resources (say, fuel) more efficiently. This seems all well and good, until you meet the second part. In the second part of a classic Jevons Paradox, people consume more of the resource as a result of the new, more efficient technology.[164]" ***"Specialists point to the idea that there is a large rebound effect to increased energy efficiency. The concept here is that when we use products that consume less energy, we end up using more of the product or using more products – or both. Direct rebounds include the example of driving a more efficient car more often, ultimately using up any potential fuel savings. An indirect rebound occurs when money pocketed through energy-efficiency savings is spent on something else, such as a big-screen TV."***[165]

2.2.6. Green Globes

The Green Globes rating system was first developed by ECD Energy using the BREEAM program (Building Research Establishment Environmental Assessment Method) to stablish a baseline. It helped set the standard for green building and measuring a building's environmental performance. The New Construction Standard development began in 1996, and completed in 2002. By 2004, the Building Owners and Manufactures Association of Canada adopted Green Globes. In the US: Green Building Initiative GBI (Nonprofit Organization) acquired the license to promote and develop this system.The GBI developed the ANSI/GBI 01-2010: Green Building Assessment Protocol for Commercial Buildings and used it as the basis for the latest enhancements to the Green Globes for New Construction protocol. (Reeder, 2010)

The objectives of this rating system are:

- Reduce operating costs
- Qualify for tax incentives
- Meet government regulations
- Attract and retain employees
- Increase property's marketability

Green Globe Ratings (descriptions are from GBI)[166]

- **Four Globes 85-100%** (Reserved for select buildings that serve as national or world leaders in reducing environmental impacts and efficiency of buildings)
- **Three Globes 70-84%** (Demonstrates leadership in energy and environmentally efficient buildings and a commitment to continual improvement)
- **Two Globes 55-69%** (Demonstrates excellent progress in reducing environmental impacts by applying best practices in energy and environmental efficiency)
- **One Globe 35-54%** (Demonstrates movement beyond awareness and a commitment to good energy and environmental efficiency practices)

[164] http://www.csrwire.com/blog/posts/1524-three-jevons-paradoxes-for-the-future-of-sustainable-supply-chain-management-and-one-way-to-resolve-them-all
[165] http://www.thestar.com/business/2012/08/10/way_more_pros_than_cons_to_energy_efficiency.html
[166] http://www.nlcpr.com/greenglobe.php

Levels are determined by percentages rather than point totals to show that the total number of points varies by project, points that cannot be earned because of project specifics are deducted from the total number. (see table 2.9)

This system can be used to assess and manage building performance, life cycle costing models and waste and water management best practices across a retailer's portfolio. CIEB looks at actual energy performance compared to Energy Star normalized national averages and CO_2 emissions, as well as prescriptive features, management policies, and transportation. The integration of best building management practices through Green Globes' interactive software assists facility maintenance professionals in saving energy, minimizing greenhouse emissions and water resources. Green Globes is a leadership and guidance tool to validate system improvements.

2.2.6.1. Green Globes New Construction[167]

Green Globes for New Construction is part of an integrated design process. It utilizes an online building assessment tool for each design phase from pre-design to construction documents. A third-party assessor is assigned to the project to review the online assessment and construction documents and then perform an on-site inspection. The process is user-friendly, and having an assigned assessor to contact regarding decisions and certification requirements ensures it is transparent and interactive. This tool enables project teams to: Focus on sustainability, consider options in environmental improvements during the design and delivery process, and evaluate and rate the benefits of different design scenarios.The GBI also has Green Globes certification programs for existing buildings (called Continual Improvement of Existing Buildings, or CIEB) and CIEB for Healthcare.[168]

The Process

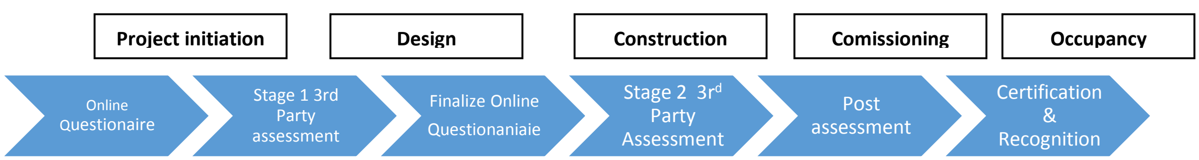

Figure 2.10 – GBI rating & Certification process

1. Client completes the online evaluation score> 35% to move forward
2. Stage third-party assessment- design review includes evaluation report and recommendations
3. Client updates the online questionnaire to reflect design changes, if needed
4. Stage 2 third-party assessment-onsite meeting and building tour
5. Post assessment client delivers additional documentation, assessor prepares report with recommendations, GBI issues final report, client reviews findings
6. Certification and public recognition of the achievement

[167] http://www.thegbi.org/green-globes-certification/how-to-certify/new-construction/
[168] Green Globes® for New Construction (Donald Martin, AIA, NCARB, LEED AP, GGP MARSTON design studio)Better Building Science for Better Results , v, 2013

Criteria Incorporates Advanced Building Science. The Green Globes certification process has seven environmental assessment areas showed in table 2.9:

Environmental assessment Areas	%	Paths
Management	50	Integrated Design Process, Meetings, Performance Goals, Environmental Management, Commissioning
Site	115	Development Area, Ecological Impacts, Stormwater Management, Landscaping, Exterior Light Pollution
Energy	390	Performance, Demand, Metering, Measurement and Verification, Building Opaque Envelope, Lighting, HVAC Systems and Controls, Efficient Equipment, Renewable Energy, Energy Efficient Transportation **Path A**: ENERGY STAR Target Finder **Path B**: ASHRAE 90.1-2010 **Path C**: ANSI/GBI 01-2010 Energy Performance Building Carbon Dioxide Equivalent Emissions (CO2e) **Path D**: ASHRAE Building Energy Quotient (bEQ)
Water	110	Consumption, Cooling Towers, Boilers & Water Heaters, Water Intensive Applications, Treatment, Alternate Sources, Metering, Irrigation The GBI has created a water calculator that allows clients to gauge a building's water performance by benchmarking it against a base building. This Excel-based water calculator offers the following features: 1. Input assumptions, such as building size and type, operating hours, and fixture use frequency 2. An output page that displays calculated baseline water use and allows the addition of other water consumption features, such as HVAC systems, pools, water features, commercial kitchens, etc. 3. Project use analysis, which includes water performance improvements over the baseline 4. A parallel program for multi-unit residential buildings
Materials & resources (The Materials & Product Selection section of Green Globes for New Construction is divided into two categories: Building Assembly and Interior Fit-Out.)	125	Building Assembly, Interior Fit-outs, Re-use, Waste, Building Service Life Plan, Resource Conservation, Building Envelope **Path A**: Performance Path Green Globes for New Construction encourages use of the Athena Impact Estimator and/or other life cycle assessment tools for the Building Assembly and third party peer reviewed life cycle assessments for the Interior Fit-out. **Path B**: Prescriptive Path Currently, the most common method for sustainable product selection is the evaluation of "single attributes" (e.g. VOC's, recycled content, bio-based, etc.), which is not ideal.
Emissions	50	Heating, Ozone-depleting Potential, Global Warming Potential
Indoor environment	160	Ventilation, Source Control and Measurement, Lighting Design and Systems, Thermal Comfort, Acoustic Comfort

Table 2.9 ENVIRONMENTAL ASSESSMENT AREAS Modified from: http://www.thegbi.org/green-globes-certification/how-to-certify/new-construction/

Note: The energy, materials & resources, and water assessment areas are what separate Green Globes for New Construction from other green certification programs.

2.2.7. Plan Bâtiment Durable /HQE (France)[169][170]

La demarche HQE was launched in 2005, HQE stands for Haute Qualité Environnmentale (High Environmental Quality) by AFNOR (France's national standards-setting organization and ISO representative) The HQE generic method is defended by the Association HQE France’s Green Building Council.

It is voluntary program, but certification will require verification by an independent body. In France, the HQE certification scheme is operated through 3 different certification bodies:

Certivéa (non-residential sector)
Cerqual (collective housing)
Cequami (individual housing)

Outside of France, the HQE certification scheme is operated by Cerway. To assist those involved in projects applying for certification outside of France, Cerway has recognized a number of HQE “Référents”. These “Référents” are professionals in the construction, property management or planning sectors (architects, engineers, town planners, etc.) who have been accredited after training and examination.In Brazil, Cerway operates in partnership with the Vanzolini Foundation (Fundaçao Vanzolini) who provides AQUA certification (a direct translation of HQE).

Current versions	**Under development**
Current versions of HQE exist for the following building types: Commercial centres Hotels Schools Houses (NF Maison Individuelle HQE environmental option) Residential (NF Logement HQE Environmental Option) Offices In Use	The following versions of HQE are currently under development: Healthcare Sports buildings Operational buildings

Table 2.10 HQE programs

[169] http://www.edsf.com/fileadmin/user_upload/Dokumente/2013/Sustainability_Certification_Systems.pdf
[170] http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/94372/ESL-IC-10-10-01.pdf

Description of System

HQE is a national certification system for residential and non-residential buildings. The system identifies 14 environmental issues and covers two aspects: environmental quality of the building, and environmental management of the entire project. The two aspects have been translated into linked reference frameworks, with performance criteria in the first and management requirements in the second. This “two-in-one” concept is probably HQE´s most original aspect. 14 environmental issues have been defined; they fall into four main areas, the first two having to do with the exterior environment and the second two with the interior.

Principles of the French HQE® Approach HQE® approach is a standard for Green Buildings in France designed to improve the environmental quality of the built environment. It leads to a certification that approves the consideration of environmental issues in the construction process of a building.

HQE helps contracting authorities, architects, manufacturers and entrepreneurs control the building impact on the outdoors environment and create ahealthy and comfortable indoors environment for their clients. It can be used as a criterion for investors and property developers to monitor the financial performance of a building or a portfolio. HQE is applicable to all types of new and existing buildings in the residential, tertiary and industrial sectors.

Three levels of performance are set: “basic,” corresponding to current regulations or normal practice; “good”; and “very good”.Certification will be granted upon achievement of a “minimum environmental profile”comprising a “very good” rating for at least three issues, “good” for at least four and“basic” for no more than seven. For the “good” and “very good” rankings, a “principle of equivalence” is allowed. That is, the applicant can suggest an alternative assessment approach

The figure is displayed in figure 2.11

Figure 2. 11 Display of Results
Retrieved from:
http://www.edsf.com/fileadmin/user_upload/Dokumente/2013/Sustainability_Certification_Systems.pdf

Environmental profile according with the 14 issues

Very good level at least 3 issues
Good level at least 4 issues
Basic level 7 issues at most

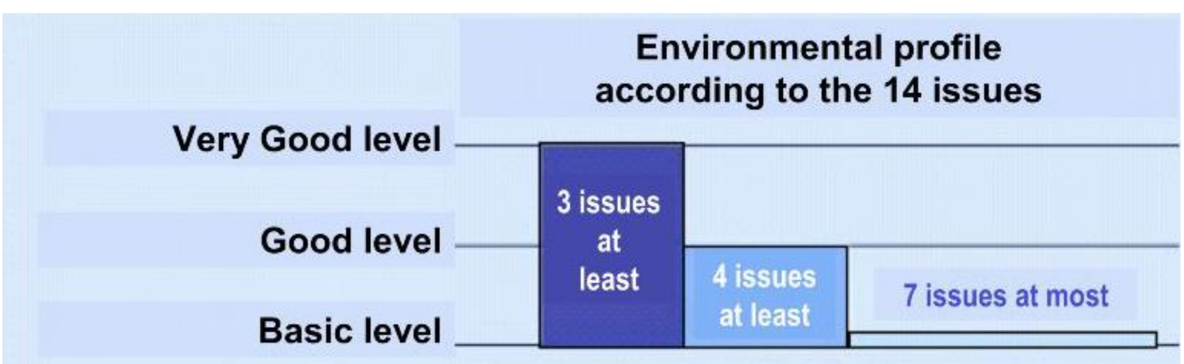

Figure 2.12 HQE® Environmental Profile according to the 14 targets.
Retrieved from: http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/94372/ESL-IC-10-10-01.pdf

HQE is an approach that leads to a certification that approves the consideration of environmental issues in the construction of a building. This approach is divided into 14 targets distributed in 4 families and each target decomposes itself into a number of sub-targets, bringing the number of treated topics up to 52, with as many questions to be asked.(see table 2.11)

Controlling the impacts on the outer environment	**Create a satisfactory internal environment**
ECO-CONSTRUCTION : **1. The harmonious relationship of the building with its direct environment** **2. Choice of integrated products and building materials** **3. A site with low pollution**	**COMFORT :** **4. Hygrometric** **5. Acoustic** **6. Visual** **7. olfactive**
ECO-MANAGEMENT **8. Energy** **9. water** **10. activity waste** **11. preservation and maintenance**	**HEALTH :** **12. sanitary condition of the space** **13. the air quality** **14. the water quality**

Table 2.11 HQE´s targets
https://books.google.com.mx/books?id=pYzTAAAAQBAJ&pg=PA68&lpg=PA68&dq=issues+demarche+hqe&source=bl&ots=A1YnCcZzAi&sig=q6wWHiLwrBjDeUMm2d4J_YsOyX4&hl=es&sa=X&ved=0ahUKEwjclZ7rpYvKAhVMMyYKHejWD_sQ6AEIUjAH#v=onepage&q=issues%20demarche%20hqe&f=false

The HQE certification is a 3-step process:[171]

Project initiation

The applicant issue an application request with the relevant operator, including a description of the Environmental Targets the project is planning to reach

- An eligibility check is carried out by Cerway outside France or, in France, by the relevant operator
- An offer of agreement is made with Cerway outside France or, in France, by the relevant operator this offer initiates the certification process

Audits: Audits are third party assessment and verification processes which allow to determine that the HQE criteria are met. The results of each audit are captured in a report.

- The project initiation audit is designed to check whether all project management requirements are met. This audit is optional for the non-housing related schemes.
- The design audit allows to check that the agreed environmental targets will be met. This audit is also optional for the non-housing related schemes

The completion audit is conducted onsite, following project completion.

[171] http://www.sballiance.org/our-work/libraries/haute-qualite-environnementale/

Certification

- The audit reports are submitted to a commission run by the scheme operator
- Upon review of the documentation submitted, the commission may issue approval and issues a precertificate. This can be done after each audit phase: the commission then simply updates the pre-certificate as the project moves from initiation, to design, to completion
- The final HQE certificate is delivered upon approval of the final, completion audit

Critical Reviews

"The comparison has shown that a common base exist between the two approaches regarding the evaluation of the compared environmental issues. We have also noted that HQE® has an advantage in the number of environmental sub-issues evaluated compared to "LEED®" and is much further ahead the consideration of the urban development operations is compared."[172]

2.2.8. Envirohome & BuiltGreen (Canada)

EnviroHome

Canada has become a world leader in residential construction technology. The EnviroHome Initiative was established in 1994 by the Canadian Home Builders Association and TD Canada Trust to recognize and support innovative new home builders who are committed to offering consumers sustainable homes with the slogan"better for you, better for your community and better for the environment".[173]

"The EnviroHome Initiative is a marketing program for R-2000 builders and R-2000 homes.In order to be considered for the EnviroHome designation, the builder must start with an R-2000 home and incorporate proven and commercially available features that enhance the indoor air quality and make the home more environmentally responsible. These features must then be put on display for the public through an open house period, along with literature which explains the features and thereby raises the awareness of the public about R-2000 homes and the many steps that builders are taking to protect and care for our environment."

(Note: This program will be further review in chapter three, since it´s part of Canadian green building strategy. See section 3.3.4.4)

Maybe the main characteristic that differentiate this program from others, Is the form how homebuilders try to engage future owners with Green Construction, not only because through performance of both, appliances and HVAC/Electric installations they demonstrate energy/water savings, but they also explain how building construction impacts environment. [174]

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[172] Green Buildings: Principles, practices and techniques, The French "HQE®" Versus The American "LEED®". Dr. Karim GAZZEH, Dr. Hend Ben Mahfoudh, 2010, http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/94372/ESL-IC-10-10-01.pdf

[173] http://www.chba.ca/envirohome.aspx

[174] http://www.chba.ca/r-2000.aspx

R-2000 homes are the most energy-efficient and environmentally responsible new homes on the market. They are built to demanding standards for energy efficiency and indoor air quality that far surpass others in the marketplace. They are designed and constructed by specially trained builders. Every R-2000 home is certified by the Government of Canada under a quality assurance process.

Built Green Canada is an industry-driven, voluntary program that promotes “green” building practices to reduce the impact building has on the environment. Our programs benefit the home buyer, the home builder, the community, and the environment, and offer everyone an opportunity to choose a “green” future.

Built Green is a national organization that works with those interested in responsible sustainability practices within the residential building sector; this includes builders, renovators, product suppliers and manufacturers, service providers, community developers, and municipalities

The primary purpose of Built Green Canada is to encourage and enable the use of practices, technologies, and products within the residential building sector that will:

- Provide greater energy efficiency and reduce pollution and waste
- Provide healthier indoor air
- Reduce water usage
- Preserve natural resources
- Improve durability and reduce maintenance

The BUILT GREEN program concentrates on seven areas*:* energy efficiency; materials and methods; indoor air quality; ventilation; waste management; water management; and business practices.

Some benefits received from the BUILT GREEN

Enhanced and retained home value
Increased home durability
Reduced utilities' costs
Indoor environment quality
Free pollutants air
Environmnetal friendly materials

“You live in a healthier home with better ventilation and fewer allergens in the air: low or zero VOC paints, low or formaldehyde-free building materials, and third-party certified floor coverings all contribute to a healthier indoor environment for you and your family you can expect to breathe easier, and the severity of asthma and allergies in these homes is far reduced”[175]

Economical aspects
Save a minimum of approximately 10% in annual utility bills compared to a code-built home. Canadian Mortgage and Housing Corporation (CMHC) and Genworth Financial mortgage insurance rebates are available for BUILT GREEN® homes. The efficient use of building materials and processes. This means a longer life for the home with lower maintenance costs.

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[175] http://www.builtgreencanada.ca/homeowner-benefits

Comfort aspects
Energy efficient homes have a significant reduction of drafts, cold spots, and temperature variance

Health aspects
Built Green Canada offers many options to improve indoor air quality; homeowners can choose from low or zero VOC (volatile organic compounds), low or formaldehyde-free building materials, and third-party certified floor coverings, since builders are encouraged to use Heat Recovery Ventilators, which constantly circulates air in the home and removes allergens from the air, indoor ambient can be improved.

Quality aspects
By implementing quality materials and certified appliances new homes are expected to last at least 100 years.

2.2.9. National Green Building Standard™ (NGBS) (USA) [176]

NGBS is a research and development program to improve energy performance of new and existing homes. Since the U.S. is divided in, eight climate zones (see table 2.12) It´s important to achieve cost-effective and energy efficient homes for all climate zones.

Climate Zone	Criteria
Hot Humid	1.67°F (19.4°C) or higher wet-bulb temperature for 3,000 or more hours during the warmest six consecutive months of the year; 2.73°F (22.8°C) or higher wet-bulb temperature for 1,500 or more hours during the warmest six consecutive months of the year.
Mixed Humid	It´s a region that receives more than 20 inches (50 cm) of annual precipitation, 5400 heating degree-days (65°F basis), and where average outdoor temperature drops bellows 47°F (7° C) in winter months
Hot Dry	It´s a region that receives less than 20 inches (50 cm) of annual precipitation, and the average outdoor temperature remains above 45°F (7° C) through the year.
Mixed Dry	It´s a region that receives less than 20 inches (50 cm) of annual precipitation, 5400 heating degree-days (50°F basis) or fewer, and where average outdoor temperature drops bellows 47°F (7° C) in winter months
Cold	It´s a region that receives 5400 heating degree-days (65°F basis) or more, and fewer than approximately 9000 heating degree-days (65°F basis)
Very Cold	It´s a region that receives 9000 heating degree-days (65°F basis) or more, and fewer than approximately 12600 heating degree-days (65°F basis)
Subarctic	It´s a region that receives 12600 heating degree-days (65°F basis) or more
Marine	1.Mean temperature of coldest month between-3°C (27°F) and 18°C (65°F) 2.Warmest month mean < 22°C (72°F) 3.At least four months with mean temperatures over 10°C (50°F) 4. Dry season in summer.

Table 2.12 U.S. Climate Zones Source: www.iccsafe.org[177]

[176] National Green Building Standard Analysis Building America Building Technologies Program Office of Energy Efficiency and Renewable Energy U.S. Department of Energy, 2012
[177] https://energycode.pnl.gov/EnergyCodeReqs/

Point thresholds determine the project's compliance with the criteria that support progressively higher rating levels: Bronze, Silver, Gold and Emerald.(See table 2.13). The ICC 700-2008, practices defined in the areas of site development (Lot Design, Preparation and development), resource efficiency, energy efficiency, water efficiency, indoor environmental quality, and operation, maintenance, and building owner education earn points toward an overall green rating level.[178]

In contrast to the NAHB Guidelines which apply only to new single-family homes, the NGBS has a a wider scope and applies to all residential projects that are not classified as institutional, and to all U.S. Climate zones.

Green Building Categories			**Performance Level Points**			
			Bronze	**Silver**	**Gold**	**Emerald**
1	Chapter 5	Lot Design, Preparation and development	39	66	93	119
2	Chapter 6	Resource efficiency	45	79	113	146
3	Chapter 7	Energy efficiency,	30	60	100	120
4	Chapter 8	Water efficiency,	14	26	41	60
5	Chapter 9	Indoor environmental quality	36	65	100	140
6	Chapter 10	Operation, maintenance, and building owner education	8	10	11	12
7		Additional Points from any category	50	100	100	100
		Total Points	222	406	558	697

Table 2.13 NAHB Performance Level Points

2.2.10. STARS (academic institutions)[179]

The Sustainability Tracking, Assessment & Rating SystemTM (STARS) is a voluntary, self-reporting framework for helping colleges and universities track and measure their sustainability progress. It is designed to:

Provide a framework for understanding sustainability in all sectors of higher education.
Enable meaningful comparisons over time and across institutions using a common set of measurements developed with broad participation from the campus sustainability community.
Create incentives for continual improvement toward sustainability.
Facilitate information sharing about higher education sustainability practices and performance.

STARS is intended to engage and recognize the full spectrum of colleges and universities—from community colleges to research universities, and from institutions just starting their sustainability programs to long-time campus sustainability leaders. STARS encompasses long-term sustainability goals for already high-achieving institutions as well as entry points of recognition for institutions that are taking first steps toward sustainability.

[178] IDEM
[179] https://stars.aashe.org/pages/participate/register-stars.html

AASHE defines sustainability in a pluralistic and inclusive way, encompassing human and ecological health, social justice, secure livelihoods, and a better world for all generations. STARS attempts to translate this broad and inclusive view of sustainability to measurable objectives at the campus level. Thus, it includes credits related to an institution's environmental, social, and economic performance.

An institution's STARS score showe in table 2.14 is based on the percentage of applicable points it earns across four categories: [180]

1. **Academics (AC)**
2. **Engagement (EN)**
3. **Operations (OP)**
4. **Planning & Administration (PA)**

Rating	**Minimum Score Required**
STARS Bronze	25
STARS Silver	45
STARS Gold	65
STARS Platinum	85

Table 2.14 STARS rating system

Note: This rating system will receive further annalist in chapter three, since this tool is used for the comparison of green building programs of Ontario´s Colleges, and Mexican Univesity (UNAM).

2.2.11. BOMA (Building renovation)[181]

BOMA BESt certified buildings achieve better energy and water use intensities than the national average. The program helps building owners, managers and facility operators establish a building baseline performance, implement initiatives over time, and achieve an improved score upon recertification.[182][183]

For almost 100 years, BOMA International has set the standard for measuring buildings. In 1915, BOMA first published the Standard Method of Floor Measurement for Office Buildings, an accepted and approved methodology by the American National Standards Institute. Throughout the years, the standard has been revised to reflect the changing needs of the real estate market and the evolution of office building design. Today, BOMA International is the secretariat of a suite of measurement standards:

BOMA International's Sustainability resource site provides a step-by-step guide to finding information, training, best practices, and certification for commercial buildings and management teams all in one place.

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[180] Stars technical Manual Version 2.0 , 2014 by the Association for the Advancement of Sustainability in Higher Education.
[181] http://www.bomacanada.ca/
[182]http://www.bomacanada.ca/resources/standards.html
[183]http://www.boma.org/sustainability/Pages/default.aspx

BOMA's Sustainability menu is easy to navigate. Information is organized chronologically starting with free information and resources, such as articles, websites and guides, and ending with building certification and recognition opportunities, such as the BOMA 360 Performance Program, ENERGY STAR, LEED and Green Globes. Links lead you to more detailed information and instructions.**CERTIFICATION** (See table 2.15).

BOMA BESt Level 1: The building has met all BOMA BESt Practices (includes performing an energy audit and a water audit, continually monitoring resource consumption and having a preventative maintenance program).

BOMA BESt Level 2: The building has met all BOMA BESt Practices AND has achieved a score of 70–79% on the BOMA BESt assessment. The building is moving towards better energy and environmental performance through improved management practices

BOMA BESt Level 3: The building has met all BOMA BESt Practices AND has achieved a score of 80–89% on the BOMA BESt assessment. The building is moving towards excellence in energy and environmental performance through excellent management practices.

BOMA BESt Level 4: The highest level of certification. The building has met all BOMA BESt Practices AND has achieved a score of over 90% on the BOMA BESt assessment. These buildings are high performers with low energy consumption, excellent management, and often combine new technologies and industry leadership.

Office Building: A property providing environments conducive to the performance of management and administrative activities, accounting, marketing, information processing, consulting, human resources management, financial and insurance services, educational and medical services and other professional services. At least 90 percent (90%) of the interior space is designed and finished to accommodate office usage but the space may include other usage.

Office Building Types:
Low-rise: fewer than seven stories above ground level.
Mid-rise: Between seven and 25 stories above ground level.
High-rise: Higher than 25 stories above ground level.

Office Building Complex / Suburban Parks: Defined as a group of buildings that have common management personnel, common management practices, and a common central plant.

Office Module	
BOMA BESt Assessment Section	Weight (%)
ENERGY	35
WATER	8
WASTE DIVERSION & SITE	11
EMISSIONS & EFFLUENTS	17
INDOOR ENVIRONMENT	18
ENVIRONMENTAL MANAGEMENT SYSTEM	11

Table 2.15 BOMA BESt SCORING BY ASSESSMENT SECTION
Source:BOMA BESt Assessment Overview 2013 by BOMA Canada.

Green Office Partnership

Whether you own your office space or lease it, as an office manager you make operational and purchasing choices every day that can significantly reduce the footprint of your office and provide a cleaner, healthier environment for your staff.

The **Green Seal** Green Office Partnership Program is designed to guide offices in the straightforward steps they can take to become more sustainable. The program focuses only on those areas that are within the direct control of office managers, including:

- Waste reduction and recycling
- Office supplies
- Kitchen and pantry supplies
- IT equipment and management
- Operational systems
- Transportation
- Training and education for staff

2.2.12. CASBEE (JAPAN)[184]

CASBEE stands for Comprehensive Assessment System for Built Environment Efficiency: The Japanese Green Building Council (JaGBC) has developed a comprehensive family of green building rating tools for many markets and building types. The CASBEE rating systems are designed to analyze building performance at several stages in the building lifecycle. Currently, there are four distinct tools to match building phases from pre-design to renovation for commercial and industrial buildings. All of the rating tools use two general categories of analysis. Q (quality) assessments are taken at the building level, while L (load) assessments look at the building's impact on the local environment or neighborhood. Buildings are rated using the Built Environment Efficiency (BEE) ratio by taking Q category scores and dividing by L category scores.1 See figure below (See figure 2.13).

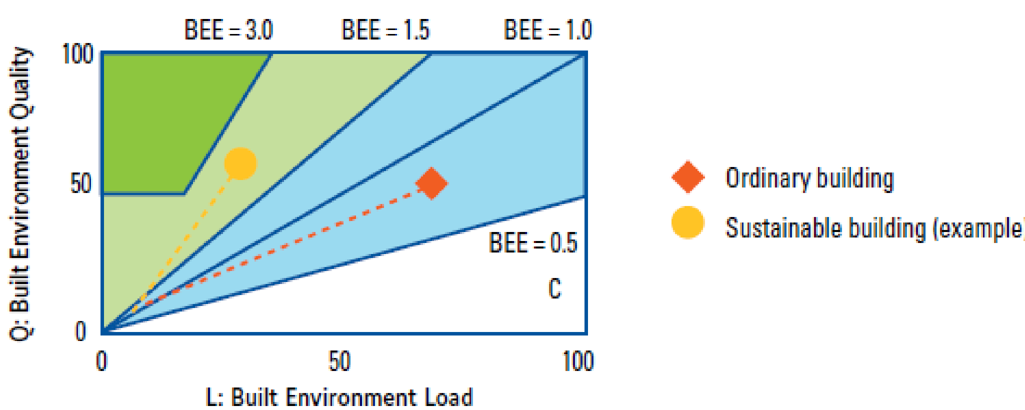

Figure 2.13 CASBEE sustainability process

[184] Green Building Rating Systems: JAPANFact Sheet September 2013

One of the main characteristics of LCA tools, It is how they implemented two important topics energy efficiency, and environmental impact. Since CASBEE is a performance oriented system they establish their own scale to determine a coefficient Q for (Built Environmental Quality), in my opinion this create a leverage in comparison with other systems.

Two Categories of assessment **Q** and **L**

Under CASBEE there are two spaces, internal and external, divided by the hypothetical boundary, which is defined by the site boundary and other elements, with two factors related to the two spaces. Thus we have put forward CASBEE in which the **"negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)"** and **"improving living amenity for the building users"** are considered side by side. Under CASBEE, these two factors are defined below as **Q** and **L**, the main assessment categories, and evaluated separately.

Q (Quality): Built Environment. Evaluates "improvement in living amenity for the building users, within the hypothetical enclosed space (the private property)."
L (Load): Built Environment. Evaluates "negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)."

BEE (Building Environment Efficiency)= Q (Quality): Built Environment/ L (Load): Built Environment (See figure 2.13)

"In Japan, a sustainable building is often defined as one that is designed "to save energy and resources, recycle materials and minimize the emission of toxic substances throughout its life cycle, to harmonize with the local climate, traditions, culture and the surrounding environment, and to be able to sustain and improve the quality of human life while maintaining the capacity of the ecosystem at the local and global levels"[185]. While the emphasis on energy, resources and recycling are commonly the focus subjects in sustainable building, which is obvious within the LEED guidelines, the concept of **harmoniz[ing] with the local climate, traditions, culture and the surrounding environment** ***is somewhat unfamiliar to the American culture."*** [186]

Current CASBEE Tools for Commercial, Industrial and Residential Buildings:[187]

- Tool 0 – CASBEE for Pre-Design (Under development)
- Tool 1 – CASBEE for New Construction
- Tool 2 – CASBEE for Existing Buildings
- Tool 3 – CASBEE for Renovation

A number of other versions of the CASBEE rating systems exist for specific purposes, such as heat island minimization, urban development and city planning. CASBEE assesses issues under the following categories:

[185] Architectural Institute of Japan (AIJ). (2005). Architecture for a Sustainable Future – All About the Holistic Approach in Japan. Institute for Building Environmental and Energy Conservation (IBEC).
[186] http://www.ide.titech.ac.jp/~nabe/wp/casbee-vs-leed-how-is-each-embraced-by-its-building-community/
[187] http://www.ibec.or.jp/CASBEE/english/overviewE.htm

Energy efficiency
Resource efficiency
Local environment! Indoor environment

Facts:

- By April 2015, the total number of the CASBEE certified buildings is over 450.[188]
- By March 2015, 24 Japanese local governments have introduced CASBEE system as their environment measures for encouraging green buildings. The governments require the building owners to report the assessment results by CASBEE before its construction.
- By March 2014, 14048 reports have been submitted to the local governments
- There are over 12000 CASBEE-APs in total. (as of March 2015)

2.2.13. Eco-cycle (Sweden)

There are important drivers in the planning development process of communities or districts, these drivers determine energy, and water schemes, either within the boundaries of a development or a neighbourhood (Appleby, 2011): [189]

- Carbon efficiency
- Economies of scale and diversity
- Potential for external funding, design, construction and operation
- Energy strategy of local authority

Eg.: Iceland derives 95 % of its heating from geothermal district heating, Denmark offsets 60 % of its total heat demand from district systems, 80 % of which uses CHP plant[190]

Appleby suggests that permutations of energy can be applied to system to meet energy demand, such as: Integrated photovoltaic cells or wind turbines and concluded that economic equation will depend on the availability of a feed in tariff (see energy section in chapter one) for electricity and the differential between tariffs for differential sources. For this reasons it is important to have and integrated utility approach like Hammarby used in Sweden, and involve Eco-Cycle Model showed in figures.2.14, 2.15, and 2.16.

The **Eco-Cycle Model 2.0**. was one of a total of five sub-projects in the city of Stockholm which have been granted economic support from the Swedish Delegation of Sustainable Cities in order to contribute to making the Royal Seaport in Stockholm a world-class environmental profiling urban area. This Model includes overall and detailed descriptions of resource flows in different time perspectives such as:[191]

- Global and local challenges concerning to natural resources depletion with specific relevance for urban development
- Available models which visualise functions, resource flows and resource synergies in the eco-cycle in a qualitative way
- Available accounts of flows of material, energy and water

[188] http://www.ibec.or.jp/CASBEE/english/statistics.htm
[189] District energy schemes require large central plant rooms and usually extensive lengths of buried pipework.
[190] http://www.greencitytimes.com/Sustainability-News/geothermal-district-heating-in-iceland.html
[191] IDEM

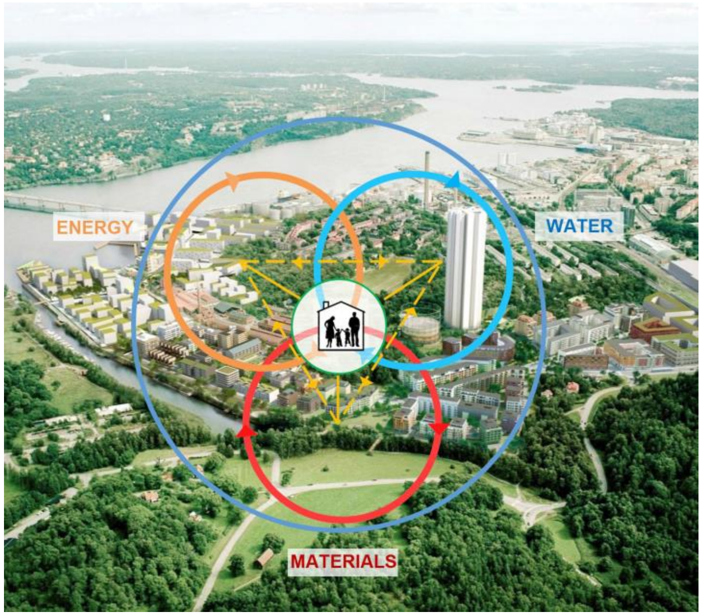

Figure 2.14 Feasibility study final report City of Stockholm KTH School of Architecture and the Built Environment, Ulf Ranhagen and Björn Frostell, July 2014 retrieved from: http://cal.abe.kth.se/uploads/Reports/Eco-cyclemodel2.0.pdf[192]

In order to accomplish project´s goals the stakeholders were involved in the development process, representatives from different organisations were invited to two workshops where ideas were developed and combined.

The primary objective of the eco-cycle model is to contribute to drawing attention to and explaining important connections and synergies between resource flows.

The secondary objectives that can be fulfilled after supplementing the development work:

- Monitoring and follow-up of environmental objectives
- Continuous analysis of resource flows including the operations phase
- Comprehensive

The proposed eco-cycle model 2.0. is not only a general map of functions and flows related to the eco-cycle which characterised the Hammarby Model (Figure 2.15), but also a line of arguments supported by illustrations on four different levels: (Venou, 2014)

- **Level 0** Established theories and concepts for sustainable societal and urban development constituting the basis of the eco-cycle model
- **Level 1** Anchoring of the eco-cycle model in a more comprehensive sustainability concept
- **Level 2** General Map of functions and flows related to the eco-cycle model including optional systems solutions both within and outside the city district (outside the defined systems boundary). Conceptual future image for 2030 with a perspective towards 2050.
- **Level 3** Resource flow analysis related to accounting systems for energy, material and water eco-cycles. Conceptual future image for 2030 with a perspective towards 2050.

[192] Feasibility study – final report Eco-cycle model 2.0. for Stockholm Royal Seaport City District, July 2014 retrieved from: http://cal.abe.kth.se/uploads/Reports/Eco-cyclemodel2.0.pdf

City statement for a neighborhood project:

Eg. As it is described in Walkable City (2010), for the case of Stockholm Royal Seaport "the focus will be on energy-use, transport, climate friendly living, the eco-cycle (see Box: Eco-Cycle Model 2.0) and lifestyle issues that will contribute to make this neighbourhood fossil fuel free by 2030". (Venou, 2014)

Some of the outcomes derived from Eco – Cycle´s Energy section for Stockholm was that the city needs to reduce fossil dependency, to raise the share of renewable electricity and to improve the efficiency of the system in general (reduce losses) needs to be utilized to a significantly higher degree. Heat pump technology and geothermal energy can also be developed as an integral part of the district heating and cooling system in order to reduce emissions.[193]

Maybe, one of the biggest limitations of green building ratings systems is the impacts that they create in the communities; they have also received critics for the lack of commitment to create links between building owners, communities, and authorities. In recent years, programs like BREAAM Communities, and LEED for Neighborhoods have tried to fill that gap. Eco – Cycle model brings a different approach to develop Urban Planning Process. This system encompasses Global, and local Levels, and allow us differentiate developed countries from developing countries.

Global leves

At the global level there are at least three main concepts that have had relevance in the development of the eco-cycle model: the planetary boundaries concept, the ecological footprint and the carbon footprint Planetary Boundaries (the planet's limits) is a new approach to defining the conditions for human development that was launched in a now well known article in Nature in 2009, see (Rockström, J. et al, 2009).[194] Here, it has been found that exceedance of the basic biophysical boundaries will have serious consequences for humanity. Three of the nine thresholds that are presented have already been exceeded to a major extent as a result of human actions and activities that have significantly affected the environment since the industrial revolution.
(For further information on this topic see section 4.3)
The researchers present the following facts:

1. The accelerating loss of biodiversity including the reduction of certain species in the wild is estimated to be 100-1,000 times higher than what can be considered natural.

2. Negative impact on the nitrogen and phosphorous cycles, with conversion of more than 120 million tonnes of nitrogen from the atmosphere into reactive forms, mainly due to production of synthetic fertilizers and legumes, as well as a tenfold increase in the amount of phosphorous that flows from agriculture fields into the oceans compared to preindustrial levels.

3. The ongoing climate change has attracted even more attention since the article was published, and many people are questioning the viability of limiting the increase in the global temperature to 2 degrees Celsius, which would demand a limitation in the

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[193] http://hammarbysjostad.se/?lang=en
[194] http://www.ecologyandsociety.org/vol14/iss2/art32/

atmospheric CO_2 concentration to 350 ppm and a maximum increase in outgoing heat radiation to 1W/m2 compared to pre-industrial levels.

These three factors are closely linked to the six other boundary conditions: global use of freshwater, land use change, the presence of aerosols in the atmosphere, chemical pollution, acidification of the oceans, and reduction in the levels of stratospheric ozone.

Local level

Eg. ***Stockholm has been successful in combining a decrease in CO2 emissions with economic growth. According to a recent OECD report (2013),reduced its per capita CO2 emissions by 30% while economic growth (measured as GDP per capita) increased by 76%.*** [195]

Challenges that are mentioned in the OECD report and are of direct relevance for the eco-cycle model are:

District heating and cooling, which provide for 80% of the heating and cooling needs in Stockholm, have strongly contributed to low per capita emissions in Stockholm. District heating and district cooling account for 10% of the region's electricity use. Although district heating is primarily produced using biofuels (37%) and waste incineration (31%), around one third (32%) is based on fossil fuels in the form of oil and coal.

Although waste generation in Stockholm is somewhat lower than the average for the OECD countries (1.43 kg/capita/day compared to the OECD average of 1.48 kg/capita/day), the share of incineration of solid waste is high (69%) and the recycling rate for organic waste and bulky waste is relatively low.

Eg: European cities. It is notable that of the household waste that is incinerated, 38% consists of organic waste that could be utilized for production of biogas.

Stockholm enjoys a high quality supply of fresh water. Lake Mälaren provides 90% of Stockholm's drinking water and in the past 10 years, 96% of the water samples have shown the highest level of water quality according to the EU Water Framework Directive and 4% have shown the second highest level. There are potential risks in the current trends for protection of fresh water reservoirs in the form of increased run-off of polluted storm water into Mälaren. With a projected rise in sea levels by 50 cm by 2050, saltwater penetration into Mälaren may require extensive infrastructure measures.

[195] *This does not include the CO2 that is embedded in our imports, for example of consumption goods*.

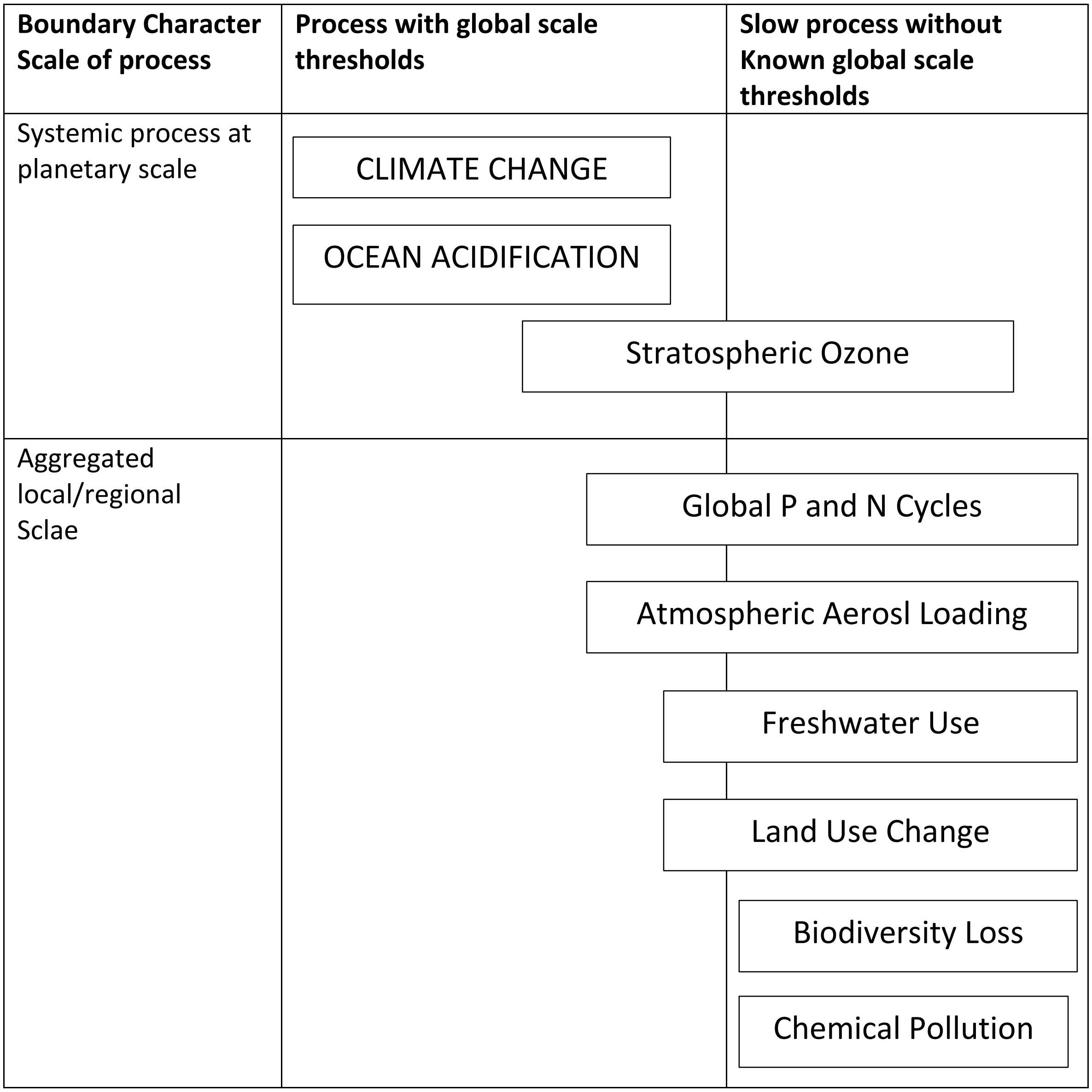


Figure 2.15 Categories of planetary boundaries (Rockström, J. et al, 2009) retrieved from: http://www.ecologyandsociety.org/vol14/iss2/art32/

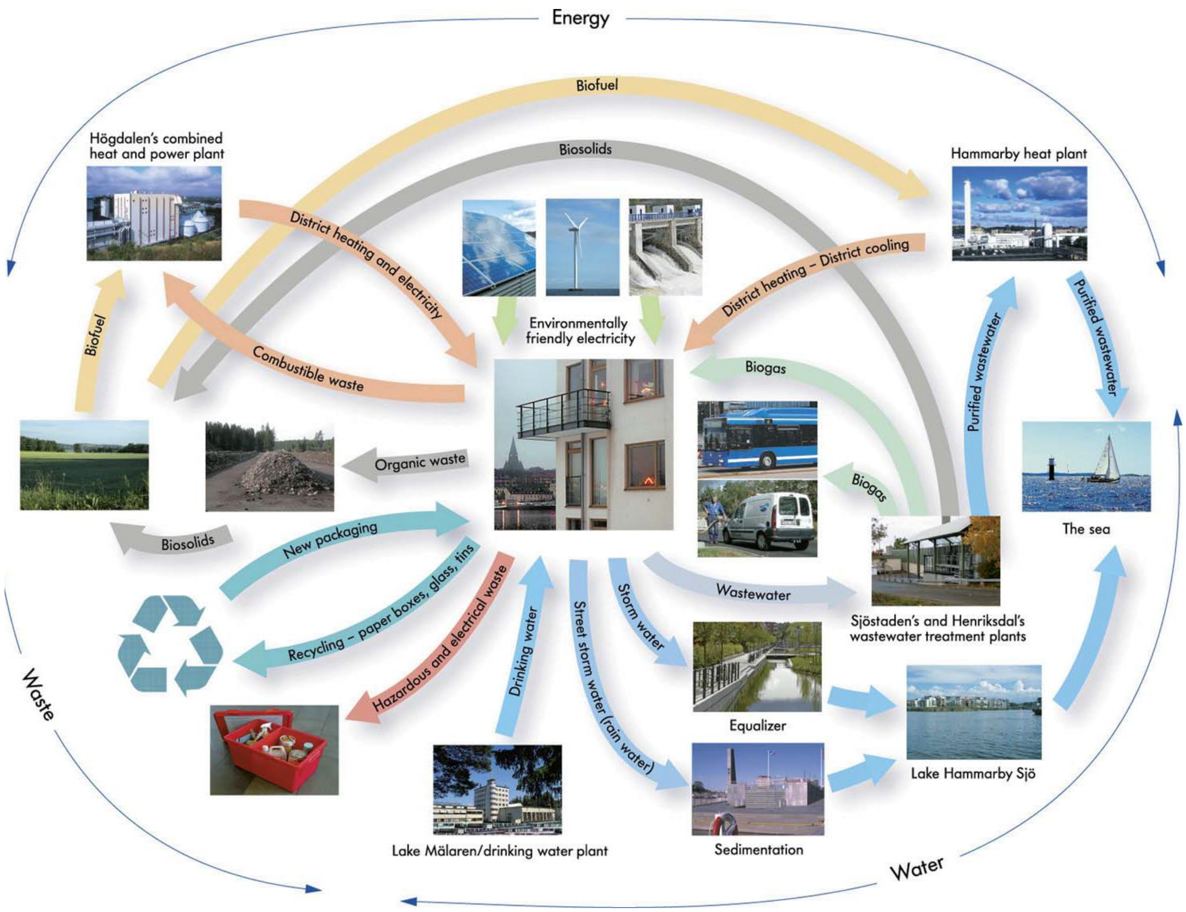


Figure 2.16 The Hammarby model Eco-cycle model 2.0 for S.R.S.(Stockholm Royal Seaport)[196]

In particular, there are two main types of earlier approaches that have been useful as a basis for development of the eco-cycle model:

- Models that visualize functions, flows and synergies in the eco-cycle in a qualitative way.
- Material, energy and water accounts that quantify functions and flows in the eco-cycle.

[196] The so-called Hammarby Model (see Figure 2) is naturally an important platform for this work, since for many years it has served as a basis for describing the intentions in terms of the resource cycles for energy, water and waste in Stockholm's first environmental profiling urban area, Hammarby Sjöstad.

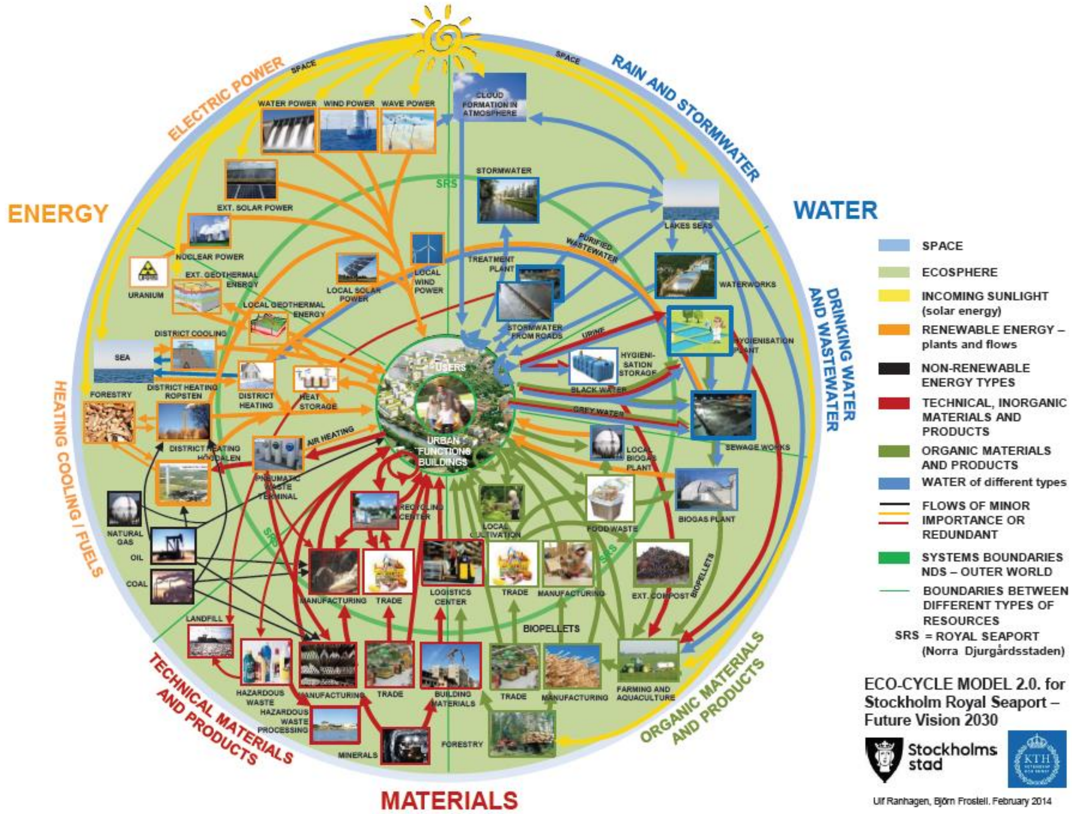


Figure 2.17 Final draft Eco-cycle model with overview of functions, flows and synergies.

It is important to remark how detailed is the analysis in the case Stockholm Royal Seaport, Figure 2.17 show us how the three main areas are divided. Water is divied in two blocks one includes water that is related in human consumption, and the other with nature; Energy is divided in electric power, and heating cooling process, finally Materials are split in Technical, and organic Materials.

Eco-system also incorporates four different types of services that involve not only human related actions: This services are included in the final draft of the process diagram as showed in figure 2.16.

- **Supporting services** are necessary for the production of all other eco-system services, such as nutrient and water cycling.
- **Regulating services** consist of somewhat more specific functions such as pollination, purification of air and water, as well as attenuation of storm water flows (our addition).
- **Cultural services** include everything that we use for our more emotional well-being, such as aesthetic and recreational experiences
- **Provisioning services** refer to food and materials that we can obtain and use more or less directly.

Figure 2.18 shows how Eco-Cycle 2.0 is used in the planning process of new cities, sustainable reviews, and transformation of cities in different cities around the world. This process has raised interest not only in Europe, but also in America and Asia.

Planning of new cities and towns[197] Tangshan Bay Eco-City, China Chang-Ji Special Eco-Zone, China The Dongli Lake Project, China Wuxi Eco-City, China Luodian Town in Shanghai, China Baltic Pearl Project, Russia Skolkovo Innovation City, Russia Hammarby Sjöstad, Sweden[198] Western Harbor in Malmö, Sweden	 ***NEW CITIES* TANGSHAN BAY ECO-CITY, CHINA**
Sustainability reviews Cork South Docklands Master Plan, Ireland Toronto Waterfront Revitalization Project, Canada Hohhot and Wuhai Green Cities, Inner Mongolia	 ***SUSTAINABILITY REVIEWS* TWRC TORONTO WATERFRONT REVITALIZATION PROJECT, CANADA**
Transformation of cities and towns Matsumoto City and Yamada Town Workshop, Japan Edmonton City Center Airport Lands, Canada Tallinn Old City Harbor, Estonia Nelson Mandela Bay Municipality, South Africa River City International Workshop, Sweden	 ***TRANSFORMATION* TALLINN OLD CITY HARBOR, ESTONIA**

Figure 2.18 Eco-cycle world projects

[197]https://www.sweco.se/Global/Sweden/Areas%20of%20operation/Architecture/Documents/SUCI_brochure_US_english_100dpi.pdf
[198] http://siteresources.worldbank.org/INTEASTASIAPACIFIC/Resources/226262-1246459314652/Eco2Cities_PartThree_ConfEdition6-26-09.pdf

2.3. Mexico

In order to present and introduction for chapter three I would like to introduce some facts , and quotes related to the main Green Building programs, and policies in Mexico, that demonstrates both success cases, and failing programs in recent Mexican administrations.

The National Balance of 2008, states that the annual energy consumption was 4,815 PJ, which 19% belongs to residential, commercial and public sectors, the energy main demand belongs, this type of building accounts for 27 % national electric power.[199]

According with a research developed by **the Institute of Engineering of the National Autonomous University of Mexic**o, determined that hospitals, schools, hotels, and self-service stores are the main consumers of electric power per unit area.

"*Mexico City has the highest level of energy efficiency, only using 0.3 gigajoules of electricity to generate US$1,000 of GDP (Index average: 0.8 gigajoules)."* [200]

"The state of Jalisco is developing a "State Action Programme on Climate Change", modeled on other statewide plans created elsewhere in Mexico. Although still unfinished, some of the plan's details have been released. It will call for an inventory of greenhouse gas emissions in the state, and promote greenhouse gas reductions through a number of specific measures aimed at buildings, landfills, transport, and forest protection. Many of these measures are aimed specifically at improving Guadalajara's environmental performance. In addition, the 2009 opening of the city's first "bus rapid transit" (BRT) could reduce the city's CO2 emissions by 30,000 tonnes per year, according to city officials (see "green initiatives" under "Transport" below)." [201]

Since 2012, Zapopan Municipality has provided tax benefits for projects developed under USGBC standards (LEED), according to tax year report of 2014, from 2012 to 2014 up to 1 million dollars has been granted to green building projects in the municipality since this program started.

2.3.1. FIDE (Energy Savings Trust, Mexico)

FIDE is a private, non-profit organization created in 1990 by the national power utility (CFE) and is supported by a small internal tax on CFE's suppliers and by loans from international development banks. FIDE´s objective is to promote actions that encourage and foster electricity conservation and its rational use. FIDE has provided financing for hundreds of energy audits and the purchase of several million units of energy efficient lamps, motors, AC units and refrigerators, thus achieving important energy savings in industrial and commercial installations of the private sector, as well as municipal lighting and pumping systems[202]

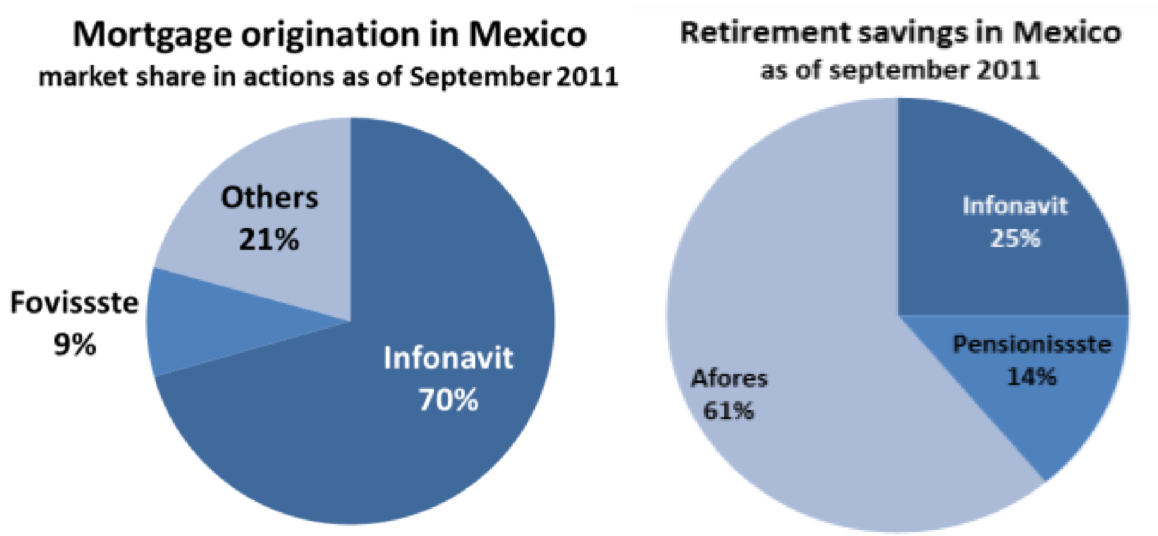
[199] Estudio sectorial edificaciones sustentables, Centro Mario Molina, 2012
[200] The Green City Index A summary of the Green City Index research series A research project conducted by the Economist Intelligence Unit, sponsored by Siemens
[201] Latin American Green City Index Assessing the environmental performance of Latin America's major cities A research project conducted by the Economist Intelligence Unit, sponsored by Siemens
[202] http://www.ewg.apec.org/documents/EWG34PledgeReview_Mexico.pdf

"In 2000, Promoting and Energy Efficient Public Center (PEPS) and CONAE, the National Commission for Energy Conservation, began a programme to promote energy-efficient purchasing by national government agencies in Mexico. The idea was to take advantage of the momentum of the APF program, which was demonstrating considerable success in generating audits and lighting retrofits in large government buildings. PEPS aimed to get APF-participating agencies and facilities to institute procurement policies that, as a complement to the retrofit projects, would commit them to buy energy-efficient products in their day-to-day purchasing. However, the effort to launch a full-blown initiative at the federal level was not successful.[203]

2.3.2. Green Mortgages (INFONAVIT – MEXICO)

The Mexican National Fund for Workers' Dwelling (INFONAVIT) has a dual nature in the Balance sheet: as a Social Mortgage lender (assets) and as a Pension Fund (liabilities) both are the axes from which all action takes off in Infonavit, which is also a Fiscal authority for collection of mortgages and contributions.(See figure 2.16)

INFONAVIT has recently launched and is promoting loans and special mortgages for people who acquire properties with green features, especially those related to energy saving. This institute is an organization founded in 1972 whose main function is to give workers credit for home acquisition. The 'Green Mortgage' program was launched in 2007.



Facilitate opportunities for homeownership to low income workers.

Receives funding and pays competitive returns, Infonavit has the 25% market share of total retirement funds.

Figure 2.19 Mortgage and Retirement programs in Mexico

[203] Eco-Innovation Policies in Mexico http://www.oecd.org/mexico/42876980.pdf

"The increase in the financing the Infonavit gives to the families goes from six to eight thousand pesos, which equal about 720 US dollars but the institute says can represent an extra bedroom or a more spacious house. The benefits are also for developers: according to the institute, the ones who aim to build projects with these characteristics have easier city hall paper work. The 'Green Mortgage' plan was inspired by all the initiatives that have took place in the United States, Canada or Australia, and aims to encourage green building in the country".[204]

"It's likely that widespread regulatory requirements and subsidies will be needed to force the Mexican building industry to adopt green practices So far, the most successful case of an association leading a positive change in the industry is the "Hipoteca Verde" (Green Mortgage) by national mortgage lender Infonavit. This program led to booming demand for basic green construction products such as insulating panels, heat-reflective paint, and solar water-heating systems, and five million green mortgages were initiated during the last six years."[205]

Note: This program will receive further annalist in chapter three.

2.4. Standards

Sustainability and environmentally friendly construction are not mere bywords; a whole host of standards for materials, construction methods and traceability exist to ensure that materials are eco-friendly, waste is minimized and safety standards are met. Green construction standards have been issued by groups from the ISO to ASTM to LEEDs.[206]

ISO 9000 (quality)
ISO 14000 (environmental management)

ISO STANDARDS (International Organization for Standardization)[207]

ISO is not truly an acronym. It was chosen as the name for the organization because it means equal in Greek. No one acronym would be the same in every language worldwide. Currently, ISO has 16,500 standards in a wide range of categories including agriculture, construction, mechanical, engineering, manufacturing and distribution, transportation, medical devices, information communication technologies, good management practices and services. The standards are created with a consensus based process in which each member country has one vote, giving each member equal power. The types of standards created are largely market driven by a current need. Following ISO standards is voluntary and all standards are reviewed periodically at least every five years to keep up with changing technologies and market innovations.[208]

ISO designates its standards with numbers. Usually the number refers to a specific standard but sometimes the number refers to a family of standards. ISO 14000 refers to a family of standards in

[204] http://www.treehugger.com/corporate-responsibility/green-mortgage-to-promote-sustainable-building-in-mexico.html
[205] http://www3.cec.org/islandora/es/item/11387-improving-conditions-green-building-construction-in-north-america-enhancing-capabilities-en.pdf
[206] http://hubpages.com/technology/Sustainability-and-Green-Construction-Standards
[207] www.iso.org
[208] IDEM

the environmental management category. ISO 14001:2004 is part of the environmental management family. The date indicates when the standard was created or last updated.

An increasing number of construction firms are becoming certified to international standards worldwide, especially the International Organization for Standardization ISO 14001 series, which provide guidelines for implementing an EMS. (Gwen Christini, Michael Fetsko and Chris Hendrickson, 2004)

The ISO 14000 family is a commonly noted standards family regarding sustainability. It sets out guidelines for a company or organization to create an Environmental Management System (EMS) to help the organization reduce pollution, save natural resources and in general minimize their negative impact on the natural world. ISO 14001:2004 provides the framework for a holistic, strategic approach to the organization's environmental policy, plans, and actions. ***"It gives generic requirements but does not prescribe how the goals are to be met and does not require specific levels of environmental performance"***[209]. It does require objective evidence, which can be audited to verify continual improvement.

Their environmental policy encompasses the following seven areas:

1. Regulatory compliance,
2. Prevention of pollution,
3. Conservation,
4. Emissions and effluents,
5. Ecology and habitat,
6. Hazardous and toxic substances, and
7. Communication

Additional specific environmental concerns that are addressed in the 14000 family include environmental aspects of products, environmental labeling, environmental performance evaluation, life cycle analysis, and environmental communication.[210]

Standards relating to sustainable design:

ISO 16813:2006 General principles of building environment design including IAQ. Applies to new construction and existing buildings.
ISO 15392:2008 General principles of sustainable design/build based on life cycle concerns. Does not include benchmarks from which claims can be made.
ISO 21930:2007 Principles and requirements for type III environmental declarations of building products.
ISO 19011:2002 Guidance for conducting Environmental management System (EMS) audits and for competence of auditors.

[209] http://easytobegreen.com/Preview/standardsP.shtm
[210] Environmental management The ISO 14000 family of International Standards http://www.iso.org/iso/theiso14000family_2009.pdf

The following standards relates with indoor quality environment:
ISO 16017-2:2003 General guidance for sampling and analyzing volatile organic compounds (VOCs) in indoor ambient air. Note: the 16000 family addresses many other indoor air quality issues.
ISO 17624:2004 Guidelines for noise control in offices and workrooms by means of acoustical screens. Note: one example of many acoustics related standards.

ISO 14064 International Standard for GHG Emissions Inventories and Verification[211]

Part 1*: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*

Part 2*: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements*

Part 3*: Specification with guidance for the validation and verification of greenhouse gas assertions*
This part of I**SO 14064** details principles and requirements for designing, developing, managing and reporting organization- or company-level GHG inventories. It includes requirements for determining GHG emission boundaries, quantifying an organization's GHG emissions and removals, and identifying specific company actions or activities aimed at improving GHG management.

ISO 14064-2 focuses on GHG projects or project-based activities specifically designed to reduce GHG emissions or increase GHG removals. It includes principles and requirements for determining project baseline scenarios and for monitoring, quantifying and reporting project performance relative to the baseline scenario and provides the basis for GHG projects to be validated and verified.

ISO 14064-3 details principles and requirements for verifying GHG inventories and validating or verifying GHG projects. It describes the process for GHG-related validation or verification and specifies components such as validation or verification planning, assessment procedures and the evaluation of organization or project GHG assertions. Figure 2.20 displays the relationship between the three parts of **ISO 14064**.

[211] https://www.iso.org/obp/ui/#iso:std:iso:14064:-1:ed-1:v1:en

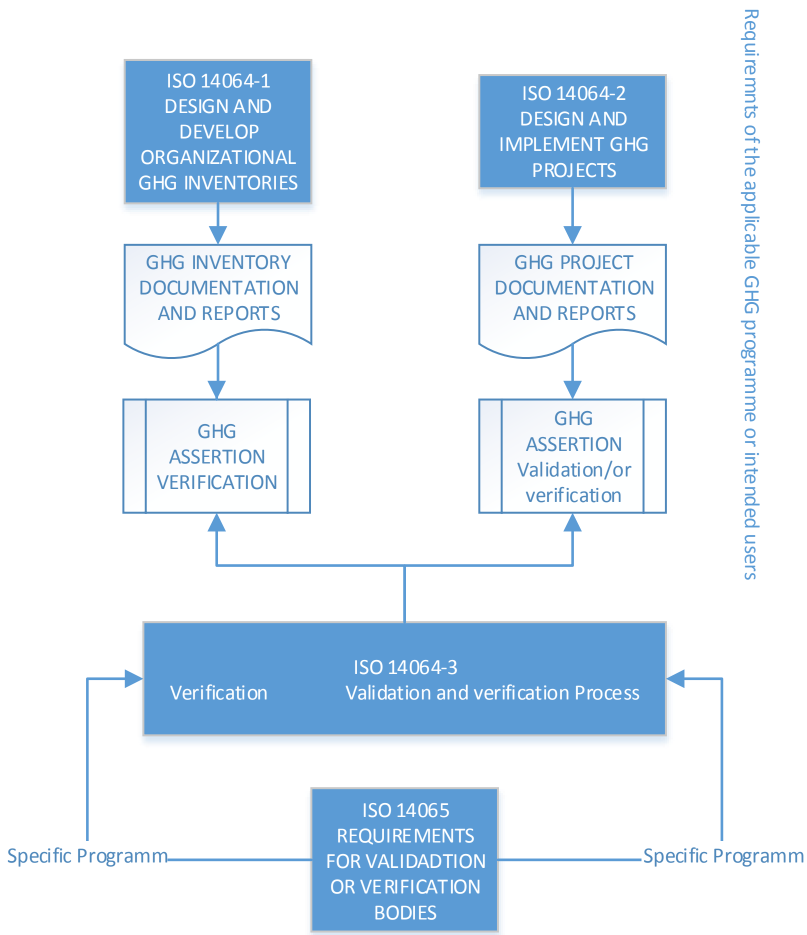


Figure 2.20 Relationship between the parts of ISO 14064
Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso:14064:-1:ed-1:v1:en

2.4.1. ISO 50001 - Energy management

Characteristics of ISO 50001

- Voluntary international standard framework to manage energy
- Based on “Plan – Do – Check –Act” continuous improvement cycle
- Leads to improved energy performance and reduced costs
- Integrates energy efficiency into management processes
- Shares many core elements in common with ISO9001 (quality) and ISO14001 (environmental) ISO standards (See table 2.16 to know how these standards interact with each other)

Content	ISO 50001	ISO 14001	ISO 9001
Core concept for establishing guidelines	Based on energy consumption of the whole organization or particular production process	Based on relevant environmental aspects	Based on clients' quality requirements
Policy	Energy policy illustrates the strategy of the organization on energy management. The policy provides the frame for setting up associated objectives and targets to enhance energy performance.	Environmental policy illustrates how the organization handles environmental matters, commitment to environmental protection, as well as associated objectives and targets. Normally the policy will include the organizations' commitment to preventing pollution, regulatory compliance and continuous improvement.	Meet the clients' Requirements
Strategy	Conducting energy reviews to identify significant energy use activities and set up energy baseline, as well as energy performance indicators Compliance to relevant regulatory requirements and setting up energy objectives, targets, and implementation plans	Compliance to relevant environmental regulatory requirements Setting up Environmental objectives, targets and implementation plans	Setting up quality objectives, targets, and quality management plans
Baseline	Energy baseline is foundational to establish the system.	No such Requirement	No such Requirement

Table 2.16 ISO 50001 vs Other Management System Standards Modified from: Guidebook for ISO 50001 Energy Management System[212]

[212] http://www.hkeia.org/iso50001/eguidebook/ISO50001%20guide_ENG%2019Aug(Final).pdf

ISO 50001:2011 specifies requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption.

ISO 50001:2011 specifies requirements applicable to energy use and consumption, including measurement, documentation and reporting, design and procurement practices for equipment, systems, processes and personnel that contribute to energy performance.

ISO 50001:2011 applies to all variables affecting energy performance that can be monitored and influenced by the organization. ISO 50001:2011 does not prescribe specific performance criteria with respect to energy.

ISO 50001:2011 has been designed to be used independently, but it can be aligned or integrated with other management systems.

ISO 50001:2011 is applicable to any organization wishing to ensure that it conforms to its stated energy policy and wishing to demonstrate this to others, such conformity being confirmed either by means of self-evaluation and self-declaration of conformity, or by certification of the energy management system by an external organization.

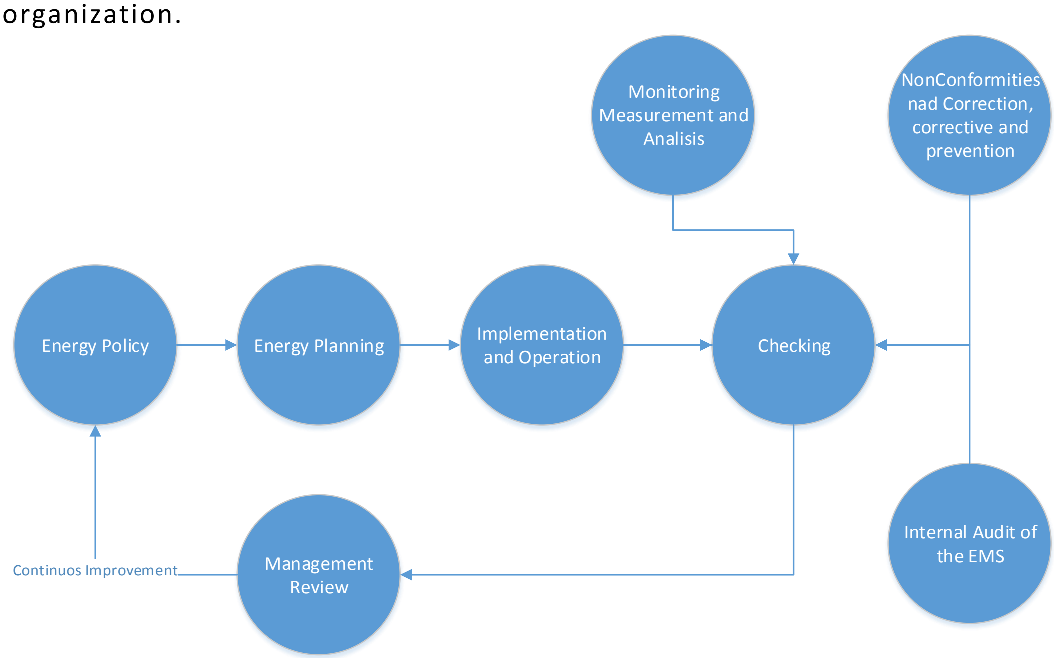


Figure 2.21 Main Elements of Energy Management

2.4.2. ISO 21931 Sustainability in building construction

ISO/TS 21931:2006, Sustainability in building construction—Framework for methods of assessment for environmental performance of construction works—Part 1: Buildings, is intended to provide a general framework for improving the quality and comparability of methods for assessing the environmental performance of buildings. It identifies and describes issues to be taken into account when using methods for the assessment of environmental performance for new or existing building properties in the design, construction, operation, refurbishment and deconstruction stages. It is not an assessment system in itself but is intended be used in conjunction with, and following the principles set out in, the ISO 14000 series of standards.

The ability to measure and understand the environmental performance of buildings is essential for communicating their potential environmental impacts and their influence on sustainable development.

This part of **ISO 21931** establishes a framework for methods of assessment of the environmental performance of buildings and related external works, which is a central part of the process. Such assessments can be used for benchmarking performance and monitoring progress towards improvement of performance. This part of ISO 21931 does not set benchmarks or levels of performance relative to environmental impacts and aspects.

The development of methods of assessment of the environmental performance of buildings has been ongoing since the early 1990s. This has been prompted by:

a. Recognition of impacts of buildings on the environment;
b. Increased focus on sustainability and sustainable development in the construction sector;
c. Need to meet the market demand for differentiation between buildings, based on measured environmental performance and environmental information;
d. Shift from single performance measures to a more comprehensive set of environmental considerations;
e. Recognition of the benefits of proactive voluntary measures.

The methods of assessment of the environmental performance of buildings provide a basis for demonstrating and communicating the result of efforts to improve environmental performance in construction works. The methods typically establish a means of assessing a broad range of environmental considerations against explicitly declared criteria, and give a summary of environmental performance.

The methods of assessment of the environmental performance of buildings provide:

- Common and verifiable set of references, such that building owners, striving for higher environmental standards, have a means of measuring, evaluating and demonstrating that effort,
- Reference as a common basis by which building owners, design teams, contractors and suppliers can formulate effective strategies in building design and operation, which are intended to improve environmental performance,

- Detailed information on the building which is gathered and organized in such a way that it can be used to lower operating, financing and insurance costs, and vacancy rates, and increase marketability,
- Clear description of the factors considered to be the key environmental considerations and their relative importance, thereby assisting the design process.[213]

The relationship among the International Standards is illustrated in the following figure.

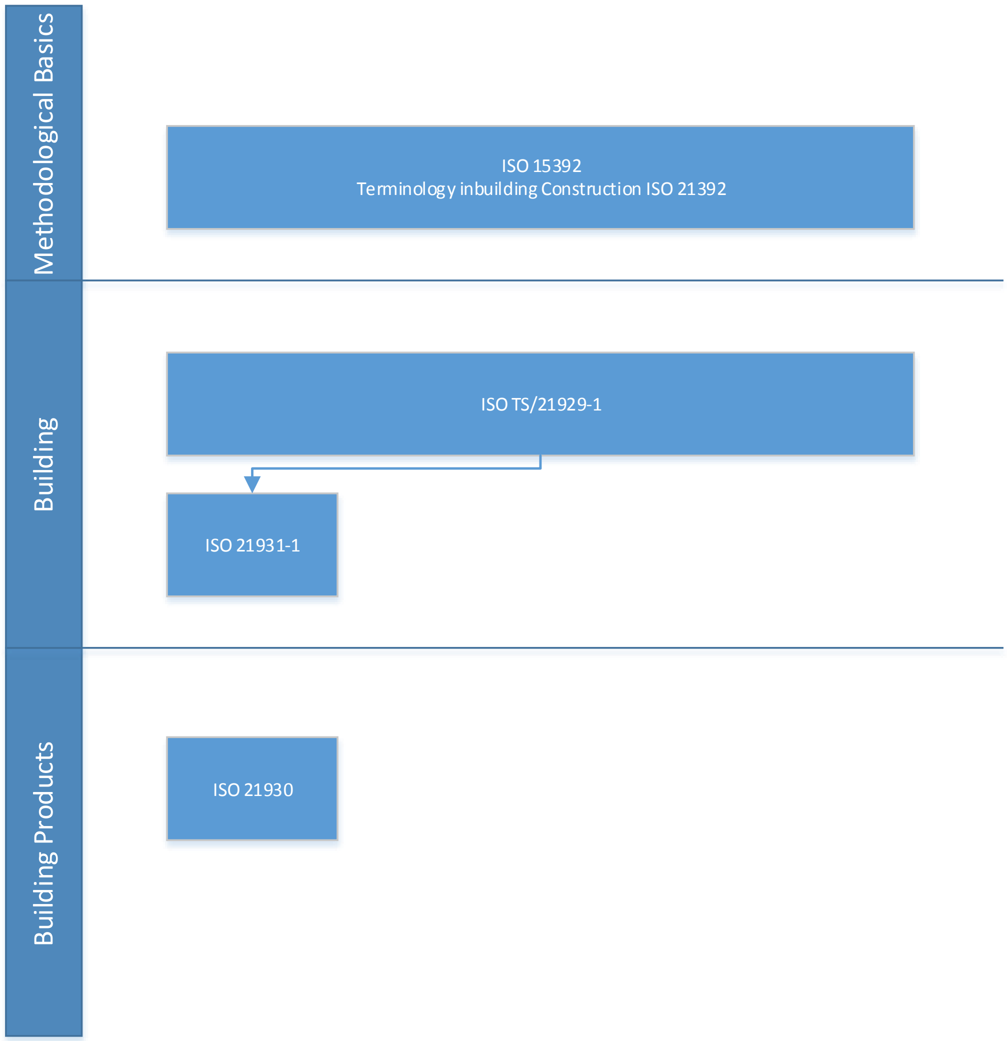


Figure 2.22— Suite of related International Standards for sustainability in buildings and construction works

[213] https://www.iso.org/obp/ui/#iso:std:iso:21931:-1:ed-1:v1:en

2.4.3. ISO 26000 - Social responsibility

This International Standard is intended to:

- Assist organizations in contributing to sustainable development.
- Encourage them to go beyond legal compliance, recognizing that compliance with law is a fundamental duty of any organization and an essential part of their social responsibility
- Promote common understanding in the field of social responsibility
- Complement other instruments and initiatives for social responsibility, not to replace them

In applying this International Standard, it is advisable that an organization take into consideration societal, environmental, legal, cultural, political and organizational diversity, as well as differences in economic conditions, while being consistent with international norms of behaviour.

This International Standard is not a management system standard. It is not intended or appropriate for certification purposes or regulatory or contractual use. Any offer to certify, or claims to be certified, to ISO 26000 would be a misrepresentation of the intent and purpose and a misuse of this International Standard. As this International Standard does not contain requirements, any such certification would not be a demonstration of conformity with this International Standard.

ISO 26000:2010 provides guidance rather than requirements, **so it cannot be certified to unlike some other well-known ISO standards**. Instead, it helps clarify what social responsibility is, helps businesses and organizations translate principles into effective actions and shares best practices relating to social responsibility, globally. It is aimed at all types of organizations regardless of their activity, size or location.

The standard was launched in 2010 following five years of negotiations between many different stakeholders across the world. Representatives from government, NGOs, industry, consumer groups and labour organizations around the world were involved in its development, which means it represents an international consensus.

2.5. ASHRAE

ASHRAE*: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, it has influence over two main categories:* ***CFC refrigerants*** *and* ***CO2 emissions*** *created when buildings use energy.* ***Environmental health*** *is another area ASHRAE influences with standards directed toward improved Indoor Environmental Quality, especially air quality and thermal comfort. The standards ASHRAE develops are used as a resource for code-writing, used by the government for federal buildings, are the basis for mandated energy efficiencies for buildings, and are referenced in voluntary programs like the U.S. Green Building Council's LEED rating systems.*

Environmental control standards include Energy Efficiency 90.1 and 90.2, Indoor Air Quality 62.1 and 62.2, and Thermal Comfort 55. The ASHRAE standards are numbered by category and then followed by a date which indicates the date the standard was created or revised. Energy Efficiency code 90.1-2004 is the latest version of that standard. ASHRAE also publishes a Handbook, Advanced Energy Design Guide, and GreenGuide which all support engineering professionals in sustainable practices. All ASHRAE standards are available for purchase and my be available in some public or University libraries for reference.[214]

2.5.1. ASHRAE Standard 62.1

ASHRAE Standard 62.1: Ventilation for Acceptable Indoor Air Quality is the most commonly referenced standard to quantify acceptable conditions and appropriate HVAC system design.

Some topics included in this standard are Fire, Life Safety Electrical, Lighting Building Types Codes and Standards HVAC Education and Training

ASHRAE 62.1: A review of key requirements and concepts

ASHRAE Standard 62.1: Ventilation for Acceptable Indoor Air Quality is the most commonly referenced standard to quantify acceptable conditions and appropriate HVAC system design.

Indoor air quality (**IAQ**) is probably the most commonly discussed aspect of building **indoor environmental quality** (**IEQ**). IAQ has direct effects on our health as well as the perception of an acceptable indoor environment. In the United States, **ASHRAE Standard 62.1**: Ventilation for Acceptable Indoor Air Quality is the most commonly referenced standard to quantify acceptable conditions and appropriate HVAC system design. **ASHRAE Standard 62.1** either forms the basis for most mechanical codes or is directly referenced by the codes themselves.

This standard is best known for its regulation of the amount of ventilation air delivered to each space by HVAC systems through its ventilation rate procedure approach to system design. However, the standard covers many other aspects of building design that are less well known and understood.

The key aspects of building design that it covers are outdoor air quality, envelope design and construction, HVAC system construction, concept of air classes, the ventilation rate procedure, the IAQ procedure, the natural ventilation procedure, and operations and maintenance.

Outdoor air quality[215]

Given the general approach within the standard of **"dilution is the solution to pollution"**,having good outdoor air quality is a very important premise when outdoor air is used as the **"fresh"** source to dilute the polluted indoor air. The standard requires two key pieces of information to perform the ventilation system design—demonstration of regional compliance with the National Ambient Air Quality Standards and the completion of a local survey of the specific project site. The survey is an important, and an often overlooked, aspect of the outdoor air quality. The survey is expected to focus on local sources of pollution—such as vehicular traffic—as well as other potential pollutant sources on adjacent properties such as boiler exhaust, process exhaust discharges, cooling tower discharges, and generator exhausts.

[214] http://easytobegreen.com/Preview/standardsP.shtm
[215] http://www.techstreet.com/ashrae/products/1865968

Outdoor air is required to be specially treated when the local conditions exceed the national standards. The standard focuses on outdoor air treatment of particulates and ozone. For high particulate areas, HVAC systems are required to provide varied levels of air filtration effectiveness (MERV 6 or MERV 11) depending on the whether the location is in particulate matter (PM) 10 or PM 2.5 noncompliance. For areas with ozone noncompliance, ozone removal systems must be installed. Luckily for most designers, there are only four locations listed that require ozone removal systems and they are all in California (Riverside, Kern, Los Angeles, and San Bernardino counties).

Envelope design and construction[216]

Unbeknownst to many architects, ASHRAE 62 includes aspects of architectural design within its scope of requirements—**it is not just a standard for mechanical engineers. It is important for mechanical engineering consultants and contractors to educate their architectural colleagues on those requirements.** The architectural requirements generally focus on moisture management within the building enclosure to prevent or reduce the risk of mold growth within the building and include requirements for vapor and air barrier constructions.

While the architect generally relies on the engineer to identify air inlet and exhaust locations, the specification and detailing of the louvers associated with these functions is often by the architect (Division 8 per CSI). In particular, the standard has specific requirements for rain intrusion protection for louvered openings that need to be specified and considered when selecting louvers for a project. **The other major aspect of the standard that affects architects is the requirement for physical separation of certain spaces, particularly between parking garages and occupied spaces and smoking and nonsmoking areas.**

HVAC system construction[217]

Like the architectural requirements, much of the focus of the HVAC system requirements deals with moisture management within the system and its components. The main area of focus is on the requirements for drain pan construction and placement. Additional requirements govern the materials used for air conveyance (limiting material susceptibility to moisture damage and mold growth as well as erosion), coil design (limiting coil pressure drop where inadequate access is provided), and insulation requirements to prevent condensation on interior surfaces (noting that specific resistance values are not required, it is up to the designer to determine the required thermal resistance for the specific application).

Access for proper operations and cleaning is also important to maintaining equipment to allow for continued high levels of IAQ. While many of the requirements are common practice, it is worth reviewing the standard when designing or inspecting systems to ensure adequate access and cleanability is provided.

This standard applies to all spaces intended for human occupancy except those within single-family houses. ANSI/ASHRAE Standard 62.1-2013 3 family structures of three stories or fewer above grade, vehicles, and aircraft.

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[216] IDEM
[217] IDEM

This standard defines requirements for ventilation and air-cleaning-system design, installation, commissioning, and operation and maintenance. Additional requirements for laboratory, industrial, health care, and other spaces may be dictated by workplace and other standards, as well as by the processes occurring within the space.

Although the standard may be applied to both new and existing buildings, the provisions of this standard are not intended to be applied retroactively when the standard is used as a mandatory regulation or code.

This standard does not prescribe specific ventilation rate requirements for spaces that contain smoking or that do not meet the requirements in the standard for separation from spaces that contain smoking. Ventilation requirements of this standard are based on chemical, physical, and biological contaminants that can affect air quality.

Consideration or control of thermal comfort is not included. This standard contains requirements, in addition to ventilation, related to certain sources, including outdoor air, construction processes, moisture, and biological growth.

2.5.2. Standard 189.1-2014[218]

Standard for the Design of High Performance, Green Buildings Except Low-Rise Residential Buildings

This standard provides minimum criteria that apply to the following elements of building projects:

- New buildings and their systems.
- New portions of buildings and their systems.
- New systems and equipment in existing buildings.

Address *site* sustainability, water use efficiency, energy efficiency, indoor environmental quality (**IEQ**), and the building's impact on the atmosphere, materials, and resources.

The provisions of this standard do not apply to single-family houses, multifamily structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular), and buildings that use none of the following: electricity, fossil fuel, or water.

This standard shall not be used to circumvent any safety, health, or environmental requirements.

[218] http://www.techstreet.com/ashrae/products/1865968

2.5.3. Standard 90.1-2013 (I-P)

Energy standard for commercial and multi-family residential buildings over three floors (ECPA, Public Law 94-385). PNNL analyzed the cost-effectiveness of changes in Standard 90.1 from 90.1-2007. **ASHRAE Standard 90.1** is the national model energy standard for commercial and multi-family residential buildings higher than three floors, which is the subject of this report.

The main target of this Standard is to render minimal prerequisites for the energy-efficient architecture excluding low-rise housing buildings. This Regulations provides (1) minimum energy-efficient demands for the plan and building of new buildings and their arrangements, 2) new constituents of buildings and their systems, and 3) new arrangements and equipment in present buildings and standard measures for verifying compliancy with these essentials.

The preparations of this standard apply to the envelopes of buildings, as long as the enclosed areas are heated up by a heating system for which the end product capacity is more important than or equal to 3.4 Btu/h ft2 or two cooled down by a temperature reductions system whose sound yield capability is greater than or equal to five Btu/hour ft2. The preparations also apply to the next systems and machinery used in co-occurrence with buildings: **1) heating, ventilating, and A/C, 2) service H_2O heating, 3) electric power distribution and metering capacities, 4) electric engines and belt drives, and 5) lighting.**

The plannings of this Standard do not apply to (a) 1 family habitations, multi-family constructions of three floors or fewer above grade, store-bought houses (mobile homes) and manufactured houses (modular), (b) constructions that do not use either electricity or petroleum, or (c) machinery and constituents of construction systems that employ energy mainly to allow for industrial, manufacturing, or mercantile processes. Where specifically noted in these Regulations, certain other buildings or components of buildings shall be free of. [219]

Energy Conservation in New Buildings except Low-Rise and Residential Buildings—was originally published in 1975. The current standard is 90.1-2010, and it was rewritten with the goal of reducing building energy costs by 30% compared to the 2004 version of the standard.

ASHRAE 90.1 addresses the energy-efficiency requirements for the design, materials, and equipment used in nearly all new construction, additions, renovations, and construction techniques. The requirements of 90.1 affect the overall energy efficiency of any structure and can reduce the energy needed to maintain a healthy, comfortable, and fully functioning indoor environment. The standard applies to:[220]

Building envelope
HVAC systems, equipment, and controls
Service water heating systems and equipment
Power
Lighting systems, equipment, and controls
Other equipment.

[219] http://www.sofame.com/index.php?module=CMS&id=92&newlang=eng
[220] http://www.csemag.com/home/single-article/documenting-ashrae-901-compliance/275aae2f4c30bf85951a68913f0103a7.html

Once you have determined whether your building must comply with the standard, the next step is to determine the best path for compliance. Standard 90.1 gives you three options:

- The simplified approach option for HVAC systems (Section 6.3)
- Mandatory provisions (Section 6.4) required for prescriptive path (Section 6.5)
- Mandatory provisions (Section 6.4) required for energy cost budget (ECB, Section 11).

Submittal Requirements

The last step in documenting compliance for all paths is the submittal requirement, and it includes the following:

Record drawings
Record drawings must be provided to the owner within 90 days of building acceptance.
O&M manuals: The manuals must include (at a minimum):
Submittal data
HVAC manuals
Service agency
HVAC control information
System balancing
Construction documents must require the systems to be balanced.
A test and balance report must be provided to the owner for spaces greater than 5,000 sqft.
System commissioning

For projects larger than 50,000 sq ft (except warehouse and semi-heated spaces), the instructions for commissioning the HVAC system must be provided by the system designer in the project plans and specifications. These instructions are also included in the record drawings provided to the owner.

2.6. Software

Several meteorological databases are available with different quality of data. However, they differ in input data, covered area, methodology, time intervals and spatial resolution. For this reason is important for the building design industry to have reliant on energy models as a means of proving total building energy performance.

Database based on ground station	**Database based on satellite images**	**Derived database and system integrating data**
World Radiation Data Center (WRDC) *http://wrdc.mgo.rssi.ru/ and http://wrdc-mgo.nrel.gov/*	SSE rel. 6 (NASA) *http://eosweb.larc.nasa.gov/sse/*	Solargis http://www.solargis.info
Global Energy Balance Archive (GEBA) *http://www.geba.ethz.ch/*	Satel-light (ENTPE) *http://www.satel-light.com/index2.htm*	NCEP/NCAR reanalysis (ESRL) *http://www.esrl.noaa.gov/psd/data/reanalysis/*
Baseline Surface Radiation Network (BSRN) *www.bsrn.awi.de*	HelioClim (Mines-ParisTech) *http://www.helioclim.org/*	ERA (ECWMF) http://data.ecmwf.int/data/
International Daylight Measurement Programme (IDMP) *http://idmp.entpe.fr/*	SolarAnywhere *http://www.solaranywhere.com*	Meteonorm (Meteotest) *http://www.meteonorm.com*
National Solar Radiation Database (NSRDB) *http://rredc.nrel.gov/solar/old_data/nsrdb/*	3TIER http://3tier.com	ESRA (Mines-ParisTech) *http://www.helioclim.com/esra/*
Deutscher Wetterdienst (DWD) *www.dwd.de*	SOLEMI (DLR) *http://www.solemi.de/home.html*	PVGIS (Joint Research Center) *http://re.jrc.ec.europa.eu/pvgis/*
	EnMetSol (Univ. of Oldenburg)	
	focus solar *http://www.focussolar.de*	
	Solargis http://www.solargis.info	

Table 2.17 Overview of available meteorological databases [221]

[221] Comparison of Different Sources of Meteorological Data for Central Asia and Russia Christian Budig* , Janybek Orozaliev and Klaus Vajen retrieved from: https://www.uni-kassel.de/maschinenbau/fileadmin/datas/fb15/100725_EuroSun2010_Paper_headline.pdf

2.6.1. METEONORm[222]

Meteonorm is a comprehensive climatological database for solar energy applications with databases from all parts of the world (see tables 2.18 and 2.19), that includes climatological data for solar engineering applications at every location on the globe. The results are stochastically generated typical years from interpolated long-term monthly means. They represent an average year of the selected climatological period based on the user's settings; this program also includes engineering simulation programs in the passive, active and photovoltaic application of solar energy with comprehensive data interfaces.

The *Meteonorm* software can be downloaded at http://meteonorm.com/en/downloads.
To specify a user defined site, the following parameters must be available:

- Name of site
- Coordinates (as longitude, latitude in decimal degrees)
- Altitude

	Parameter	**Unit**
m	Month	
dy or dm	Day of year or day of month	
h	Hour	
gh	Global radiation	[W/m²]
ta	Temperature	[°C]
dh	Diffuse radiation	[W/m²]
bn	Beam radiation	[W/m²]
td	Dew point temperature	[°C]
rr	Precipitation	[mm]
ff	Wind speed	[m/s]

Table 2.18 Parameters for data import. The timestamp (m, dy or dm, h) is mandatory, all other parameters are optional. The parameters must be separated with tabulators[223]

[222] http://meteonorm.com/images/uploads/downloads/mn71_software.pdf
[223] Export Formats More than 35 output formats are available: CSV, TMY2, TMY3, EPW, PVSol, PVSyst, Polysun etc. See the list of all formats

Available parameters	Global radiation and temperature	Temperature, additional parameters	Only temperature or radiation	Total
Europe	365	1'180	55	1'600
North America	343	2'252	30	2'625
South/Central America	92	638	70	800
Asia (with Russia)	325	1'540	35	1'900
Australia / Pacific	75	675	50	800
Africa	125	435	40	600
World	1'325	6'720	280	8'325

Table 2 19 Distribution and number of available stations.

2.6.2. RETSCREeN

RETScreen is a Clean Energy Management Software system for energy efficiency, renewable energy and cogeneration project feasibility analysis as well as ongoing energy performance analysis. It has an Excel-based clean energy project analysis software tool that helps decision makers quickly and inexpensively determine the technical and financial viability of potential clean energy projects. Under a Windows-based platform for energy management software tool that allows project owners to easily verify the ongoing energy performance of their facilities.

2.6.3. Green Building Studio[224]

Green Building Studio® is an energy-analysis software that enables architects and designers to perform whole-building analysis, optimize energy consumption, and work toward carbon-neutral building designs that starts at the earlier stages of the design process. One of its assets is that works in a Cloud-based energy-efficiency that helps teams to achieve sustainable building designs faster and more accurately with powerful energy and carbon-analysis tools.
Features:

Whole-building energy analysis
Detailed weather data
Energy Star and LEED support
Carbon emissions reporting
Daylighting
Water usage and costs
Natural ventilation potential

[224] http://www.autodesk.com/products/green-building-studio/overview

"The apparent benefit of this tool is that BIM-based design information and geometry can be used for energy analysis during the earlie ststages of the design process. It supports performance-based design via integrated energy modeling and analysis features. GBS is a web-based energy modeling software that can be used for early design decision-making, and allows for data exchange between BIM design programs and energy modeling engine."[225]

2.6.4. ATHENA[226]

ATHENA EcoCalculator assemblies for instant life-cycle assessment (LCA) results for hundreds of common building assemblies thanks to the *ATHENA® EcoCalculator for Assemblies*. LCA—which allows the impartial comparison of building designs based on measures such as global warming potential—is an essential part of the effort to help fight climate change by achieving ambitious reduction targets for greenhouse gas emissions while at the same time incorporating other "green" considerations. The results embedded in the tool are based on detailed assessments completed with the ATHENA® Impact Estimator for Buildings, which in turn uses ATHENA's own widely-acclaimed datasets and data from the U.S. Life Cycle Inventory Database.

Developed by the Athena Institute in association with the University of Minnesota and Morrison Hershfield Consulting Engineers, the tool was commissioned by the Green Building Initiative™ (GBI) for use with the Green Globes™ environmental assessment and rating system. Because of its value as an indicator of climate change impacts, the GBI supported the team's creation of a generic version for use by the entire sustainable design community. This variant, the ATHENA EcoCalculator, is available free of charge, in two versions: EcoCalculator for Commercial Assemblies and the new EcoCalculator for Residential Assemblies.

2.6.5. BEES[227]

BEES stands for Building for Environmental and Economic Sustainability. The BEES software brings a powerful technique for selecting cost-effective, environmentally-preferable building products. Developed by the **National Institute of Standards and Technology** (**NIST**) Engineering Laboratory, the tool is based on consensus standards and designed to be practical, flexible, and transparent. BEES Online, aimed at designers, builders, and product manufacturers, includes actual environmental and economic performance data for 230 building products, **measures the environmental performance of building products by using the life-cycle assessment approach specified in the ISO 14040 series of standards**. All stages in the life of a product are analyzed: raw material acquisition, manufacture, transportation, installation, use, and recycling and waste management. Economic performance is measured using the ASTM standard life-cycle cost method, which covers the costs of initial investment, replacement, operation, maintenance and repair, and disposal. Environmental and economic performance are combined into an overall performance measure using the ASTM standard for **Multi-Attribute Decision Analysis**. For the entire BEES analysis, **building products are defined and classified according to the ASTM standard classification for building elements known as UNIFORMAT II.**

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[225] Abul Abdullah and Ben Cross, Whole Building Energy Analysis: A Comparative Study of Different Simulation Tools and Applications in Architectural Design University of Massachusetts : http://aceee.org/files/proceedings/2014/data/papers/11-203.pdf

[226] https://wbdg.org/tools/athena_ec.php?a=1

[227] https://wbdg.org/tools/bees.php?a=1

2.6.6. e-Quest [228]and CanQuest[229]

Energy Conservation eQuest has;

- A function where Energy Efficiency Measures* can be created and manipulated to see the resulting changes to a model.
- A life cycle cost analysis tool for each EEM applied to the model. ESCO Analysis
- The opportunity to input several different utility bill rates and structures to find the annual cost difference for changing ESCOs.
- Utility rates can be complicated, and eQuest is equipped to handle the most complex billing structures.
- Simulated Building Performance

The program is equipped to handle multiple EEMs and a baseline.It is able to calculate daily values for energy consumption based on the building and the HVAC system inputs. It downloads weather data history from the internet. Once the simulation is performed, several reports are available

"P***rovides results by combining a building creation wizard, an energy efficiency-measure wizard and a graphical results display module with an enhanced DOE-2.2 derived building energy simulation program. The building creation wizard walks a user through the process of creating a building model. Within eQUEST, DOE-2.2 performs an hourly simulation of the building based on inputs that describe its construction, occupancy patterns, equipment load, plug loads and lighting loads, as well as heating and cooling systems. eQUEST allows users to create multiple simulations and view the alternative results in side-by side graphics."***

CAN-QUEST is new software from **Natural Resources Canada** (**NRCan**) for modelling building energy use. It is based on **eQUEST 3.62**. **CAN-QUEST** includes such features as:

- Canadian weather data support for metric and imperial measurements
- English and French interfaces

The tool improves upon **NRCan's EE4** software, which has been in wide use across Canada for more than 10 years.

Improvements in CAN-QUEST is supported by a DOE2.2 energy simulation engine uses advanced 2- and 3-D graphical representation of building geometry supports parametric runs for a quick assessment of an energy-efficient design supports technologies such as photovoltaics, ground loop heat exchangers, cogeneration, thermal storage, and new types of heating, ventilating and air-conditioning systems offers "wizard" functionality to allow for quick preliminary assessments of energy use provides detailed help resources within the user interface

Note: **National Energy Code of Canada for Buildings**(The 2011 *National Energy Code of Canada for Buildings* (NECB 2011) requires that **commercial and institutional buildings be 25 percent more energy efficient than the previous code**. To date, four provinces (Nova Scotia, Ontario, Manitoba and British Columbia) and one charter city (Vancouver) have adopted the NECB 2011. Several other provinces and territories are expected to adopt the NECB 2011 by 2015.)[230]

[228] http://www.doe2.com/equest/
[229] https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oee/files/pdf/publications/13-0431_CanQuest_e_Access.pdf
[230] idem

2.6.7. EE4[231]

The **EE4** computer software developed by NRCan was specifically designed as a compliance checking tool for the MNECB and NRCan's validation. Under NRCan rules, building energy efficiency must be calculated using EE4 software. In special circumstances, DOE2 is required to simulate features that are not readily simulated in EE4. This is allowed with prior written permission from NRCan provided the basic building architectural and mechanical systems are entered in EE4 to determine the corresponding reference case.

The EE4 software simulates the energy use of the proposed building design and the reference building design. (The software can also simulate the energy use of buildings that do not comply with the MNECB or that use non-standard operating schedules and inputs such as occupant heat gain and receptacle loads.

2.6.8. **EnergyPlus**[232]

Is a whole building energy simulation program that engineers, architects, and researchers use to model both energy consumption for heating, cooling, ventilation, lighting and plug and process loads and water use in buildings. Some of the notable features and capabilities of EnergyPlus include:

- **Integrated, simultaneous solution** of thermal zone conditions and HVAC system response that does not assume that the HVAC system can meet zone loads and can simulate un-conditioned and under-conditioned spaces.
- **Heat balance-based solution** of radiant and convective effects that produce surface temperatures thermal comfort and condensation calculations.
- **Sub-hourly, user-definable time steps** for interaction between thermal zones and the environment; with automatically varied time steps for interactions between thermal zones and HVAC systems. These allow EnergyPlus to model systems with fast dynamics while also trading off simulation speed for precision.
- **Combined heat and mass transfer** model that accounts for air movement between zones.
- **Advanced fenestration models** including controllable window blinds, electrochromic glazings, and layer-by-layer heat balances that calculate solar energy absorbed by window panes.
- **Illuminance and glare calculations** for reporting visual comfort and driving lighting controls.
- **Component-based HVAC** that supports both standard and novel system configurations.
- **A large number of built-in HVAC and lighting control strategies** and an extensible runtime scripting system for user-defined control.
- **Functional Mockup Interface** import and export for co-simulation with other engines.
- **Standard summary and detailed output reports** as well as user definable reports with selectable time-resolution from annual to sub-hourly, all with energy source multipliers.

[231] https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/pdf/fichier/79060/EE4-English-2008-02-01.pdf
[232] https://energyplus.net/

This tool can be downlowded in https://energyplus.net/downloads

Critical reviews

"EnergyPlus is one of the most advanced, publicly-available building energy simulation programs, whose development begun in 1996 with funding from the U.S. Department of Energy. While the program borrows what was effective from BLAST and DOE-2, it contains a number of innovative features, including sub-hourly time steps, user-configurable modular HVAC systems that are integrated with a heat and mass balance-based zone simulation, as well as input and output data structures that can facilitate third party module and interface development. Graphical user interface has recently been developed and released for EnergyPlus (OpenStudio), and a software development kit has been developed to simplify the creation of applications that use simulation models."[233]

[233] http://aceee.org/files/proceedings/2014/data/papers/11-203.pdf

Chapter Three

3.- Green construction in Canada and Mexico

I would like to start this chapter explaining why I decide to compare the green construction sector in Mexico and Canada. Firstly, even recognizing the cultural and economic gaps between both countries sustainability policies most rule over urban planning and construction codes otherwise it will be impossible for each country to achieve COP 21 main goal to keep global warming below 2°C[234],and it will compromise seriously cities development, for this reason it is important than every city creates and adopts their own policy statement for "**Sustainable development**". Secondly, In order to communicate how policies and programs outcomes, It is important to recognize success cases in both countries and make suggestions to potential adoption of schemes, at this regard I conducted several interviews and talks with different actors in the construction sector, and government. Finally, I decided to address the case of STARS certification process that is currently performed in the Autonomous National University of Mexico (UNAM), and several Ontario´s Colleges (Niagara College, Mohawk College, and Humbard College). In my opinion It is important to demonstrate how effective these institutions are intending to tackle both climate change, and sustainable development.

In recent days, news related to sustainable development and urban planning have been released in newspapers, web media, and broadcasting systems in different context in Canada and Mexico. Niagara Peninsula Conservation Authority is trying to present a pilot project to explore the possibility of wetland offsetting programs to allow development on restricted areas[235](see figure 3.2), from this article I quote the following statement: ***"Niagara West MPP Tim Hudak said "if the government does the right thing" it will give Niagara the opportunity to have more local decision making. He said the rules restricting urban growth used in Toronto don't make sense for the Niagara Peninsula where growth is needed."*** This makes perfect sense if we are only taking into account local development, and not international agreements. In the other case Chapultepec Avenue Cultural Corridor (See figure 3.1) in Mexico City, was submitted to strong criticism, and create intense controversy for the treatment and management of public spaces, which by definition are: **"Those that are declared, frequented, known, or seen by all, and which belong to the community as a common asset of the people."**[236]

According to the Ontario government Wetland Conservation in Ontario: A Discussion Paper, **"wetland loss has been most severe in Southwestern Ontario, parts of eastern Ontario and the Niagara and Toronto areas."** The loss has been over 85 percent, with land being converted for other use. Wetlands work as a water filtration system, removing impurities. If there is a significant loss of wetlands it could create flooding or draught.

In the article entitled **"Chapultepec Ave.: Cultural corridor or urban scar?"** The author mentioned that the government lack of financial resources to develop the project, and present the business model as a win win situation for the investors and the City, and suggest a mechanism under the title

[234] http://www.cop21paris.org/about/cop21
[235] http://www.stcatharinesstandard.ca/2015/11/13/review-of-conservation-act-concerns-environmentalists
[236] http://inmobiliare.com/chapultepec-ave-cultural-corridor-or-urban-scar/

"Renacimiento Urbano" (Urban Rebirth), explaining that there is virtuous circle that uses the value added that the city itself generates by driving the development that an urban improvement project will attract naturally and intentionally, to finance environmental improvement projects, even for other spaces in the city, in areas that don't have the attraction and potential of broad avenues, but that do have the same need for improvement. The author concluded the article with the following statement ***"The end result of this debate will set a precedent we can either be proud of or we can regret in the next 40 years, and as in all discussions there will be winners, hopefully it will be the city and its residents who will win this time."***[237]In my opinion, urban planning is not a question about regrets and winners, but city improvement for all city inhabitants including present and future generations. That bring us back about the fact that Cities most have a definition of sustainable development in their policies, true commitment to enforce the policies, and provide the mechanisms to allow community engagement in the decision making process.

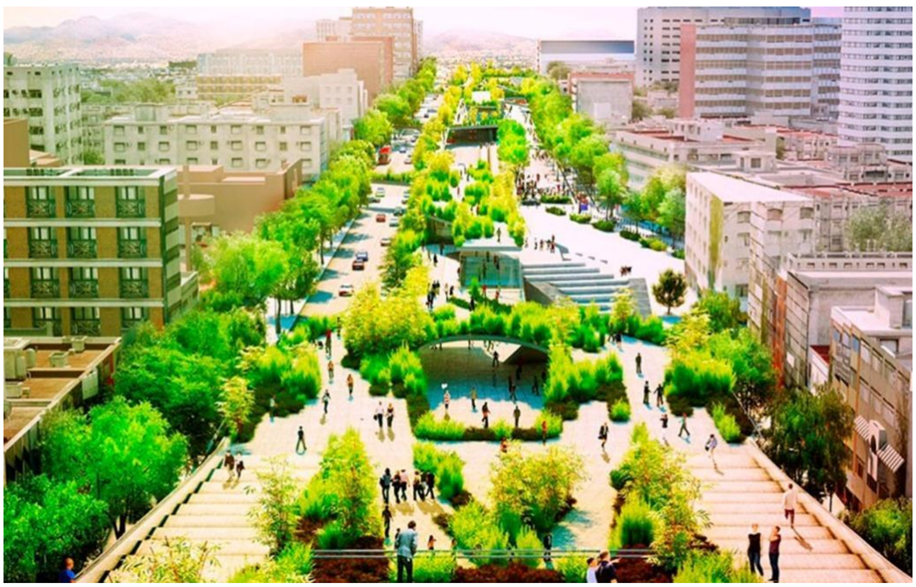

Figure 3.1 Chapultepec Avenue Cultural Corridor retrieved
from: http://mexicodesign.com/corredor-cultural-chapultepec/

[237] I (Hassan, 2000)DEM

Figure 3.2 Wetland offsetting for Hwy 97 A new pond built by researchers from Ontario's University of Waterloo and the B.C. Transportation Ministry. Researchers hope amphibians that live in the area where Hwy. 97 is being expanded will colonize the new wetland area. Photo submitted.
Retrieved from: http://www.osoyoostimes.com/researchers-hope-new-pond-culverts-will-offset-impact-of-highway-construction-on-amphibians/

3.1. General Scope

In order to continue with the presentation of Canada and Mexico Green building regulations and initiatives, I would like to introduce the following definitions:

Sustainable developmentmeans meeting the needs of the present without compromising the ability of future generations to meet their own needs. For municipalities, this means making financially sustainable strategic decisions and implementing operational changes that support broader social, economic, cultural and environmental objectives. Communities need long-term economic and social security to build a more sustainable future. This security depends on environmentally sustainable development, as well as on sharing our human, financial and technical resources. To make cities and communities sustainable, all orders of government must work together and with industry, non-governmental organizations, Aboriginal peoples and community associations. Initiatives must recognize the diversity of Canada's municipal sector, which includes not just big cities, but also rural, remote and northern communities. [238]

Urban sustainability is the practical application of community planning to ensure long-term, viable, and self-sustaining community vitality in urban settings. Sustainability refers to practices developing an environment in which degradation does not exceed the capacity of regeneration within the system. An example would be a public park. If the number of visitors exceeds the carrying capacity of the park, degradation occurs and public officials may have to limit hours or visitors to ensure the sustainability of the park's attributes.

[238]https://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=892FBDA6-1#s2

Urban planning can be described as a technical and political process concerned with the welfare of people, control of the use of land, design of the urban environment including transportation and communication networks, and protection and enhancement of the natural environment.[239]

Urban planning encompasses pursues the following objectives:

- Compactness: urban containment and residential intensification
- Completeness: mixed-use development
- Conservation: protection of sensitive environmental areas and preservation of historic, visual, and cultural resources
- Comfort: creation of pedestrian friendly areas and reduced car dependence
- Coordination: linked planning and management activities
- Collaboration: participation by stakeholder groups[240]

Green Construction: Is a generic term that refers to the use of environmentally preferable practices and materials in the design, location, construction, operation, re-use and disposal of buildings. It applies to both renovation and retrofitting of existing buildings and construction of new buildings, whether residential or commercial. Green building is a key component of building healthy, vibrant and economically strong communities.[241]

Sustainable community planning looks at the long-term economic, social and environmental well-being of our communities, with the aim of improving the quality of life for citizens now and over the long term. These plans set a clear direction for the community that recognizes the diverse needs of existing and future residents. Through these plans, our communities coordinate and integrate development practices that build resiliency and a high quality of life for the community.

Ecosystem Management recognizes the interrelated nature of air, land, water and living organisms. Ecosystem management develops effective partnerships that define units of management by using natural boundaries, such as watersheds, instead of geopolitical boundaries and departmental divisions. This approach considers the natural environment, society and the economy, and incorporates the broader concepts of sustainability.[242]

Green buildings have less impact on the environment (smaller footprint), in these areas: Material use, including harvesting and extraction of natural resources; depletion of fossil fuel energy resources, and corresponding generation of greenhouse gases; use of potable waster resources, discharge of wastewater, and stormwater runoff; and generation of solid wastes, both during and after construction. [243]

The Canada and U.S. Green Building Councils define **Green Building** as **"Design and construction practices that significantly reduce or eliminate the negative impact of buildings on theenvironment and occupants".**

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[239] https://www.mcgill.ca/urbanplanning/planning
[240] Selma Hassan, Sustainability and Urban Regions How sustainability criteria appear in urban sustainability literature, planning frameworks and specific initiatives
[241] Green Building in North America OPPORTUNITIES AND CHALLENGES Report Commission for Environmental Cooperation, 2008
[242] https://www.fcm.ca/Documents/corporate-resources/policy-statements/Environmental_Issues_and_Sustainable_Development_Policy_Statement_EN.pdf
[243] http://www.wbdg.org/design/sustainable.php

Sustainable building is defined as: Design and construction practices that eliminate negative impacts on the environment, do not impede the natural environment's ability to sustain living systems, rely only on current flows of natural capital and internalize all external costs. Sustainable building (and restorative as well) also includes a broader set of social issues. (MCDONALD, 2005)

Restorative Building is: design and construction practices that have a positive effect on the environment, help the natural environment improve its ability to sustain living systems, reinvest in and restore natural capital and produce external benefits.

The following table presents the approaches towards sustainability

Green Building	Sustainable Building	Restorative Building
• Reduce negative impacts on the environment • Continues rely on stored stocks of natural capital • Some external costs remain	• Eliminate negative impacts on the environment • Relies only on current flows of natural capital • No external costs;all external cots are internalized	• Positive effect on the environment • Reinvets in and restores natural capital • External or public benefits
Weak sustainability		Strong Sustainability

Table 3.1 Defining Green Building, Sustainable Building and Restorative Building
Modified from: (MCDONALD, 2005)

Table 3.1. help us to demonstrate several levels of green building. Intead of reducing negative impacts constructions bring positive effects to the environment and community

Building resiliency is the capacity of a building to continue to function and operate under extreme conditions, such as (but not limited to) extreme temperatures, sea level rise, natural disasters, etc. As the built environment faces the impending effects of global climate change, building owners, designers, and builders can design facilities to optimize building resiliency.

Building adaptability is the capacity of a building to be used for multiple uses and in multiple ways over the life of the building. For example, designing a building with movable walls/partitions allow for different users to change the space. Additionally, using sustainable design allows a building to adapt to different environments and conditions.

Carbon-neutral buildings are generally understood to be those that require no GHG-emitting energy to operate. They do this by combining on and off-site renewable energy generation with ultra-efficient building materials and equipment.

Net zero-energy buildings are buildings that generate as much energy as they use over the course of a specific period of time, usually a year, but they can use carbon-based energy from the grid when needed.

Greenwashing is what happens when a hopeful public eager to behave responsibly about the environment is presented with "evidence" that makes an industry or a politician seem friendly to the environment when, in fact, the industry or the politician is not as wholly amicable as it is or he might be. We touched on this concept when we talked about the Christmas tree-growing industry presenting partial evidence of its ecobenefits for example: tree farms as carbon sinks while neglecting to mention the polluting pesticides or harvesting helicopters. Greenwashing is a marketing strategy, and one the public might grow ever more susceptible to as our need for energy expands and the CO2 in our atmosphere continues to accumulate.[244][245].

Two methods, currently popular in North America, that have been used to support more sustainable planning decisions are **"Smart Growth"** and **"New Urbanism"**. These two approaches are very similar. Both encourage the development of high density neighbourhoods with a diversity of land-use, housing types and integrated transport solutions.

The commonality between these two approaches, and those characteristics that mark sustainable planning processes are the development of neighbourhoods that are good places to live and where most of life's requirements are provided within walking distance in a place that inspires those that live their and promotes community spirit. The aim is to develop a quality of life that promotes well being and lifts the human spirit. In order to understand each approach I prepare table 3.2 that enlist the main objectives of each method.

Smart Growth • This model arose out of the realization that sprawl-based models come with long term costs as infrastructure is allowed to decay in downtown cores and reconstructed at the edge of the growing region, and municipalities are faced with large maintenance bills for the road infrastructure. Such planning leads to long commutes and neighbourhoods that are not easily served by transit, while brownfields sit empty within older areas with established infrastructure already in place. • In general, smart growth aims to revitalize city centers by making them better places to live, supports the quality of life in established communities, and presents a model of new development based on mixed use, transit use, and pedestrian spaces.	**New Urbanism** shares many characteristics with Smart Growth, the focus is on walkability and people rather than car centred planning and development. The principles of New Urbanism are: • Walkability: A neighbourhood should have most things required for living in it within a 10 minute walk. The streetscape should reflect this by being pedestrian friendly in design and free of cars as much as possible. • Connectivity: An interconnected street network disperses traffic and eases walking. • Mixed-use and diversity: Within buildings, between blocks and within neighbourhoods helps the delivery of the walkability of the neighbourhood. Note: There are several principles that are found within smart growth planning processes
• Mixed Land Uses: A mix of commercial, business and retail uses reduces the need for people to travel. The constant presence of people means an area is safer,	• Mixed housing: A range of types, sizes and prices increases social diversity. • Quality architecture and urban design: Community pride and a sense of place is

[244] http://www.scientificamerican.com/article/greenwashing-green-energy-hoffman/
[245] http://dictionary.reference.com/browse/greenwash

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encourages community life and increases the opportunities for business bringing more tax revenue and higher property price. Compact Building Design: By increasing densities means the required population base for local business and transit success is provided. Compact building design also allows more open space to be preserved for recreation, storm-water mitigation and places for nature.

A Range of Housing Opportunities and Choices: Sustainable communities are diverse, provide housing for such communities means providing a mixture of high density and lower density housing choices.
Walkable Neighbourhoods:
Walkability is created by mixing land uses, building compactly, and creating safe and inviting pedestrian corridors.
Foster Distinctive, Attractive Communities with a Strong Sense of Place: Defined neighbourhoods with a strong identity improve the sense of community and increase the desirability of a place.
Preserve Open Space, Farmland, Natural Beauty and Critical Environmental Areas: habitats, community space, farm lands, wetlands, and other critical elements of the landscape, contribute to the character of a neighbourhood, the environmental integrity of the landscape and provide animal and plant habitat, combat air pollution, filter runoff, and control wind and noise.
Strengthen and Direct Development towards Existing Communities: Directing growth towards existing communities and downtowns preserves open space and maximises the value of existing infrastructure in order to improve quality of life.
Provide a Variety of Transportation Choices: A mix of automobile infrastructure, rapid transit, bike lanes, and pedestrian friendliness can greatly increase the efficiency of travel.

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enhanced if the living environment is attractive and comfortable. Human scale architecture & beautiful surroundings nourish the human spirit.

Traditional neighbourhood structure: This means having an edge, public space at the centre, a public realm that is high quality in appearance and is designed as civic art. The neighbourhood should also have a transect that moves from dense in the centre to less dense at the edge, including the consideration of natural habitat into the urban area.
Increased Density: Having people and services close together increases liveability and walkability in the neighbourhood.
Smart Transportation: A network of high quality mass transit options connecting towns and neighbourhoods. This in combination with local networks that encourage a greater use of bicycles, rollerblades, scooters, and walking as daily transportation.
Sustainability: Minimal environmental impact and respect for the value of natural systems.
Quality of Life: The creation of places that enrich, uplift and inspire the human spirit.

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• Encourage Community and Stakeholder Collaboration: As people spend more time in their community they will need to have more input in to the decisions that develop their community. • Historic preservation: The past in creating a sense of place. Preserving historical sites helps to maintain identity, provides a sense of pride about the factors that created the community.	

Table 3.2 Smart growth and new urbanism comparison

Building facts in North America showed in table 3.3.

Canada[246]	United States of America	Mexico
• 33% of total energy consumption • 50% of natural resources 12% non-industrial consumption • 25% of debris are diverted to landfills • 10% of airborne particles 35% of GHG[247]	• 40% of total energy consumption • 12% of total water consumption • 68% of total electricity consumption • 38% of total CO_{2e} emissions 60% of total non-industrial waste[248]	• 17% of total energy consumption • 5% of total water consumption • 25% of total electricity consumption • 20% of total CO_{2e} emissions • 20% of total debris generated
Actual trends demonstrate that the residential and commerceenergy consumption sectors are expected to grow 28 %, and 39 % respectively. Thereby generating additional 46 mega-tonnes (MT) CO_2emissions by 2030, compared with current emissions.	Actual trends demonstrate that the residential and commerce energy consumption sectors are expected to grow 23 %, and 36 % respectively. Thereby generating additional 680 mega-tonnes (MT) CO_2 emissions by 2030, compared with current emissions.	Actual trends demonstrate that the residential and commerce energy consumption sectors are expected to grow 152 %, and 144 % respectively. Thereby generating additional 119 mega-tonnes (MT) CO_2 emissions by 2030, compared with current emissions.

Table 3.3 North America Greenbuilding facts

Green-City Facts (a comparison between Toronto and Mexico City)

Toronto **BUILDING PERFORMANCE EMISSIONS**	**MEXICO CITY** **BUILDING PERFORMANCE EMISSIONS**

[246] http://www.canadainternational.gc.ca/mexico-mexique/canmex.aspx?lang=eng
[247] CaGBC Municipal Green Building Toolkit, capítulo 1, p. 2.
[248] see <http://www.epa.gov/greenbuilding/pubs/whybuild.htm>.

• City-wide Emissions (metric tons CO2e) 20,660,000% of Emissions from the Building Sector (-) • 45 LEED Certified Projects (Toronto) • 32 LEED Registered Projects(Toronto) • LEED Credentialed Professionals (Toronto)5 1,153[249] **CITY EMISSIONS TARGET:** 30% reduction in carbon-dioxide emissions by 2020, compared with 1990 levels. The Toronto Green Standard, adopted by City Council in December 2010, is a two-tier set of performance measures, with accompanying guidelines, related to sustainable site and building design for new developments.[250] Toronto's Eco-Roof Incentive Program, launched in 2009, aims to promote the installation of green and cool roofs on the city's new and existing buildings.[251] **GREEN SCHOOLS** The Solar Schools Project is a Toronto District School Board initiative to install solar panels on the roofs of 311 schools starting in spring 2014.[252] **The Toronto 2030 District** A private sector-led initiative Sponsored by BOMA Toronto, the Ontario Association of Architects, and Sustainable Buildings Canada	• City-wide Emissions (metric tons CO2e)7 26,230,000 % of Emissions from the Building Sector 46% • 40 LEED Certified Projects (Mexico City) • 136 LEED Registered Projects (Mexico City) • 399 LEED Credentialed Professionals (Mexico)[254] **CITY EMISSIONS TARGET:** 50% reduction below 2000 levels by 2050. [255] In 2008, the Mexico City´s Sustainable Building Assessment Program (PCES in Spanish) started by 2014, only 8 buildings had been accredited with the certification and there were other 40 buildings under the certification process.[256]

[249]LEED Professionals and Project Figures were retrieved on 6 January 2015 from .()
[250]City of Toronto: City Planning: Toronto Green Standard: http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f85552cc66061410VgnVCM10000071d60f89RCRD.
[251]City of Toronto: Live Green Toronto: http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=8131fbfa98491410VgnVCM10000071d60f89RCRD
[252]Toronto District School Board: Solar Schools Project: http://www.tdsb.on.ca/AboutUs/FacilityServices/SolarSchoolsProject.aspx
[254]LEED Professionals and Project Figures were retrieved on 6 January 2015. http://www.cagbc.org/CAGBC/Resources/GreenBuildMarketRes2014/CAGBC/Resources/Green_Building_Marke.aspx?hkey=36b22df4-d4f7-4bc2-80da-fd8767ff42d6
[255]Secretary of the Environment: Mexico City Climate Action Program 2008-2012, Summary. http://www.sma.df.gob.mx/sma/links/download/archivos/paccm_summary.pdf.
[256]http://www.conuee.gob.mx/work/sites/CONAE/resources/LocalContent/8711/1/PCESparaforodeCONUEE6mrzo.pdf

supporting district-wide reductions in building related energy, water and transportation emissions across Toronto's downtown core.[253]	

Table 3.4 Toronto and Mexico City Greenbuilding facts

The **North American Free Trade Agreement** (**NAFTA**), came into effect on January 1, 1994, generating economic growth and helping to raise the standard of living for the people of all three member countries. By strengthening the rules and procedures governing trade and investment, the NAFTA has proved to be a solid foundation for building Canada's prosperity and has set a valuable example of the benefits of trade liberalization for the rest of the world.[257]

Canada and Mexico are each other's third largest trading partner. Canada-Mexico two-way trade amounted to pver $34.3 billion in 2014. This is a remarkable increase of more than 650% in merchandise trade since 1993, the year before NAFTA came into force. Canadian direct investment in Mexico reached over $13 billion (stock) in 2014, while Mexican direct investment in Canada totaled $884 million (stock) in 2014. There is a significant number of Canadian companies that export to Mexico. Mexico is also a priority market for Export Development Canada (EDC), which has had a resident presence since 2000, providing extensive financial services related to Canadian exports and Canadian investments in the country. Mexico's demographic and economic prospects point toward an even greater growth in commercial exchanges.[258]

The Canada-Mexico relationship is characterized by sustained political engagement and regular dialogue in the bilateral, North American, hemispheric and multilateral contexts. Dialogue is pursued through a variety of means, ranging from periodic high-level consultations to inter-parliamentary meetings and the North American Leaders Summits, to more institutionalized mechanisms such as the innovative Canada-Mexico Partnership (CMP). The CMP, established in 2004, aims at promoting collaboration between the public and private sectors and operates through a series of working groups dealing with trade, investment and innovation, agri-business, environment, forestry, human capital, energy and labour mobility. A multi-track security dialogue involving annual security consultations as well as political-military and military talks is complemented by security and justice cooperation through the Anti-Crime Capacity Building Program.[259]

The **North American Agreement on Environmental Cooperation** (**NAAEC**) is an environmental agreement between the United States of America, Canada and Mexico as a side-treaty of the North American Free Trade Agreement. The agreement came into effect January 1, 1994.

The agreement consists of a declaration of principles and objectives concerning conservation and the protection of the environment as well as concrete measures to further cooperation on these matters between the three countries. Part Three of the **NAAEC** establishes the **Commission for Environmental Cooperation** (**CEC**), which was set up as part of the agreement. The structure of the CEC is composed of the Council, which is the governing body, a Secretariat based in Montreal and the Joint Public Advisory Committee.

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[253] http://sbcanada.org/toronto2030district.html
[257] http://www.international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/nafta-alena/index.aspx?lang=eng
[258] http://www.canadainternational.gc.ca/mexico-mexique/canmex.aspx?lang=eng
[259] http://www.edc.ca/EN/Country-Info/Pages/mexico.aspx

The objectives of this Agreement are to:[260]

- Foster the protection and improvement of the environment in the territories of the Parties for the well-being of present and future generations;
- Promote sustainable development based on cooperation and mutually supportive environmental and economic policies;
- Increase cooperation between the Parties to better conserve, protect, and enhance the environment, including wild flora and fauna;
- Support the environmental goals and objectives of the NAFTA;
- Avoid creating trade distortions or new trade barriers;
- Strengthen cooperation on the development and improvement of environmental laws, regulations, procedures, policies and practices;
- Enhance compliance with, and enforcement of, environmental laws and regulations;
- Promote transparency and public participation in the development of environmental laws, regulations and policies;
- Promote economically efficient and effective environmental measures; and
- Promote pollution prevention policies and practices.

3.2. Reports

3.2.1. CEC

The **Commission for Environmental Cooperation** (**CEC**) is an international organization created by Canada, Mexico, and the United States under the North American Agreement on Environmental Cooperation (NAAEC). The CEC was established to address regional environmental concerns, help prevent potential trade and environmental conflicts, and promote the effective enforcement of environmental law. The Agreement complements the environmental provisions of the North American Free Trade Agreement (NAFTA).

This report presents North American leaders with a trinational plan for making green building a foundational driver for change in Canada, Mexico, and the United States of America. The report was prepared over two years, with the help of leading North American experts on green building and input from the naaec parties and the public. througth this process, the CEC secretariat identified the key opportunities and challenges facing green building in North America.

THE PROCESS

To examine the status of green building in North America, as well as some of the drivers and barriers to its development and implementation, in February of 2006 the Secretariat of the CEC initiated this study.In this report, the Secretariat of the Commission for Environmental Cooperation (CEC) recommends that North American leaders make green building a foundational driver for environmental, social, and economic improvement in Canada, Mexico, and the United States.

[260] http://www.cec.org/about-us/NAAEC

By continually improving how we locate, design, build, operate, and retrofit buildings, North American leaders can significantly improve the well-being of North America. Advanced energy-saving technologiesapplied in buildings can result in enormous reductions in demand for fossil fuels and emissions of greenhouse gases (GHG). Better design and building practices can also help address environmental challenges such as natural resource depletion, waste disposal, and air, water, and soil pollution. Green building can also help achieve gains in human health and prosperity.

The 2009 report affirmed that despite this potential for transformation, green building represents only a small percentage of building in North America., and added that some estimates, green building currently accounted for about two percent of the new non-residential building market in the United States and 0.3 percent of the residential market. In Canada, green building trends were generally thought to be similar to those in the United States. **In Mexico, there were no reliable figures showing the extent to which green building exists in the marketplace**. Although the green building market was expected to grow rapidly in all three countries in the coming years, a substantial shift from the status quo was needed to make these high-performance buildings the norm in North America. (JONATHAN WESTEINDE et al, 2008)

PROMOTING MUTUALLY BENEFICIAL COOPERATION

Similarities and differences within North America present an opportunity for governmental and nongovernmental institutions and industry in the three countries to work to improve the building sector. This effort can help strengthen the economies of North America by spurring new markets and business opportunities for manufacturers, utilities, and other companies.

The Comission for Environmental Cooperation proposed the following recommendations call upon North American government, industry and nongovernmental leaders to:[261]

1. ***Work together to develop a lasting and achievable vision for green building in North America.*** *This vision will help drive targets and strategies for green building and could result in the creation of a common set of principles and planning tools for green building, with each country having region/ context-appropriate policies and programs to address differences in building codes, regulatory environments, climate, and economic and social conditions. To work toward this vision, the recommendations call for the creation of national, multi-stakeholder task forces in each of the three countries, coordinated by the environment or other appropriate ministry of each country and linked internationally through a cooperative mechanism such as the CEC.* ***These task forces would promote aggressive and consolidated approaches for accelerating the achievement of this vision at the North American level, with united and integrated participation of representatives of all components of the building sector and civil society.***

2. *Set clearly defined targets with the goal of achieving the most rapid possible adoption of green building in North America, including setting aggressive, realistic targets for carbon-neutral or net zero-energy buildings.* ***Modeling should be conducted and targets set for other environmental parameters such as water use, wastewater generation, land conversion, use of environmentally preferable materials, embodied energy and waste loads, and to monitor performance for continual improvements.***

[261] http://www3.cec.org/islandora/en/item/2335-green-building-in-north-america-opportunities-and-challenges-en.pdf

3. *Implement a set of strategies for enhancing, accelerating and integrating ongoing or new efforts in support of green building. These strategies should include efforts to promote private sector fi nancing and proper valuation methods, and to increase knowledge through research and development, capacity building, outreach, and the use of labels and disclosures on green building performance.* ***These efforts are particularly important for Mexico, considering its urgent need for affordable housing and the need for widely recognized green building rating systems and a nationally-coordinated framework that will support and enhance existing Mexican policies and programs that favor green building****. North American governments at all levels should build on their progress to date and, as swiftly as possible, adopt comprehensive and ambitious policies requiring all government procurement in the building sector to achieve high levels of green building performance, with a fi rm commitment to continual improvement over time.These efforts should also push for continual improvement in policies, regulations, and codes and develop and enforce effective mechanisms to monitor implementation. These include tax and other fi nancial incentives, such as graduated utility rates that encourage conservation, non-tax incentives like expedited permitting, priority plan review, and density bonuses, among others. Over time, government should emphasize the appropriate use of mandates, in addition to incentives, with the view toward the advancement of green building performance targets. It is critical that all policies and programs related to green building be integrated with comprehensive urban development programs geared toward the development of sustainable communities.*

Finally, the recommendations call for North American leaders to promote North American and global cooperation in green building in such areas as trade in materials, conducting joint or coordinated research programs, and to promote the sharing of data, information, and best practices.

I decided to include these three paragraphs underlining the main points related to transboundary policies. I have the opportunity to ineterview CEC´s staff members to ask about the follow-up of the recommendations and projects suggested in the report. Today, the only CEC remain action is the “Accelerating Adoption of ISO 50001 and Superior Energy Performance (SEP) Program Certifications in North America”. In my opinion, there are strong evidence of bylateral cooperation between USA and Canada. However, in the case of Mexico there is not exhibits of current work with Mexico. For this reason, It´s time for the construction sector to decide wether to continue working with UK and Germany in projects like NAMA and Passive House or establishing programs with NAFTA members specifically in standards and codes for procedures and materials.

Current green building practices are not limited to one type of building or market niche, geographic location or business model. Increasingly, green building is seen as part of comprehensive urban development programs geared toward development of sustainable communities with emphasis on integrating green building with sustainable urban infrastructure for transportation, gas and electric utilities, potable water, waste disposal and recycling, storm water and wastewater management and sewage.

Data collected from Canada and Mexico to illustrate these impacts.

In Canada, buildings are responsible for:

33 percent of all energy used;
50 percent of natural resources consumed;
12 percent of non-industrial water used;
25 percent of landfi ll waste generated;
10 percent of airborne particulates produced; and
35 percent of greenhouse gases emitted.3

In Mexico, buildings are responsible for:

17 percent of all energy used;
25 percent of all electricity used;
20 percent of all carbon dioxide emissions;
5 percent of potable water consumption; and
20 percent of the waste generated.

3.2.2. C40

In october of 2005 the Major of London Ken Livingstone called up the representatives of 18 cities, to work towards the GHG emissions and risk derived from climate change reduction creating the **C 40 Cities initiative**[262]. In the report submitted by New York Major Michael Bloomberg in September of 2014 to the UN Secretary General underlined the the great potential of cities to reduce emisions from building "urban actions could decrease global greenhouse gas (GHG) emissions by 3.7 GtCO2e below what national actions are currently on track to achieve in 2030, and by 8.0 GtCO2e in 2050. "[263], In February of 2015 a report with more than 50 cities profiles was presented each one includes programs, policies and statistical data.[264]

Cities Highlihts

Toronto became the first city in North America to enact a bylaw requiring and governing the construction of green roofs on new developments. Adopted in May 2009, under Section 108 of the city of Toronto Act, the bylaw applies to new residential, commercial and industrial developments with a minimum gross floor area (GFA) of 2,000 square meters.Under the city's Energy Retrofit Program, instituted in 2004, more than 200 municipally owned buildings have been retrofitted, saving Toronto more than $4 million and reducing Co2 emissions by more than 15,000 tons. The retrofits target lighting systems, building automation systems, building envelope, pipe insulation, solar water heating systems, and equipment and system upgrades, along with waste diversion measures.

In 2008, Mexico City initiated a Climate Action Plan with the immediate goal to reduce the city's CO2 emissions by 12% within four years. This goal complements the city's overall emissions reduction target of 50% below 2000 levels by 2050. 26 initiatives, focused on energy and water

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262 http://www.c40.org/history
263 C40 Cities Report: Advancing climate ambition: cities as partners in global climate action, 2014 (http://c40-production-images.s3.amazonaws.com/other_uploads/images/128_Advancing_Climate_Ambition.original.pdf?1411486101)
264 http://c40-production-images.s3.amazonaws.com/researches/images/35_USGBC_C40_WGBC_City_Market_Brief_Compendium.original.pdf?1427985432

efficiency, transportation, waste management and reforestation, support the goals of the Climate Action Plan.

3.2.3. Arcadis Sustainable Cities Index Report

A city is much more than just a place for people to live and do business. Cities are areas of emotional attachment, each with their own distinct personality, traditions and attraction factor.

This Index remarks that City leaders need to find ways to balance the demands of generating strong financial returns, being an attractive place for people to live and work in, whilst also limiting their damage to the environment. The first ARCADIS Sustainable Cities Index explores these three demands of People, Planet and Profit to develop an indicative ranking of 50 of the world's leading cities

No North American city makes it into the top ten. Toronto is the highest ranked at 12th, Boston (15th) and Chicago (19th) are the most sustainable US cities. Toronto's population is set to grow by over a quarter,and London's by a fifth by 2030. London and. Toronto are already placed high in the sustainability rankings Mexco City is 32th. The three areas of assessment are People, Planet and Profit showed in the figure 3.3

The **People** sub-index rates transport infrastructure, health, education, income inequality, work-life balance, the dependency ratio and green spaces within cities. These indicators can be broadly thought of as capturing 'quality of life' for the populace in the respective cities.	The **Planet** sub-index looks at city energy consumption and renewable energy share, recycling rates, greenhouse gas emissions, natural catastrophe risk, drinking water, sanitation and air pollution.	The **Profit** sub-index examines performance from a business perspective, combining measures of transport infrastructure, ease of doing business, the city's importance in global economic networks, property and living costs, GDP per capita and energy efficiency.

Figure 3.3 Arcadis indicators system (John J Batten et al, 2015)

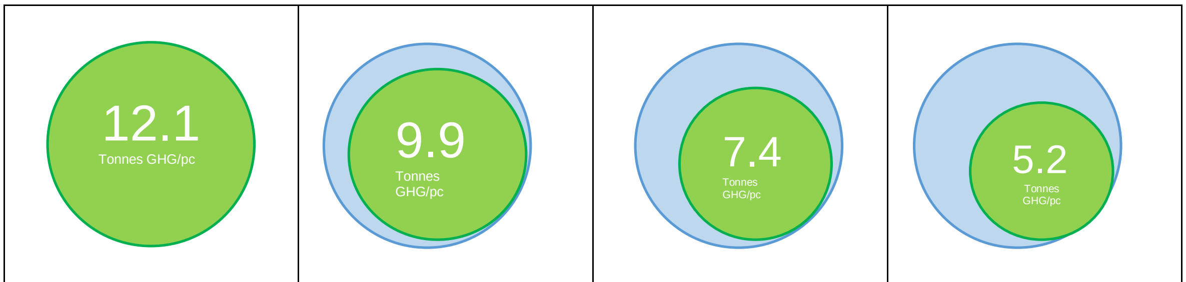
3.2.4. CDP Cities 2012 Global Report

Annual climate change reporting is catching on among cities. CDP hosts disclosure from 73 cities and local governments this year up from 48 last years from all corners of the globe, including every continent except Antarctica.

Cities report emissions totalling **977,659,014 tonnes of CO_2e**. This number represents an increase of 43% from levels reported last year, resulting from the larger number of cities reporting this year. At nearly 1 billion tonnes of CO2e, reporting cities account for emissions that are roughly equal in size to the emissions of Canada and Brazil combined.

City governments with emissions reduction targets report three times as many emissions reduction activities as cities without targets. This finding suggests that setting reduction targets provides a strong catalyst for taking action to reduce greenhouse gas emissions.

The figure 3.4 shows that larger, denser cities tend to be more economically efficient per tonne of greenhouse gas emitted. Per capita emissions in larger, denser cities tend to be lower than in smaller, less dense cities. Cities in the bottom half of density (less than 4,000 persons per sq. km) average 9.9 tonnes of GHG per capita emitted compared to 7.4 tonnes of GHG per capita emitted for cities with more than 4,000 persons per sq. km. This is due to a wide range of factors, including less reliance on cars, easier access to public transport, and other economies of scale.



Smaller cities	**Low density cities**	**High density cities**	**Larger cities**
Annual greenhouse gas emissions per capita in cities with populations less than 1.6 million	Annual greenhouse gas emissions per capita in cities with less than 4,000 persons per square km	Annual greenhouse gas emissions per capita in cities with more than 4,000 persons per square km	Annual greenhouse gas emissions per capita in cities with populations greater than 1.6 million

Figure 3.4 Impacts of city population and density greenhouse gas emissions per capita (metric tons of CO_{2e}/population)

Retrieved from: CDP Cities 2012 Global Report

European cities	**Larger cities**	**Smaller cities**	**North American cities**
Annual economic output per tonne of greenhouse gases emissions in European cities	Annual economic output per tonne of greenhouse gas emissions cities with populations greater than 600,000	Annual economic output per tonne of greenhouse gas emissions cities with populations less than 600,000	Annual economic output per tonne of greenhouse gas emissions in North American cities

Figure 3.5 Economic efficiency of greenhouse gas emissions (city GDP in $USD/metric tonnes CO2e).

Retrieved from: CDP Cities 2012 Global Report

Smaller cities sample: Amsterdam, Austin, Changwon, Copenhagen, Dallas, Denver, Helsinki, Kadiovacik, Kaohsiung, Las Vegas, Miami, Milan, Philadelphia, Portland, Riga, Rotterdam, St. Louis, San Diego, San Francisco, Seattle, Stockholm, Sydney, Vancouver, and Washington.

Low density cities sample: Amsterdam, Austin, Berlin, Changwon, Dallas, Denver, Durban, Hamburg, Helsinki, Houston, Istanbul, Kadiovacik, Las Vegas, Madrid, Portland, Riga, Rotterdam, San Diego, Seattle, St. Louis, Warsaw, and Washington.

High density cities sample: Barcelona, Bogotá, Buenos Aires, Chicago, Copenhagen, Curitiba, Hong Kong, Jakarta, Kaohsiung, London, Miami, Milan, Moscow, New York, Paris, Philadelphia, Rio de Janeiro, San Francisco, São Paulo, Seoul, Stockholm, Sydney, Taipei, Tokyo, Toronto, Vancouver, and Yokohama.

Larger cities sample: Barcelona, Berlin, Bogotá, Buenos Aires, Chicago, Curitiba, Durban, Hamburg, Hong Kong, Houston, Istanbul, Jakarta, London, Madrid, Moscow, New York, Paris, Rio de Janeiro, Rome, São Paulo, Seoul, Taipei, Tokyo, Toronto, Warsaw, and Yokohama.

Over half of responding cities (61%) report that they foresed in substantive risks to their water supply in the future. The two most common risks identified by cities are increased water stress/ scarcity and declining water quality. However, declining water quality is an immediate concern to cities (six cities report water quality as a current risk).

Toronto's main geographic feature—Lake Ontario—gives the city an advantage in terms of ongoing access to fresh water, thus reducing its water supply risk. Managing Adaptation Cities are undertaking a wide variety of initiatives aimed at reducing their risks from climate change. Creation of green space (including tree planting) is the most commonly cited individual adaptation to climate change activity, with 42% of cities reporting at least one action in this area. Storm water capture is the second most common individual action, with 41% of cities reporting installation of or improvements to a capture system.

C40 cities are not just taking action on climate change on a sector-specific basis, but are also addressing climate change at the district and city-wide level. Cities report activities like land use planning, green space, and transit-oriented development to CDP under the broad category of "Urban Land Use." C40 cities show a strong tendency to tackle climate change in these areas, especially among developed cities. The follow figure show how cities are addressing sustainability, according to data received in 2012, the most significant fact the increasing tendency of add Green space, and implementation of Eco-districts, that can be related with LEED ND and GREEAM Comunities as well as Eco-Cycle.

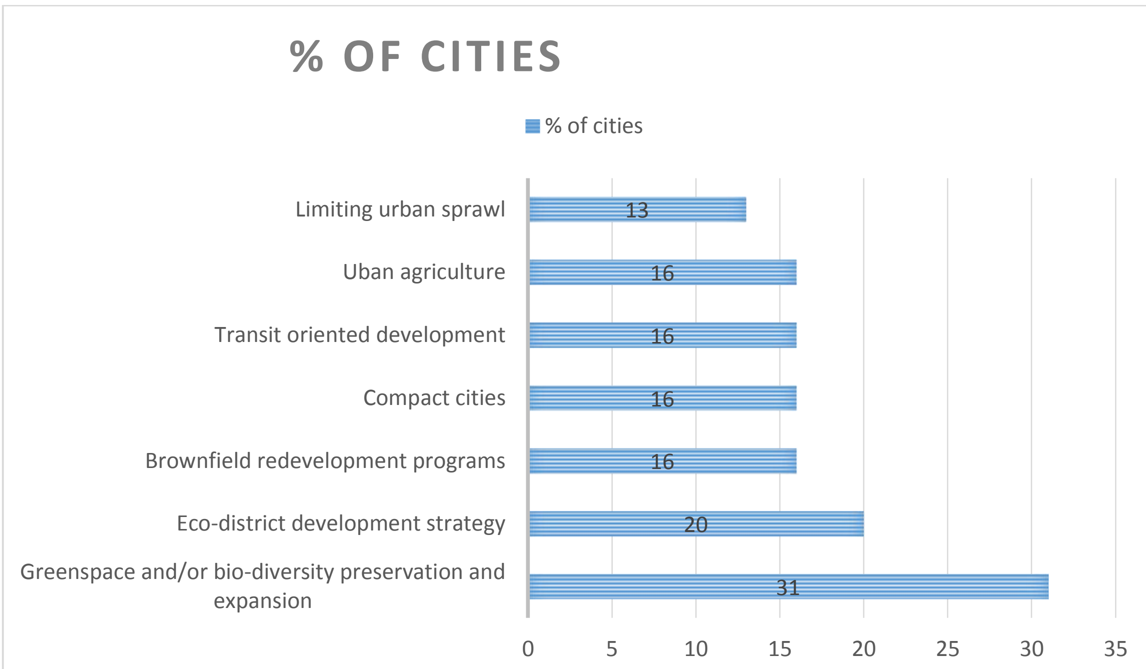


Figure 3.6 City trends in sustainability (CDP Cities 2012 Global Report, 2012)

3.2.5. GCI REPORT

Efficient and intelligent technology holds the answer to many of these urban challenges. That's why Siemens has created the Infrastructure & Cities Sector to provide cities and their related institutions with the best possible products, solutions and services

The Green City Index series measures cities on approximately 30 indicators (see table 3.5) across eight to nine categories depending on the region. It covers CO_2 emissions, energy, buildings, land use, transport, water and sanitation, waste management, air quality and environmental governance. About half of the indicators in each Index are quantitative ,usually data from official public sources, for example, CO_2 emissions per capita, water consumption per capita, recycling rates and air pollutant concentrations. The remainder are qualitative assessments of the city's environmental policies – for example, the city's commitment to sourcing more renewable energy, traffic-congestion-reduction policies and air quality codes. Measuring quantitative and qualitative indicators together means the Indexes are based on current environmental performance as well as the city's intentions to become greener.

The specific indicators differ slightly from Index to Index, taking into account data availability and the unique challenges in each region. For example, the African Index includes indicators measuring access to electricity and potable water, and the percentage of people living in informal settlements. Each city receives an overall Index ranking and a separate ranking for each individual category. The results are presented numerically (for the European, and the US and Canada Indexes see figure 3.7) or in five performance bands from "**well above average**" to "**well below average**" (for the Asian, Latin Ameri can and African Indexes). Bandings are used in regions where levels of data quality and comparability do not allow for a detailed numerical ranking.

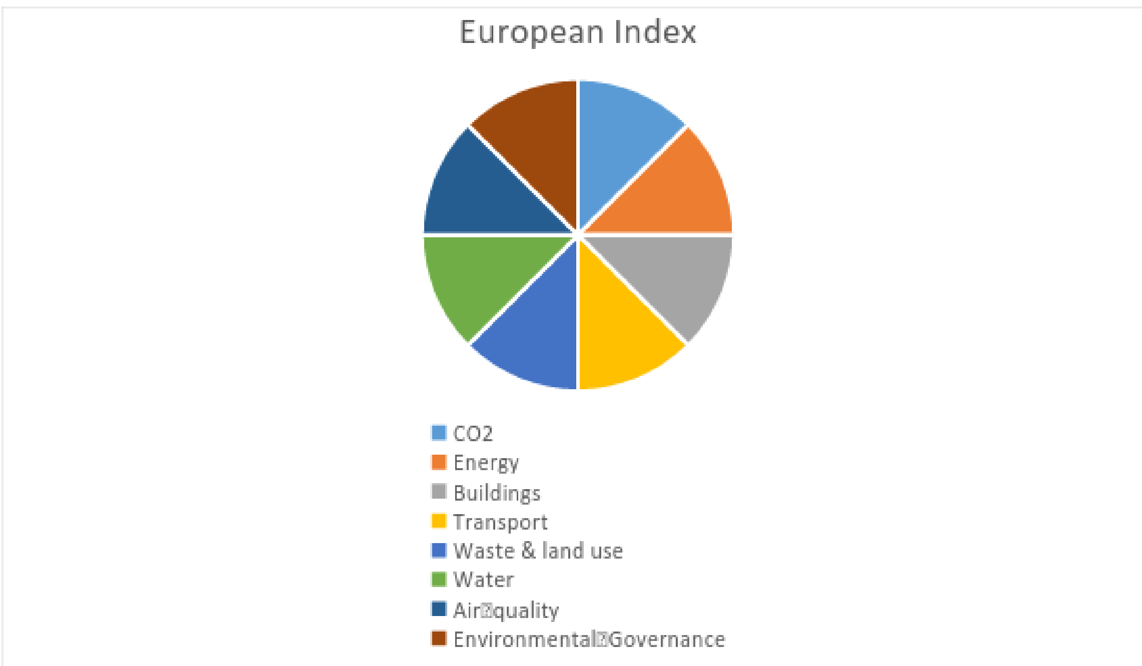


Figure 3.7 European Index

European Index	Topics
CO_2	• CO_2 intensity • CO_2 emissions • CO_2 reduction strategy
Energy	• Energy consumption • Energy intensity • Renewable energy consumption • Clean and efficient energy policies
Buildings	• Energy consumption of residential buildings • Energy-efficient buildings standards • Energy-efficient buildings initiatives
Transport	• Use of non-car transport • Size of non-car transport network • Green transport promotion • Congestion reduction policies
Waste & land use	• Municipal waste production • Waste recycling • Waste reduction policies • Green land use policies
Water	• Water consumption • System leakages • Wastewater system treatment • Water efficiency and treatment policies
Air quality	• Nitrogen dioxide • Sulphur dioxide • Ozone • Particulate matter • Clean air policies
Environmental Governance	• Green action plan • Green management • Public participation in green policy

Table 3.5 Eurepean Index Indicators

In most regions, the Green City Index series shows a clear link between greater wealth and better environmental performance. The reason is obvious: cities that are more affluent can invest more money in infrastructure and set aside more generous budgets for environmental oversight. However, money is not everything. In each Index, some cities with a below-average income clearly outperform their peer cities with higher incomes. This was the case, for example, with Berlin and Vilnius in Europe, Bogotá in Latin America, Delhi in Asia, Vancouver in the US and Canada, and Accra in Africa.(The Green City Index, 2012)

3.2.5.1. Latin American Green City Index

According to the United Nations Population Division, Latin America is the most urbanized region in the developing world. It is already more urbanized than some parts of the developed world, and the percentage of the population living in cities in Latin America is expected to rise further. By 2030, the figure will reach 86%, on a par with Western Europe.

The Index also evaluates policies, which are a reflection of cities' commitment to reducing their future environmental impact. Often it takes the public many years to recognize the effects of new policies. **An example is Mexico City. The city is almost certainly better known for its air quality weaknesses than its strengths in transport policies, let alone its advanced eco-building policies; and therefore some might expect it to perform badly overall.** The Index, however, because of what it is measuring, takes a different perspective.

Some interesting findings from the Latin American Green City Index: Curitiba is the only city in the Index to rank well above average overall. It achieves this unique distinction in two individual categories, air quality and waste, and places above average in five others. The city's environmental oversight is consistently strong too, and it has, with only a few exceptions, among the best policies in each category. Since 2009, for example, the city's environmental authority has been conducting an ongoing study on the CO_2 absorption rate in Curitiba's green spaces, as well as evaluating total CO_2 emissions in the city. It is working to relocate those living in informal settlements to low-cost housing, where sanitation, waste collection, and water are easier to supply. The state water company operating in Curitiba

Land use and buildings

The Index suggests that Latin American (**LA**) cities try harder to guard existing urban green spaces rather than create new ones. They do less well, however, on creating environmentally friendly buildings. Widespread population growth may be an influence in both cases. Urban sprawl, especially informal settlements, makes protection of green spaces a political imperative, but the need to house so many makes tough building standards problematic. Policies on green spaces are widespread. All LA 17 cities have at least some kind of protection of green spaces and environmentally sensitive areas, and all but one make some attempt to stop urban sprawl. The continuing growth of these cities, including the frequent encroachment of informal settlements into environmentally sensitive areas, however, suggests that such policies, while necessary, may not always be effective. Only nine cites have full or partial eco-building standards. Just five have full regulations in place to motivate households and business to lower their energy use. Only four fully promote citizen awareness on ways to improve the energy-efficiency of buildings. Climate change action plans address energy and emissions issues in buildings in just five cities.

Mexico City has the highest level of energy efficiency, only using 0.3 gigajoules of electricity to generate US$1,000 of GDP (Index average: 0.8 gigajoules).

"A lot of environmental performance in the US is based on the individual actions of cities rather than a centrally regulated and monitored system."

Table 3.6 and 3.7 show how well the Latin American Cities performed under GCI indicators in 2013. In my opininion an interesting finding is how Mexico City standed behind Metropolitan areas as Rio de Janeiro and São Paulo.

Overall Results	Well below Average	Bellow Average	Average	Above Average	Well above Average
	Guadalajara Lima	Buenos Aires Montevideo	Medellín Mexico City Monterrey Porto Alegre Puebla Quito Santiago	Belo Horizonte Bogotá Brasília Rio de Janeiro São Paulo	Curitiba

Table 3.6 Latin American Green City Ranking

Overall results	Well below Average	Bellow Average	Average	Above Average	Well above Average
Energy and CO2		Guadalajara Puebla	Monterrey	Mexico City	
Transport		Monterrey Puebla Guadalajara		Mexico City	
Water	Guadalajara		Mexico City Puebla	Monterrey	
Air Quality		Mexico City Monterrey	Guadalajara Puebla		
Land Use and Buildings			Monterrey Guadalajara Puebla	Mexico City	
Waste			Mexico City Guadalajara	Monterrey Puebla	
Sanitation		Mexico City Guadalajara	Puebla	Monterrey	
Environmental Governance	Guadalajara	Monterrey	Puebla		Mexico City

Table 3.7 Latin American Green City Ranking by Category

The Following table show the main highlights of each Mexican City according to the GCI report.

Puebla ranks **average** in the Index overall.	
<u>Cons</u> • The city earns average ranks in most other categories, except for in energy and CO_2 (As in other Mexican cities, air pollution is a substantial challenge in Puebla. • The problem is compounded by the city's geographical setting: it is situated in a valley surrounded by mountains and the Trans-Mexican volcanic belt and transport, where it drops to below average. Puebla's placement in these areas is a reflection of poor policy implementation in both clean energy and urban mass transport. • The city has a code aimed at containing urban sprawl, and it protects environmentally-sensitive areas from development. It also scores full marks for having green standards for public buildings. However the city does not actively Promote awareness about ways for residents to improve the energy efficiency of their homes and businesses.	**<u>Pros</u>** • The city's placement is buoyed by a particularly strong performance in the waste category, where it ranks above average thanks to a high rate of waste collected and adequately disposed, and a low amount of waste generation. • Land use and buildings: Puebla ranks average for land use and buildings. The city boasts 303 square metres of green space per person, the fifth highest amount in the Index. • In recent years Puebla has made a concerted effort to improve its parks and protect green spaces , which boosts its performance in the area of land use policies. • Puebla also joined forces with several major Mexican companies to substitute over 1 million incandescent light bulbs with energy-efficient LED bulbs in residences around the city.

Table 3.8 Puebla Sustainability Highlights

Guadalajara is ranked **well below average** overall.	
<u>Cons</u> It has significant room for improvement in the areas of water and environmental governance, placing well below average, due to a very high rate of water consumption, and weaknesses in environmental monitoring. Land use and buildings: Guadalajara is average in land use and buildings. The metropolitan area has the fourth highest amount of green spaces among the 17 cities in the Index, at 423 square metres per person.	**<u>Pros</u>** The city's highest rankings are in the land use and buildings, waste, and air quality categories, where it places average. Guadalajara places below average in energy and CO2, transport and sanitation. Guadalajara's scores in several categories are hindered by its policies, which are in many cases less robust than those of other cities in the Index; however, the city scores much better for its codes regarding clean energy, waste collection and air quality

Guadalajara is, however, marked down for its policies to maintain green spaces relative to other cities in the Index, although it does better for protecting environmentally sensitive areas from development. The city requires that all development projects pass an environmental impact study. Guadalajara's score is hindered by its policies regarding eco-buildings. The city does not set standards for the eco-efficiency of new buildings by private developers, for example, nor does it implement green standards for public building projects. However, its performance in this area should improve thanks to the state's forthcoming climate change action plan, which is expected to address some of these issues.	Green initiatives: The State Action Programme on Climate Change will outline a "state sustainable buildings policy project" that will promote using LEDs for public lighting, as well as solar panels and energy-efficient appliances in homes. The city of Guadalajara is also reviewing existing green buildings policies across Mexico, with a view to implementing its own regulations based on best practices.

Table 3.9 Guadalajaras Sustainability Highlights

Monterrey is ranked **average overall** in the Index. **<u>CONS</u>** The Monterrey's local authorities are marked down for not setting green standards for public building projects. **Green initiatives**: The state's climate change action plan includes a US$2.5 million residential programme to replace energy-inefficient lighting with LEDs, and electrical appliances with more energy-efficient equivalents. It also includes a US$3.5 million plan to install solar heaters and energy-efficient air conditioning devices. Furthermore, the state has budgeted US$2.3 million to build "eco-industrial parks", which utilise energy-efficient design and limit emissions.	**<u>PROS</u>** Its best results are in the categories of waste, water and sanitation, with above average performances. The city shows particularly strong results for the amount of green spaces per person in the city, and it has the lowest rate of water system leakages in the entire Index. Indeed, the city won an international award in 2010 for its decade-long efforts on reducing leakages. Monterrey is average in two categories—energy and CO2, and land use and buildings and below average in transport, air quality and environmental governance. Land use and buildings: Monterrey is average in the land use and buildings category. The city has the third highest amount of green spaces in the Index, at 750 square metres per person, a figure from 2005, due to a lack of more up-to-date data.

	Monterrey's performance for green spaces is partly helped by having a relatively low population, but the city also has strong land use policies. Monterrey scores particularly well for green spaces protection and urban sprawl containment. In terms of ecobuildings policies, .

Table 3.10 Monterrey Sustainability Higlights

Mexico City ranks **average overall** in the Latin American Green City Index.	
<u>CONS</u> Land use and buildings: Mexico City ranks above average in land use and buildings, which is the best placement in this category for a high-income city. Its strong performance is largely attributable to its ambitious eco-building policies, which include a plan to certify buildings as environmentally sustainable. Under the programme, the city offers incentives to encourage developers to integrate emissions reduction measures in building designs. Mexico City receives a middling score for land use policies.The city's rapid population growth and increasing urbanisation have made it difficult to contain urban sprawl and conserve environmentally sensitive areas, although officials have a set of policies in place to address both problems. Mexico's capital receives average rankings in the waste and water categories. However, the city's overall performance is hindered by poor outcomes in the sanitation and air quality categories, where it places below average. Its performance in air quality is a result of higher-than-average concentrations of the three air pollutants measured in the Index.	**<u>PROS</u>** The city ranks above average in the categories of energy and CO_2, land use and buildings, and transport. Its strongest performance is in the area of environmental governance, where it ranks well above average, **thanks to robust environmental monitoring, the wide remit of its environmental department and a high level of public participation.** **The city has 28 square metres of green spaces per person**, and with nearly 6,000 people per square kilometre, the Federal District has the fifth highest population density in the Index. Green initiatives: Since unveiling its "Green Plan" in 2007 (see "green initiatives" under "Environmental governance" below), the city has conserved some 13,600 hectares of environmentally sensitive areas. The city is also preparing to deploy an environmental surveillance force, which will have the technical expertise to protect conservation areas and limit the impact of informal settlements. The Green Plan also includes a reforestation programme, which calls for planting 2.5 million plants per year. Note: This report didn´t include ECOBICI program with over 32 million trips and 200000 users.

Table 3.11 Mexico City Sustainability Highlights

3.2.5.2. US and Canada Green City Index

The United States and Canada, already largely urban, are becoming ever more so. According to the United Nations Population Division, 82% of Americans and 81% of Canadians lived in cities in 2010 and these proportionsare set to continue rising, reaching 90% for theUS and 88% for Canada by 2050.

US and Canadian cities excel in several areas. Water infrastructure, recycling levels and environmental governance mechanisms are comparable to the best cities the Green City Indexes have evaluated around the world. For example, the average leakage rate, 13%, is lower than in any other continent and 26% of waste is recycled, compared with 28% for the 15 richest cities in Europe. Americans and Canadians are also innovating in the area of urban sustainability, as the exemplar projects show.

Canadian cities have a reputation for being more environmentally conscious than US cities, but a first glance at the Index tells a different story. Vancouver, which is one of five Canadiancities in the Index, places second overall, but the other four are clustered around the middle of the ranking. If wealth is taken into account, how ever, all of the Canadian cities punch well above their weight

Land use
US and Canada Index cities have large amounts of green space. Although often this is combined with low population density. Consistent with this, the cities tend to have good policies on parks and trees but are less active in containing urban sprawl..

Transport

The report remarks that Infrastructure is another story. US and Canada Index cities on average have only 1.1 miles of public transport network for every square mile of area, which is about a third of the 3.1 miles of European cities of the same wealth. This, however, conceals a national difference: in Canada, the average figure is 2.5 miles of public transport network per square mile, compared with just 0.7 miles per square mile in the US.

Fewer people on average commute by car to work in the Canadian Index cities, at 74%, compared with those in the US, at 90%. In global terms, however, both figures are remarkably high. In the European cities with a similar level of wealth, an average of 43% of commuters drive.

Canada´s Highlights

Montreal introduced Canada's first self-service bike rental network, BIXI a word derived from the combination of BIcycle and taxi in 2009. Itis currently North America’s biggest bike sharing scheme, with approximately 5,000 bicycles and 400 docking stations. After 3.3 million trips in 2010, only 1% of bikes were lost or stolen. The program has been introduced in Toronto and is likely to expand to Vancouver, Minneapolis, Washington DC, and even London.

Water

US and Canadian cities have efficient water infrastructure and robust policies regarding water conservation. Nevertheless, their water consumption is far higher than in Asia, Latin America or Europe. (See figure 1.9)

Waste

Although all European cities of similar income have comprehensive waste reduction strategies, only 14 of 27 US and Canada Index cities do, suggesting that waste reduction has not received as much priority in North America as it has in Europe.

Toronto, turned an energy problem into a sustainability opportunity. When the city had to move its water-intake pipe deeper into Lake Ontario, the water was too cold to be treated for consumption. Enwave used the cold water to provide air conditioning to downtown offices, saving 61 megawatts of energy annually. Moreover, this process raised the water temperature to a level sufficient for drinking-water treatment thus eliminating the original problem.

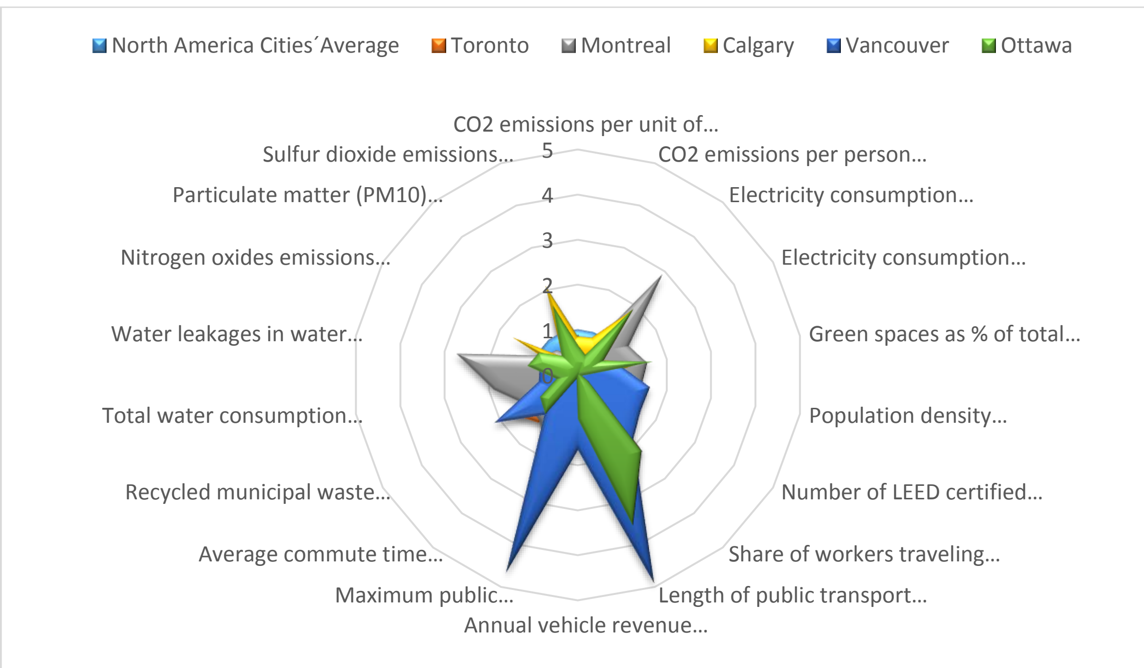


Figure 3.8 Canadian Cities Sustainability assessment

As showe in Figure 3.8 Vancouver is the most sustainable city of Canada, Montreal and Toronto stands behind above from the North America Cities´average. Public transport remains as one of the most developed backwardness. In my opinion water scarcity has become a real problem in large metropolitan areas like California and Great Toronto.

Montreal ranks 19th overall in the 27-city Index. **<u>CONS</u>** Montreal has 1.7 buildings per 100,000 peoplecertified by Leadership in Energy and Environmental Design (LEED) compared with the Indexaverage of 6.4, although a recent law (see"green initiatives" below) is likely to lead to in -creases in LEED certification for both new andrenovated buildings Montreal's overall score is in part a result of its low income and limited funding for environ mental initiatives. **Green initiatives**: From 2010 Montreal hasrequired LEED gold certification for all new publicbuildings of more than 500 square metersand LEED silver certification for all major renovationsto public buildings. To be certified, buildingsmust meet minimum requirements forenergy savings, water efficiency, CO2 emissions reduction and improved indoor environmental quality	**<u>PROS</u>** The city's strongest category is transport, where it places fourth, a performance due mainly to having the second highest percentage of non-automobile commuters in the Index. Montreal has limited authority in mandating energy efficiency audits or regulations, but the provincial government runs buildings-related programs, such as offering up to $1 million in financial incentives for companies that improve the energy efficiency of their buildings. .

Table 3.12 Montreal Sustainability Highlights

Ottawa ranks 12th overall in the Index and third among the five Canadian cities. **<u>CONS</u>** Ottawa's score in the buildings category is weighed down by a shortage of Leadership in Energy and Environmental Design (LEED)-certified buildings. The city claims 1.7 LEED buildings per 100,000 people, well below the Index average of 6.4, but this could improve as regulations implemented in 2005 take full effect in the future .	**<u>PROS</u>** Ottawa's best performance is in the area of land use, where it places third. The city limits encompass numerous semi-rural areas, which combine to give it the highest percentage of green space in the Index. Ottawa also fares well in the CO2 and transport categories, placing fifth in both. Its per capita CO2 emissions are among the lowest in the Index while the city also boasts one of the highest percentages of workers commuting by public transport, on foot or bicycle

	As of 2005 all newly constructed buildings in Ottawa greater than 500 square meters must be designed, delivered and certified by the Canada Green Building Council as being LEED-Canada “Certified” at minimum. All newly constructed buildingsmust also incorporate energy efficient features into the building design to meet the standards required by another program, the CommercialBuilding Incentive Program of 2006.

Table 3.13 Ottawa Sustainability Highlights

Toronto places ninth overall in the Index and second in Canada, behind Vancouver. **<u>CONS</u>** With a quickly growing population and cold weather concerns, building efficiency is a high priority, and Toronto appears to be on track to improve its score in this category. The city offers energy efficiency education and incentives to retrofit, while its Green Building Standard has been key to regulating energy efficiency.	**<u>PROS</u>** The city’s strongest category performance is in waste, where it ranks fourth. It also places in the top half of the Index in CO2, energy, buildings, water and air. Toronto fares well when compared to other large cities, placing second among this group in the energy, waste and water categories. It also places first among the group of cities with lower average temperatures in the Index The Toronto Green Standard is a two-tier set of performance measures that encourage developers to build environmentally friendly buildings, addressing air quality, green -house gas emissions, energy efficiency and water quality. All new public and private buil - dings are required to meet the tier 1 standard, which entails a 25% reduction in energy consumption. Buildings that meet a requisite number of additional voluntary standards (whichvary according to building type) qualify for the second tier and are eligible for a refund of 20% of development fees.

Table 3.14 Toronto Sustainability Highlights

Vancouver ranks second overall in the Index and tops the rankings in the CO2 and air categories. **<u>Pros</u>** The city has the lowest CO_2 emissions in terms of both population and GDP, while it ranks in the top three for emissions of all air pollutants measured in the Index. Perhaps more impressively though, Vancouver ranks in the top seven for all categories, with the exception of environmental governance, where it ranks tenth. Already one of the best cities overall, Vancouver fares even better when compared with its peers; compared to other low-income cities, for example, Vancouver places first overall, and in the top two in all categories.	Vancouver's score in this category is bolstered by the abundance of Leadership in Energy and Environmental Design (LEED)-certified buildings. It has among the most in the Index with10.2 per 100,000 people, compared with the average of 6.4. The city also scores well in the area of policies aimed at promoting energy efficiency in buildings. In 2008 Vancouver set a goal of making all new construction carbon neutral by 2030. As part of this goal, the Green Homes program requires that all new building permit applications for single-family homes meet a specific set of requirements, which will reduce energy consumption by 33% from current levels. Note: No CONS were mentioned in the report

Table 3.15 Vanccouver Sustainability Highlights

Andreas Georgoulias, Harvard University Graduate School of Design
Vancouver has the longest public transport network in the US and Canada Index, but it's New Yorkers who use public transport most frequently to get to work (37%).

Spotlight on Vancouver

Vancouver ranks second overall in the US and Canada Index. It is first for CO_2 and air quality and among the top 10 cities for all other Index categories. This performance comes despite having one of the lower per capita GDPs in the Index, at US$37,500 (the Index average is US$46,000). A particular highlight is Vancouver's commitment to reducing greenhouse gas emissions, which has resulted in the lowest CO_2 emissions per capita in the Index. In 2010 Vancouver unveiled plans to reduce greenhouse gas emissions by 33% by 2020 from 2007 levels. The city also set a target for all residents to live within a five-minute walk of a park, greenway or other green space – and for planting 150,000 new trees by 2020.

3.2.6. World Green building trends 2013

Outlook for Construction Projects Remains Strong
Reflecting a more positive business outlook, 65% of executives said it was extremely or very likely, their organization would undertake a new construction project over the next 12 months, while 75% said the same about undertaking a renovation project.

Emerging Sustainability Tools and Standards

The dramatic increase in extreme weather events, such as Hurricane Sandy, has led executives to place a higher priority on enhancing the resiliency of their buildings. Tthe ability to maintain, or quickly resume, operations when extreme weather or other disruptive events occur. Two-thirds of executives said improving resiliency is an extremely or very important factor when their organization designs, constructs, and operates buildings. A number of other emerging tools and standards were considered by more than half of the executives to be extremely or very important today including health product declarations (55%) and environmental product declarations (50%). Several standards were expected to become more important over the next three years including Net Zero Energy (48% today; 58% in three years) and Net Zero Waste (45% today; 54% in three years).

Given the growing evidence of their benefits, incorporating Green features in new construction and renovation projects is becoming increasingly common. While most executives said their organization would be extremely or very likely to incorporate Green features if it were undertaking a building project, most often citing improved energy efficiency (82%), 71% thought it was extremely or very likely they would incorporate improved water efficiency into new construction or renovation projects, up from 57% in 2012. This indicates a growing awareness of water as a finite and sometimes scarce resource and the importance of water efficiency.(See figure 3.9)

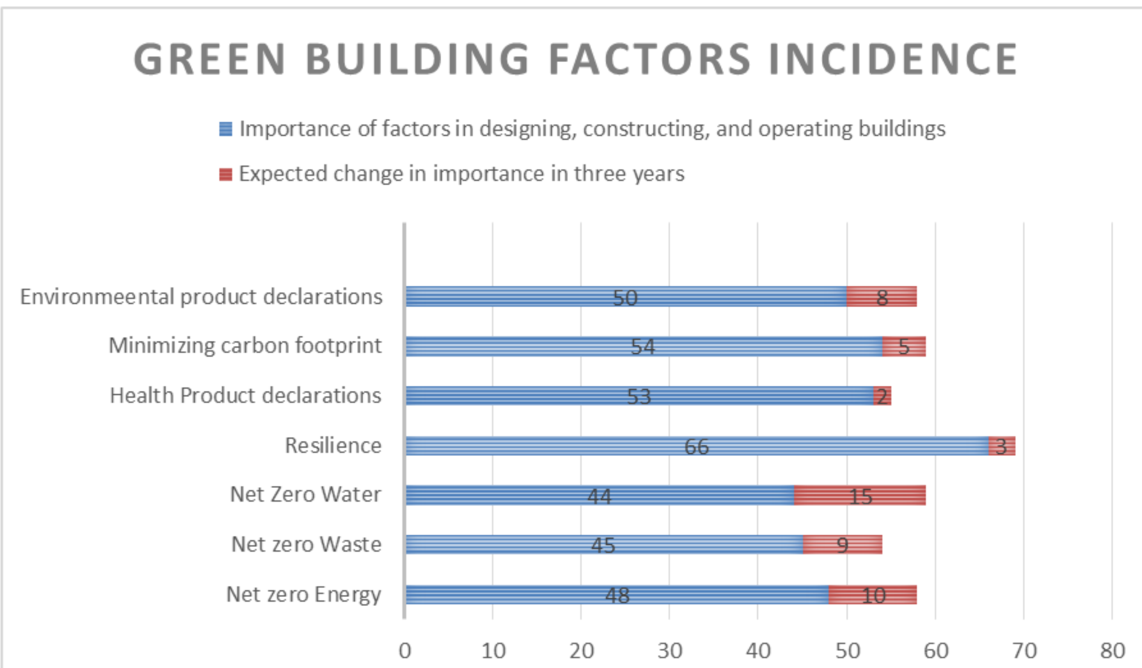


Figure 3.9 Gren Building Factors Incidence in Canada

Green buildings are one important element in an organization's broader program of becoming more sustainable, including in their procurement practices. **In the 2014 Green Building Market Barometer, for the first time, more than half of the executives said the level of a vendor's sustainable practices was extremely or very important for their organization when choosing a**

supplier of goods and materials (56%) or a service provider (52%). These figures have climbed steadily since 2010, when they were 43% for suppliers and 39% for service providers. (Harvey M Bernstain et al, 2014)

3.3. Green building in Canada

According with Natural Resources Canada´s website ***"Housing accounts for approximately 17% of secondary energy used in Canada. While most consumer products have been commoditized globally, housing is built and renovated locally, providing us with the ability to dramatically reduce the home's energy footprint ultimately moving towards Net-Zero Energy (NZE) homes."***[265]

In 2006, the Canadian government launched the first phase of a net zero-energy housing initiative. This initial phase is part of a five-year, community-scale demonstration aimed at completing 1,500 net zero-energy homes across Canada by 2011.***" Canadian demonstration projects by leading-edge builders have proven that Net Zero Energy (NZE) homes are technically feasible in our cold climate. But current building approaches are complex, custom, and expensive, adding $90-120K to the cost of a home"***.[266][267]

Green Globes, formed by groups in Canada and the United States as an alternative to LEED, emphasizes ease of use, low cost and use reducation through its web-based application.The Building Owners and Managers Association (BOMA) Canada launched a variant of Green Globes.

GoGreen, which rates existing commercial office buildings.The Built Green Society of Canada manages Built Green, a certification program for new single-family homes and row houses. It currently operates in Alberta and British Columbia.

GREEN BUILDING ACTIVITY IN CANADA

Well over half **(56%)** of the Canadian respondents to the industry survey report that over 30% of the projects they build are currently green, and by 2017, 70% expect to be doing at least that level of green construction, with 50% reporting that more than 60% of their projects will be green. This suggests that the share of green building in Canada's construction market is likely to see significant increases, creating strong opportunities for firms in this market that can capitalize effectively on this shift. While the overall level of green involvement in Canada is slightly below those reported by U.S. firms in the 2012 World Green Building Trends study conducted by McGraw Hill Construction, the degree of growth in the involvement in green anticipated in the next three years is much higher now in Canada than the anticipated level of growth over three years reported by the U.S. firms in the 2012 study. **This suggests that the Canadian market may soon be on par with the U.S. in terms of the share of green building. On the other hand, the Canadian level of green building activity is generally a little higher than the global level reported in the 2012 study, published in the *World***

[265] http://www.nrcan.gc.ca/energy/efficiency/housing/research/13628
[266] http://www.nrcan.gc.ca/energy/efficiency/housing/research/5133
[267] http://www.nrcan.gc.ca/energy/efficiency/housing/research/5131

Green Building Trends SmartMarket Report. This demonstrates the relative sophistication of the green building market in Canada.

3.3.1. Barriers & Triggers for Green building in Canada[268]

The Canada Green Building Council (CaGBC) saw a steady increase in LEED certifications in 2015, a result of green building's growing impact as one of the most effective solutions to climate change. A total of 527 LEED projects certified between January 1 and December 31, bringing the grand total of certified projects in Canada to 2,576 a total of 34,054,312 million sq. meters of certified space. Among the most notable stats for the year was the growth of certifications at LEED's most rigorous levels, Gold and Platinum, which increased over 2014 by 6.2 and 28.6 per cent, respectively. Canada also saw its first LEED v4 certified project in October, and ended the year with a total of 13 projects registered under the newest version of the rating system.

Totals by LEED certification level for 2015 were:

97 LEED Certified
187 LEED Silver
207 LEED Gold
36 LEED Platinum

"In many ways 2015 was a watershed year for green building, in Canada and on a global scale, culminating in the COP 21 'Buildings Day' in December," says Thomas Mueller, President and CEO of the Canada Green Building Council. ***"As the voice of the green building industry in Canada, we are now focusing on the federal government to leverage green building as an actionable solution to reaching Canada's climate change commitments. The upward trend of Gold and Platinum level certifications is a positive sign that the industry is capable and ready to achieve more ambitious performance targets in new and existing buildings. However, we must engage more building owners to take action through energy benchmarking and verified performance improvements."***

The top provinces for LEED certification across Canada in 2015 were :

Ontario	**198**
Quebec	**121**
British Columbia	**83**
Alberta	**75**
Manitoba	**19**
Nova Scotia	**17**

Among the most notable milestones for green building in 2015: Edelweiss House in Wakefield, QC, became the first project to certify under the LEED v4 rating system in Canada; [269][270]

TRIGGERS FOR GREEN BUILDING IN CANADA

[268] Canada Green Building Trends Report, McGraw Hill Construction,2014
[269] http://www.cagbc.org/News/EN/2016/20160203_News_Release.aspx
[270] http://www.cagbc.org/News/EN/2015/20151005_News_Release.aspx

Doing the right thing and client demand are the top triggers for increased green building activity in the Canadian market, selected by 42% as one of their top three choices. However, more respondents (24%) rank doing the right thing as the number one trigger when selecting their top three than those that select client demand as the top trigger (18%). The high influence of doing the right thing is unique in a market with the level of green experience that Canada has, and it has strong implications for the best approaches to marketing green products and services effectively to Canadian practitioners.

The importance of client demand also demonstrates the degree to which business factors also drive the market. **The in-depth interviews with green leaders in commercial real estate give a high level of importance to the role of clients and tenants in encouraging their green investments, and it demonstrates the broad awareness of the importance of sustainability in Canada. In particular, these leaders highlight the importance of institutional clients in the Canadian market whose sustainability commitments are helping to drive the market.**

Top Barriers to the Growth of Green Building

The perception of higher first costs (capital expenditures made at the start of a project) is by far the largest barrier to the growth of green building in Canada. The importance given to higher first costs as an obstacle is consistent with other McGraw Hill Construction research on green building conducted in the U.S. However, it is worth noting that concerns about higher first costs in the 2012 World Green Building Trends study was even higher globally, at 76%, and that had declined from 80% in 2008. With nearly one third of the respondents not selecting higher first costs among their top three choices, Canadian respondents seem less concerned about this factor than those in other regions.

Lack of market demand is the only other barrier considered most important by 14% of the respondents, and it was also selected by 39% as one of the top three barriers. ***This suggests that more owner and tenant education is needed in Canada on the benefits of building green.*** This is a less important factor in the U.S., with 27% selecting it among their top three barriers, the same as those concerned about affordability and the perception of green as high end, which finishes slightly lower among the Canadian respondents.

VARIATION BY FIRM TYPE

Only 29% of contractors consider the lack of products or solutions available in their market to be one of their top three obstacles, compared with 7% of architects and 15% of building owners. Since the final procurement of green products and solutions often lies with the contractors, this suggests that in Canada, this may be a larger problem than much of the industry realizes.

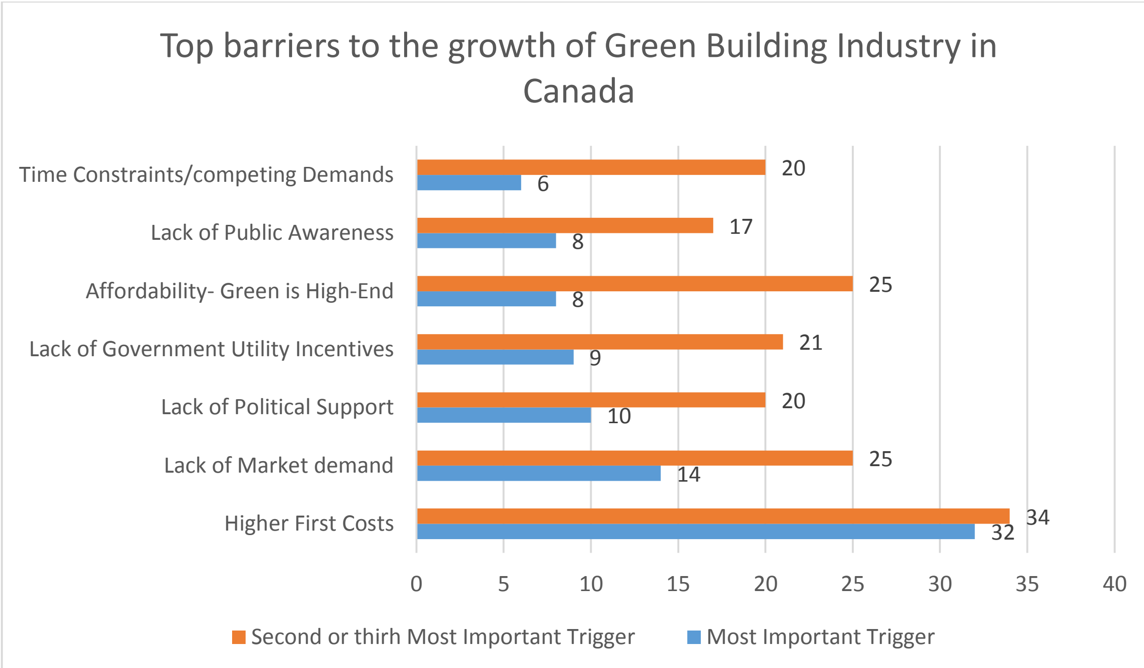


Figure 3.10 Top barriers to the growth of Green Building Industry in Canada retrieved from: Canada Green Building Trends Report, McGraw Hill Construction,2014

3.3.2. Emissions trends[271]

The analysis indicates that if consumers, businesses and governments had taken no action to reduce GHG emissions after 2005, emissions in 2020 would have risen to 862 Mt. This is in comparison to the **"with current measures"** scenario where, as a result of actions taken since 2005, emissions in 2020 are expected to be 734 Mt. This means that, taken together, actions by consumers, businesses, and federal, provincial and territorial governments have decreased emissions substantially from the "without measures" scenario

The "*Land Use, Land-Use Change, and Forestry"* (LULUCF) sector is a particularly important sector for Canada given our vast land areas. **Ten percent of the world's forests are in Canada. Our managed forest covers 229 million hectares, more than the managed forest of the entire European Union. Canada also has 65 million hectares of total farm area as reported in the 2011 *Census of Agriculture*.** Canada has opted for accounting approaches to GHG emissions for each subsector that take into account the unique structure of these forests and lands.

These policies (and government measures to reduce air pollutants) are also having an effect on short-lived climate pollutants (SLCPs) such as: black carbon (or soot), methane, tropospheric ozone and some hydrofluorocarbons (HFCs). Although SLCPs have relatively shorter "life-spans" in the atmosphere, they are responsible for a substantial fraction of current global warming and can have detrimental impacts on human health, agriculture and ecosystems. Action to reduce air pollutants from diesel vehicles is already reducing fine particulate matter and black carbon, and Canada's new coal-fired electricity performance standard will further reduce these emissions.

[271]**Canada's Emissions Trends, Environment Canada, October 2013**

Mt CO2 equivalent	1990	2000	2005	2011
Transportation	128	155	168	170
Oil and Gas	101	150	162	163
Electricity	94	129	121	90
Buildings	70	82	84	84
Emissions Intensitive & Trade Exponsed Industries	93	85	87	78
Agriculture	54	66	68	68
Waste and Others	50	51	49	49
National GHG total	591	718	737	702

Table 3.16 CANADA´s GHG emissions by economic sector (Mt Co2e) (excluding LULUCF)

Buildings

Emissions in Canada's commercial and residential buildings increased by 14 Mt between 1990 and 2005, and then remained relatively stable around the 2005 levels through to 2011. Still, since 1990 buildings have accounted for about 12% of Canada's GHG emissions in any given year. Despite a growing population and increased housing stock and commercial/institutional building stock, the stability in emissions since 2005 is attributed mainly to energy retrofits, as 40% of the floor space has seen some level of energy retrofit between 2005-2009. (See table 3.17)

Mt CO2 equivalent	2005	2011	2020	Change from 2005 to 2020
Transportation	168	170	176	8
Oil and Gas	162	163	200	38
Electricity	121	90	82	(-) 39
Buildings	84	84	95	11
Emissions Intensitive & Trade Exponsed Industries	87	78	90	3
Agriculture	737	702	734	-3
Waste and Others	N/A	N/A	-28	-28
National GHG total	591	718	737	702

Table 3.17 Change in GHG emissions by economic sector (Mt CO2e)

Buildings

Emissions from commercial and residential buildings are projected to increase by 12% over the 2005 to 2020 timeframe (excluding indirect emissions from electricity).

Residential
As shown in Table 3.17, GHG emissions from the residential sector (e.g., houses, apartments and other dwellings) are expected to remain relatively stable between 2005 and 2020, rising 3 Mt. This is despite an expected national increase of three million households between 2005 and 2020, a key driver of residential emissions growth. This highlights the decreasing emissions intensities in the average home which are taking place due to increasing energy costs being managed with, for example, better insulation technologies. In addition, federal and provincial measures aimed at increasing the energy efficiency of residential buildings, such as building code regulations and rebates for energy efficiency improvements are helping to improve efficiencies in this subsector.

Energy efficiency regulations, codes and standards for buildings and homes: The Government continues to update and strengthen energy efficiency standards forproducts under the *Energy Efficiency Act*, and is working with provinces to updatethe National Energy Code of Canada for Buildings. These actions, combined withtargeted incentive programs, have proven to be effective at reducing energy useand GHG emissions in this sector.

3.3.3. Policies, and certifications[272][273]

The National Model Codes and the User's Guide series are now collectively referred to as **Codes Canada**. The National Building Code of Canada provides a framework for provincial and municipal governments, and the updated version (2010), which will include energy efficiency requirements
In an attempt to reduce direct environmental impacts, many organizations are adopting a regulatory stance, using statutory and voluntary guidelines as methods of encouraging or mandating sustainable construction. This section examines the role of governmental and non-governmental standards and regulations concerning green construction.

Certification and standards systems in Canada have played a pivotal role in establishing green building practices.

Voluntary assessment and certification systems (national and regional) are offered through many different organizations in Canada. These organizations provide third-party certification based on point systems in the areas of sustainable site development, water efficiency, energy efficiency, materials selection and indoor environmental quality, thirteen though the emphasis varies depending on the certification systems.

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[272] http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2010_national_building_code.html
[273]**GREEN SUSTAINABLE BUILDING IN CANADA** Implications for the commercial and residential construction workforce G2011 retrieved from http://www.buildforce.ca/en/system/files/products/green_sustainable_building_in_canada_0.pdf

3.3.3.1. ONTARIO REGULATION 397/11[274]ENERGY CONSERVATION AND DEMAND MANAGEMENT PLANS

- A public agency shall prepare, publish, make available to the public and implement energy conservation and demand management plans or joint plans in accordance with sections 6 and 7 of the Act and with this Regulation.

- An energy conservation and demand management plan is composed of two parts as follows:

1. A summary of the public agency's annual energy consumption and greenhouse gas emissions for its operations.
2. A description of previous, current and proposed measures for conserving and otherwise reducing the amount of energy consumed by the public agency's operations and for managing the public agency's demand for energy, including a forecast of the expected results of current and proposed measures.

3.3.4. Ecoinitiatives

3.3.4.1. Local Energy Efficiency Partnerships (LEEP)

Builders use LEEP to reduce their time and risk in finding and trying innovations that can help them build higher performance homes better, faster and more affordably. LEEP is delivered on a regional basis with the intent to establish an ongoing critical mass of builders that are capable of pulling through the best innovations suited for the region which can in turn pull through a responsive supply chain.The results include energy savings for home owners, competitive advantage for participating builders and manufacturers, and builder driven enhancement to local building practice.[275]

3.3.4.2. Code for sustainable homes

A recent report by the Canadian Green Building Council describes the purpose of green buildings as follows: **Green buildings strive to balance environmental, economic, and social considerations in design, construction and operation. Energy, water and resource efficiency; occupant comfort and well-being; site development and community context; and the economics of building construction and operation are key considerations.** In comparison to conventional buildings, Green buildings take advantage of natural processes to generate less waste, less pollution, and reduce their overall environmental footprint.[276]Residential Buildings are designed, constructed, operated and decommissioned in a manner that supports a healthy, vibrant, inclusive and environmentally efficient economy, to support the well-being of Canada's citizens and meet their needs in asustainable manner, being sensitive to natural systems and working in harmony with them.

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[274] https://www.ontario.ca/laws/regulation/r11397
[275] http://www.nrcan.gc.ca/energy/efficiency/housing/leep/17338
[276] Paper 4c: Green Residential Building in North America: The Benefits of a North American Strategy: A Perspective from Canada, The Sheltair Group (Innes Hood)

3.3.4.3. Envirohome This joint initiative of the Canadian Home Builders' Association and TD Canada Trust is a marketing program for R-2000 builders and R-2000 homes. To qualify as an Envirohome, builders must first start with R-2000 designation and then incorporate additional features that are based on Canadian Mortgage and Housing Corporation's (**CMHC**) Healthy Housing initiative, such as: occupant health, energy efficiency, resource efficiency, environmental responsibility, and affordability. (Healthy Housing is an initiative that recognizes a builder's knowledge and skills rather awarding specific buildings).[277]

3.3.4.4. R2000[278][279]R-2000 is a voluntary standard administered by Natural Resources Canada (NRCan) and is delivered through a network of service organizations and professionals across Canada.Developed in partnership with Canada's residential construction industry, R-2000 is one of the initiatives offered by NRCan's Office of Energy Efficiency. This initiative's aim is to promote the use of cost-effective energy-efficient building practices and technologies.

Through the use of third-party evaluators and a government of Canada supported certification process homeowners are assured of real value and consistency.The R-2000 Standard (R-2000) is an industry-endorsed technical performance standard for energy efficiency, indoor air tightness quality, and environmental responsibility in home construction.Houses built to the R-2000 Standard typically exceed the energy performance requirements of the current Canadian building codes and are recognized by meeting a high standard of environmental responsibility.Since its introduction over 25 years ago, the R-2000 Standard has become the benchmark for energy efficient new home building in Canada. The Standard is continually upgraded to include new technologies as it becomes established in the marketplace furthermore it is flexible enough to apply to any type of home.[280]

This program focused on building a wellinsulated and airtight envelope, and this necessitated the installation of a controlled mechanicalventilation system, complete with heat recovery for even greater energy efficiency.
Types of Buildings to Which These Requirements Apply – This Standard applies to residential buildings that are within the scope of Part 9 of the National Building Code of Canada and are one of the following types:

(i) detached houses, including houses with secondary suites,
(ii) attached houses, which include semi-detached houses, row houses, and attached houses with secondary suites, and,
(iii) multi-unit residential buildings (MURBs), which include stacked townhouses, duplexes, triplexes and apartment buildings.

Space Heating and Domestic Hot Water Energy Target - The annual household energy consumption target for space heating and domestic hot water heating combined shall be that calculated using the current authorized version of HOT2000 and multiplied by 50%.

[277] http://www.greenbuildingcanada.ca/green-building-guide/green-building-certifications-rating-systems-canada/
[278]http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oee/files/pdf/2012%20R2000%20Standard%20EN.pdf
[279] http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/5085
[280] http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/5051

Indoor Air Quality - At least three of the indoor air quality features identified in the current version of the *R-2000 Indoor Air Quality and Environmental Features Pick-List* shall be used in the house.

Water Conservation - Plumbing fixtures shall meet the following criteria:
Toilets: Water-saver or ultra-low flush units using 4.8 litres/flush (1.3 U.S. gallons/flush) or less. Showers: Low-flow showerheads using 7.6 litres/min. (2.0 U.S. gallons/min) or less when tested at 551 kPa (80 psi). Faucets: Lavatory faucets using 5.7 litres/min. (1.5 U.S. gallons/min) or less when tested at 413 kPa (60 psi).

3.3.4.5. BOMABOMA BES*t* is a national program launched in 2005 by the Building Owners and Managers Association (**BOMA**) of Canada to address an industry need for realistic standards for energy and environmentalperformance of existing buildings.

Green Globes – This assessment and rating system is operated by BOMA BESt for existing buildings (see above) and ECD Energy and Environment Canada Ltd. for other uses. Green Globes is an online, interactive tool with automated reporting that significantly reduces the time and cost of submissions.[281]

3.3.4.6. GreenHouse

GreenHouse is an Ontario-based residential building-specific certification system offered by EnerQuality, an organization founded through a partnership between the Canadian Energy Efficiency Alliance and the GreenHouse Certified Construction is a green building certification that goes a step beyond ENERGY STAR®® for New Homes. GreenHouse adds three more sustainability metrics—water, materials & waste and indoor air quality to its core ENERGY STAR requirement.[282]**SAVINGS**– GreenHouse homes use substantially less energy and less water, expect to save approximately 20% on your monthly usage.

HEALTH–Advanced construction, better ventilation, green materials, and more insulation means GreenHouse homes are comfier, quieter and fresher.

GREEN– GreenHouse homes generate two to three tons less greenhouse gas emissions per year than homes built just to code. They reduce energy and water consumption, and the use of raw materials and waste during construction.

[281] http://www.greenbuildingcanada.ca/green-building-guide/green-building-certifications-rating-systems-canada/
[282] http://www.enerquality.ca/program/greenhousetm/

3.3.4.7. Novoclimat This initiative of the Quebec Ressources Naturelles et Faune department is a program for new homes to improve energy efficiency. Homes built according to this standard realize improved energy performance of a minimum of 25 per cent.

The Novoclimat 2.0 home section and the small multiple-unit building section are now in force.[283] Novoclimat 2.0 defines the **technical requirements** to be observed when a house or a small multiple-unit building is built in order to offer energy performance that exceeds the norms in effect.

The program includes the training and certification of construction contractors and specialists in ventilation, the inspection of dwellings when they are built, and the **certification** of compliant homes.

Lastly, the program also includes **financial assistance** that is available to:

- The purchaser and the builder under the home section;
- The promoter under the small multiple-unit building section.

Novoclimat 2.0 applies to houses and to small multiple-unit buildings (buildings of three or fewer storeys, 600 m^2 or less).

The initial Novoclimat program applied to big multiple unit buildings (buildings of over 600 m^2 and up to 10 storeys).

3.3.4.8. Built Green

This is a voluntary rating system open to members of participating Home Builders' associations. Builder training is a mandatory component, and only Built Green certified builders could construct Built Green certified homes. This certification and training system is most often used in British Columbia and Alberta. Ontario Home Builders' Association.

BuiltGreen Canada is a national certification program focused on home building. BUILT GREEN® homes account for: resource efficiency (i.e. electrical, water), comfort (i.e. airtight, sound reduction), home health (ventilation, low/zero VOC paints), durability and waste reduction. The result is a home that could save 10 per cent in annual utility bills as compared to a code-built home, is more comfortable, is healthier to live in, lasts longer and is constructed more efficiently than a conventional home.

[283] http://www.efficaciteenergetique.gouv.qc.ca/en/my-home/novoclimat/#.Vrkr7FI1YZw

3.3.4.9. ENERGY STAR for New Homes Standard The ERS development team has been researching approaches to continuing with the ENERGY STAR for New Homes (ESNH) Initiative. NRCan released a draft version of the next generationstandard in October for a public review period that closed on November 4th. This standard offers both a prescriptive and a performance path, with the requirement that the design achieve a rating of at least EnerGuide 83 using the current ERS scale.

3.3.5. Toronto Green Standard[284]The Toronto Green Standard (TGS) sets out requirements for buildings and houses in a number of sustainable performance topic areas that exceed those found in the current Ontario Building Code (OBC). These are organized into mandatory requirements under Tier I, and optional requirements under Tier II for which a rebate is offered on a portion of development charges as an incentive.

The new Toronto Green Standard (TGS) Minimum Energy Performance targets requires developments to be designed to achieve energy efficiency levels 15 percent better than the current Ontario Building Code (OBC) for Tier 1 and to be designed and constructed 25 percent better than OBC for Tier 2. The new TGS requirements applies to developments applying for site plan approval after January 1, 2014.

Building Categorizations (see table 3.18). Buildings are generally categorized by the type of occupancy. The Energy Information Agency (EIA), an arm of the Department of Energy (DOE) in the US, has been conducting the Commercial

Education Food Sales Food Service Health Care Inpatient Outpatient Lodging Mercantile Retail (Other Than Mall) Enclosed and Strip Malls	Office Public Assembly Public Order and Safety Religious Worship Service Warehouse and Storage Other

Table 3.18 Building Energy Consumption Survey (CBECS) since 1978. EIA uses the following building types (designated as "Principal Building Activity"):

The Now house Project: Now House is a process for retrofitting existing older houses into net zero energy homes, homes that produce as much energy as they use on an annual basis. Just like a typical city house, a Now House is connected to and uses energy from the local utility. However, unlike typical homes, a Now House produces energy to send to the utility company. Annually, zero energy homes produce enough energy to offset the amount purchased from the utility provider, resulting in a net zero energy bill.[285]

[284] TGS Energy Efficiency Workshop Report,December 13, 2013
[285] http://www.nowhouseproject.com/aboutWhatis.php

New energy-efficiency targets

Starting January 1, 2014
Tier 1 (Mandatory) Min. 15% better than OBC
Tier 2 (Optional) Min. 25% better than OBC

OBC has three paths for compliance Prescriptive (no model)
Compare to “adjusted” ASHRAE 90.1 (with model)
Compare to MNECB (with model)

“Toronto is experiencing a level of growth that is unprecedented , between Jan 1, 2008 and Dec 31, 2012, City Planning received 1,643 development applications. That was translated to more than 148 000 residential Units, and 4.5 million non-residential sqm”

As-Constructed Energy Report

The As-Constructed Energy Report is required at the completion of the project and should reflect the building’s final design including any changes made during the construction phase. The As-Constructed Energy Report will be necessary to document compliance with TGS Tier 2 requirements. Issued For Construction (IFC) documents in place of As-Constructed documents is deemed equivalent only if at the completion of the project, the applicant has submitted a letter signed by the professional engineer for the project confirming that the energy efficiency equipment, systems, measures that have contributed to the building’s energy performance, have been installed, scheduled and operated as illustrated in the As-Constructed Energy Report and supported documents.

An estimate of the annual emissions reductions has been prepared for 2017 and 2022 based on the end of the period for which the OBC and the (See table 3.19) TGS will have been in effect. Implementation of the proposed higher energy efficiency requirements in the TGS over the OBC will reduce GHG emissions resulting from the consumption of both electricity and natural gas. This has been projected using the following sources:

Building Type	Period of Construction	Annual GHG Emissions Avoided, tonnes CO2e	
		2017	2022
Residential	2012 - 2016 2017 - 2021	10,346	10,126 5,029
Commercial/ Institutional	2012 - 2016 2017 – 2021	24,130	22,106 20,604
	Total	**34,476**	**57,865**

Table 3.19 Summary of Avoided GHG Emissions for the Years 2017 and 2022
Retrieved from: Development of Energy Efficiency Requirementsfor the Toronto Green Standard: Final Report, 2012.

3.4 Green building in Mexico

"In Mexico, there are no current estimates on the number of green buildings. However, the country has a tradition of architecture that favors environmentally sensitive, low impact building practices and designs. In 2002 The Mexico Green Building Council was formed (MxGBC). It was re-launched in 2005 in Monterrey but, with 32 members, remains quite small in comparison to the USGBC and the CaGBC." (William Kennedy et al, 2008)

In Mexico, urban growth pressures, housing needs, corporate social responsibility strategies, and certain tourist developments are the triggers to create greater interest in green building. While in Mexico many buildings and residences already embody green building practices, such as energy effi ciency and water conservation, the widespread institutional drivers that exist in the United States and Canada do not, for the most part, yet exist.

One recent area of focus in Mexico has been on green roofs as a way to recharge aquifers, reduce storm water run-off, filter pollutants out of rainwater, provide wildlife habitats, improve roof aesthetics, as well as reduce the heating and cooling loads of buildings and the urban heat island effect.

Main Mexican agencies with sustainable building advocacy

CONAVI: Comisión Nacional de Vivienda (National Housing Commission)
FONHAPO: Fondo Nacional para las Habitaciones Populares (The National Trust Fund for Popular Housing)
FOVISSSTE: Fondo de la Vivienda del Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (Housing Fund, Social Securit yServices Institute of Public Workers)
INFONAVIT:Instituto Nacional del Fondo de la Vivienda para los Trabajadores (National Housing Fund for Private SectorWorkers)
SHF: Sociedad Hipotecaria Federal (Federal Mortgage Society)
SOFOME: Sociedades Financieras de Objeto Múltiple (Multi-purpose financial companies)

The government is responding by instituting a number of efforts to promote the uptake of green principles and practices in the residential sector, particularly in housing developments with government involvement. Mexico's National Housing Commission (Conavi) has been documenting green practices and is working on defi ning criteria and regulations for homes to receive government subsidies to incorporate water and energy conservation technologies (such as thermal insulation and efficient lighting), and the use of solar energy for hot water, and on-site power generation.

Also, INFONAVIT, a large housing fund supported by mandatory employer and employee contributions, has created a "green mortgage" program (hipoteca verde in Spanish) that will increase the amount of credit available towards the purchase of a home and grant longer mortgage repayment terms for homes that integrate "green" elements. An example of the type of construction the government is trying is promote is the "casa ecológica," built in Ciudad Juárez in 2000. So far,36 houses has been built as part of a social housing project for the climatic extremes of northern Chihuahua, it features the following bioclimatic innovations: (JONATHAN WESTEINDE et al, 2008)

FACTS

- In Mexico exist 31.6 million of housing dwelling and a lag of 8.9 million (source 2015, CONAVI/SEDATU)
- The housing sector in Mexico is responsible of 16.2% of energy consumption, and almost 5 % of CO2 emissions[286]
- Mexico is committed to reduce greenhouse gas emissions up to 50% by 2050 Policies according with 2002 emissions levels.[287]

"Mexico is the first country to submit a comprehensive NAMA aiming to improve the efficiency of the buildings sector by implementing a building energy code."[288]

The Mexican National Housing policy is focused in promoting the sustainable and orderly development in the housing construction sector by regularizing, and improving the urban dwelling and rural housing. In his presentation of August 2015 (Table 3.20), the Quality and Sustainability Manager of the National Housing Commission (CONAVI in Spanish) Carlos Carrasco underlined the in policies of the New Mexican Government he submitted the following table that I modified adding some personal comments.

Ancient housing Policy Model	Current Policy Model	Comments
The National Housing Policy was focused on massive construction of dwellings. The dwelling construction sector was concentrated in only 5 main developers. There was a lack of coordination between Federal Government Agencies (SHCP - SHF / INFONAVIT – FOVISSTE / CONAPO/CONAVI) The three tiers of Mexican Government allows the construction of subdivisions without taking into account site locations, feasibility and urban planning.	The current policy is focused on the control of city development under sustainable development by implementing actions such as retrofitting, and restoring abandoned dwelling. The Territorial, Agricultural and Urban Development Ministry was created in 2013, to coordinate the actions of the New National Housing Policy. The new model is based in Urban Containment Polygons Now It is prioritized the dwelling quality over quantity of new dwellings.	In 2013, the INFONAVIT reported that in Mexico there were almost 120 000 abandoned dwellings, and 13 650 were already vandalized.[289] Furthermore, the number of abandoned dwelling grow from 5.1 to 3.9 between 1990 to 2010. During the las twenty years, the existing housing stock has increased steadily. According to INEGI census of 2010 between 1990 and 2010, the number of dwellings increased from 16 to 28.6 millions. The National Population Council (**CONAPO**) stated that this trend will continue, and estimates that this number would grow up to 43.7 millions by 2050.

Table 3.20 Mexico Greenbuilding policies assessment

[286] Fundación IDEA (2013). ***Estrategia nacional para la vivienda sustentable.*** Componente Ambiental de la Sustentabilidad. México.
[287] Campos-Arriaga, L. (2015). La NAMA de Vivienda. Política de vivienda sustentable del Gobierno de México. SEDATU / CONAVI / BMUB / DECC / GIZ.. Material 1.
[288]**POLICY PATHWAY** Modernising Building Energy Codes, International Energy Agencie, 2012
[289] http://www.elfinanciero.com.mx/empresas/infonavit-fracasa-en-la-venta-de-vivienda-abandonada-en-mexico.html

3.4.1. Policies, and certifications

3.4.1.1. NMX-AA-164-SCFI-2013

(Voluntary Mexican standard for sustainable building environmental criteria and minimum requirements)[290]

This Mexican norm specifies the criteria, and minimal environmental requirements for sustainable buildings in order to contribute in the mitigate environmental impacts (See chapter 4.2), and reduce natural sources depletion, taking into account social and economic aspects to meet feasibility, livable, integration to urban space and natural habitat.

As mentioned, The NMX-164 is a voluntary standard issued by the Mexican national government and isn't linked to a certification, but provides minimal criteria and requirements to consider a building as sustainable, and brings basis to establish a Mexican certification in the future. Applies for residential or mixed use, including commercial and industrial buildings. This standard encompasses the whole building life from design to demolition including construction operation and maintenance. Including renovations, restoration, and retrofit of buildings.

The Standard focuses on five different topics: Territory, Energy, Water, Materials and Waste, Environmental Quality and Social Responsibility. Each of these topics was established with mandatory and optional components.[291]

This norm defines sustainable building (Green Buildings) As a building that during its life cycle meet the regulations stablished for: Site selection, energy, water, materials and resources, waste generation, environmental quality, and corporate social responsibility.[292][293]

General requirements:

- Regulation compliance (environmental, energy, health & safety, noise, urban, etc)
- Monthly statistical information (energy and water consumption, waste management)
- Users Operation & Maintenance (**O & M**)guidelines and training
- Annual **O & M**Program (see the NMX- 164 PDF document)[294]

Particular requirements

Site location for urban (must include urban infrastructure and public services included public transport, and non-urban projects (justified by an urban and environmental impacts assessment). The standard provides a list of banned places such as wetland, floodplains, conservation areas, etc.

Energy requirements Improve by 10% the reference building according with theNOM-008-ENER-2001 and NOM-020-ENER-2011 standards, compliance with NOM-018-ENER-2011, power supply must include 10% of renewable energies sources. Lighting systems must meet NOM-017-ENER/SCFI-

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[290] http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/DOFsr/DO3156.pdf
[291] Voluntary Mexican standard for sustainable building: environmental criteria and minimum requirements, M. Niño, A. Villa & F. Tena Sustainable Development and Planning VII (299-307)
[292] https://www.bing.com/videos/search?q=NMX-AA-164-SCFI-2013&&view=detail&mid=36DDC1733E8350C9980936DDC1733E8350C99809&FORM=VRDGAR
[293] https://www.iso.org/obp/ui/#iso:std:iso:15392:ed-1:v1:en
[294] http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/DOFsr/DO3156.pdf

2008, NOM-028-ENER-2010, NOM-064-SCFI-2000, and NOM-025-STPS-2008. Electric appliances are also included under NOM-015-ENER-2002, NOM-021-ENER/SCFI, the building must have an electronic telemetry metering system, etc

Note: In the case of residential building, the energy consumption must meet at least C level of the Energy-Efficient Housing Design Mexican Green Housing Evaluation System SISEVIVE-ECOCASA calculation tool) program (see section 3.4.2.1)

Water: All the showers, kitchen, and bathroom products must have a certificate of NOM compliance for water-saving, the hydraulic building design must achieve at least 20% water reduction consumption from equivalent building (Appendix 8), every building must have a water meter, and keep log register for monthly water consumption. If the project include groundwater supply from wells, the project must meet NOM-003-CONAGUA and NOM-006-ENER standards, may have rain water harvesting systems for aquifer recharge, watering, and other non-potable water use; up to 30% residual water can be transfer to sewers under the permissible pollution limits (NOM-003-SEMARNAT) , every building bigger than 2500 sqm must have a eater treatment plant.

Materials and Waste – Material´s selection must include environmental, social and economic assessment for whole life-cycle of the building, forestry products must meet the General Law for Sustainable Forest Development, and its regulations. Materials information may include life cycle assessment under NMX-SAA-14040-IMNC and NMXSAA-14044-IMNC, main raw materials of construction products, type and quantity of energy used in the manufacture, transport, M&0 processes. Supply chain origin destination for all processes mentioned before, 10% of total materials may include recycled material content, and 50% of total materials should be recyclables. It´s necessary to develop a **waste management program** that include final disposal foreseen of materials. Finally, the standard provides a list of banned materials.

Note: Materials Safety Data Sheets can be used to prove compliance for health and safety regulations. In the case of waste management this standard is supported by the NOM-161-SEMARNAT-2011 sets the obligation to generators of waste from building construction, maintenance and demolition activities, of submit a Management Plan, where generation reduction, reuse, recycle and proper disposal strategies have to be set.

Socially and environmentally responsible practices – An Environmental Management Plan must be implemented according to the NOM-059-SEMARNAT standard that include species inventory. Endangered species, and healthy trees (larger than 20 cm diameter) must be preserved, landscaping project must meet natural surroundings of the area (xeriscaping), and should help to provide services to the construction such as shading, to dampen noise, erosion control, and pollution buffering. The interior of the building must meet comfort parameters such as temperature (between 18 and 25 °C). The constructions must be physical-barriers free for handicapped people.

The standard determines that a Certified Evaluation Unit can be designated to verify the degree of compliance.

Note: The current Minimum Energy Performance Standards (MEPS) in Mexico correspond to the Normas Oficiales Mexicanas (NOM), which are mandatory, and the Normas Mexicanas (NMX), which are voluntary.

Prevailing mandatory norms related to housing energy efficiency
BUILDING ENVELOPE

NOM-020-ENER-2011 Energy efficiency on buildings, building envelope for housing.

THERMAL INSULATION

NOM-018-ENER-2011 Thermal insulation for buildings. Characteristics, standard values and testing methods. GLASS AND GLAZING SYSTEMS
NOM-024-ENER-2012 Thermal-optical characteristics of glass and glazing systems for buildings. Labeling and testing methods.

THERMAL EFFICIENCY

NOM-003-ENER-2011. Thermal efficiency of water heaters for domestic and commercial use. Standard values, testing methods and labeling.
NOM-025-ENER-2013 Thermal efficiency of household appliances for cooking using LP gas or natural gas. Standard values, testing methods and labeling.

ENERGY EFFICIENCY

NOM-005-ENER-2012. Energy efficiency of household electric washing machines. Standard values, testing methods and labeling.
NOM-015-ENER-2012 Energy efficiency of refrigerators and coolers. Standard values, testing methods and labeling.
NOM-017-ENER/SCFI-2012 Energy efficiency and safety requirements of auto-ballasted compact fluorescent lamps. Standard values and testing methods.
NOM-021-ENER/SCFI-2008 Energy efficiency, safety requirements for users in air conditioners room type. Standard values, testing methods and labeling.
NOM-023-ENER-2010 Energy efficiency on air conditioners split type, free downloading without air ducts. Standard values, testing methods and labeling.
NOM-028-ENER-2010 Energy efficiency of lamps for general use. Standard values and testing methods.
NOM-020-ENER-2012 Luminous efficiency of light-emitting diode lamps (LED) implemented for general lighting. Standard values and testing methods.
NOM-032-ENER-2013 Maximum electrical power Standard values for electrical equipment and appliances that require standby power. Testing methods and labeling.

The standard includes fourteen appendices; I would like to mention the following in particular:

Appendix 1. Recommendations for Building Users /Owners Manual – Operation and Maintenance Manual.
Note: In addition to a building owner's manual and building log book, it may also be prudent to prepare a non-technical 'building users guide' with information for users about: [295]

[295] http://www.designingbuildings.co.uk/wiki/Building_user's_guide

- The principles behind the design of the building and how these affect its operation
- The building's standard of performance
- Energy efficiency measures
- Water-saving measures
- Means of operating heating, lighting and cooling systems, and the consequences of incorrect operation
- Access, security and safety systems
- Methods for reporting problems
- Car parking and cycling provision, local public transport, car sharing schemes etc.
- Waste management
- Training

Appendix 2. Bicycle storage´s guidelines

Appendix 4. in regards to transportation the provides information to stablish an **E**fficient **M**obility **P**rogram (**EMP**), an origin-destination survey, identification of mobility opportunities, partnership research with other organizations, and cost-benefit evaluation of actions. The prosed actions to implement are Carpooling, Public Transportation, Bicycles, Shuttle bus service provided by the company, parking lot management, taxis coupon, flexible workinh hours, working at home schemes, vehicle fleet management. The **EMP**must include a Coordinator, a Comunication Strategy, and a monitoring and assessment mechanism. The **EMP**must be also accompanied by a training and sensitization workshop program.

Appendix 11, 12 and 13. Include a list of banned materials, and visual impact assessment, and a acoustic guide recommendations.

Emissions trends

In 2006, the CO_2 emisions in Mexico reached 492,862.2 Gg, 69.5 % of the national inventory with a increase of 27 % with respect to 1990. The main sources of CO_2 emissions were the burning of fossil fuels and industrial processes. The sectors with the greatest contribution of CO_2 emissions were Transport (27.2%), power generation (22.8%), manufacture ans construction (11.5%), industrial consumption (7.4%), agriculture (7.3%), others (residential and commercial 6.2 %). (Mexico National GHG emissions Inventory, 2006). As showed in the following figures the reduction tendency continues in 2010, one of the problems that I found is the accuracy for the share of each sector, and It´s especially significant in both in the construction and residential sectors. In my opinion is critical to create reliable information in order to enhace social housing programs.

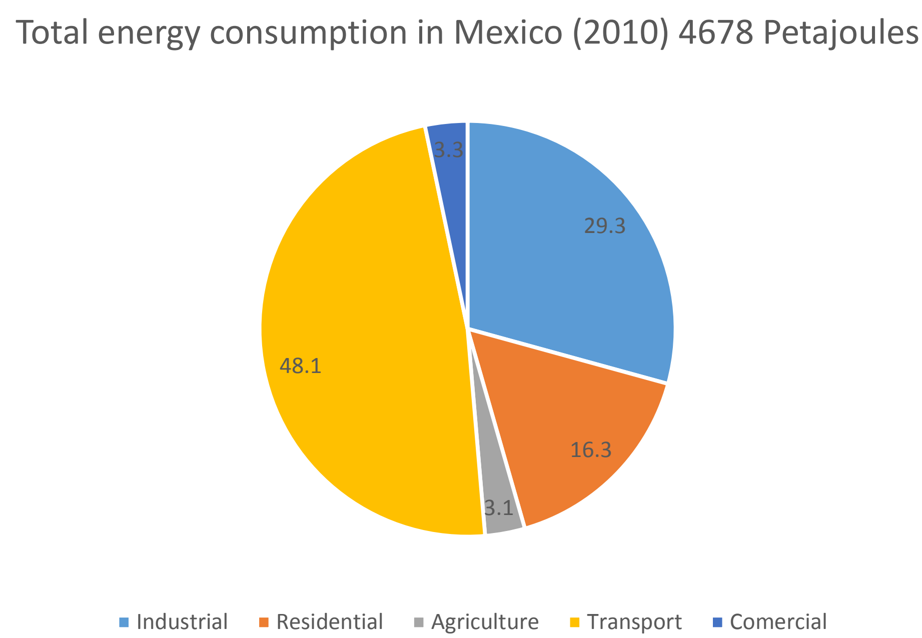

Figure 3.11 Total energy consumption in Mexico (2010) 4678 Petajoules

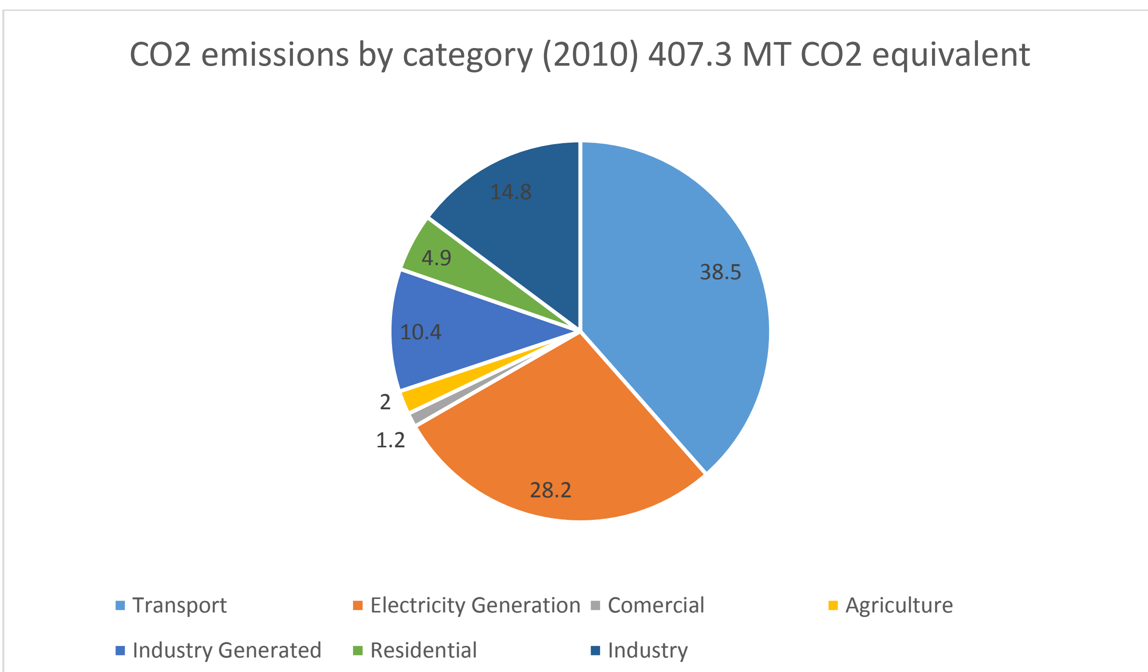

Figure 3.12 CO2 emissions by category (2010) 407.3 MT CO2 equivalent

Finally, At this regard I would like to quote Ms C. Odon de Buen ***"There is very little data on average energy use of commercial buildings in Mexico and even less on energy end uses. Some data on electricity use for lighting and space cooling in commercial buildings can be found in a series of reports prepared by the Fideicomiso de Ahorro de Energía Eléctrica (FIDE) some years ago."*** The author declares that the reports done on demonstration projects do not have consistent information. (Odón de Buen R., M.Sc. et al, 2009)

3.4.2. Programs

3.4.2.1. NAMA stands for Nationally Appropriate Mitigation Action (NAMA)[296][297]

NAMA´s potential for upcoming years is related with the need of social housing:

"The Mexican population is projected to grow from just over 110 million in 2010 to more than 160 million by 2050. At that rate, it is expected that more than 11 million new residences will be required by 2030, with 9 million existing homes requiring major retrofit. Most of this growth will occur in urban areas which will consume nearly 50% of the country's energy resources and 60% of the hydrological resources over the next 20 years."[298] "This growth will add 33 MtCO2e to the cumulative Greenhouse Gas (GHG) emissions to the country's carbon footprint. It is estimated that the Mexican housing sector produces 32% of Mexico's GHG emissions (INE, 2006) which represents 16.2% of the total energy and 26% of total electricity consumption."[299]

The Nationally Appropriate Mitigation Actions (NAMA) are voluntary activities focused at reducing greenhouse gas (GHG) emissions carried out by developing countries under the context of sustainable development and economic growth. (Jorge Wolpert,Tomasz Kotecki Golasinska, 2012). Nationally Appropriate Mitigation Actions (NAMA) are emerging market mechanisms that enable developing economies to align sustainable development with national economic priorities. Mexico's Sustainable Housing NAMA is the first of its kind in the world.

The NAMA was developed by Mexican and German institutions in 2011 (SEMARNAT, CONAVI, INFONAVIT, FOVISSSTE, SHF, PHI, and GIZ) (Feist D. W., 2012). The NAMA´s goal is to raise donor funding for upscaling Mexican efforts in energy efficient housing by demonstrating the best construction practices proven to reduce GHG emissions reduction, and cost effective affordable.

There are already nineteen different NAMAs programs in Mexico in development or implementation stage[300] The Mexican Government through CONAVI in the residential sector:

NAMA for Sustainable New Housing[301]
NAMA for Sustainable Housing Retrofit[302]
Urban NAMA[303]

There are three more NAMAS related with the Building sector
Domestic Refrigerators NAMA
Low Emission Schools
NAMA for sustainable housing in Mexico (New residential houses (maximum 4 storeys and 8 units))

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[296] HOUSING NAMA SUMMARY, SEMARNAT
[297] Campos-Arriaga, L. (2015). *La NAMA de Vivienda. Política de vivienda sustentable del Gobierno de México.* SEDATU / CONAVI / BMUB / DECC / GIZ.. Material 1.
[298] http://www.conavi.gob.mx/images/documentos/sustentabilidad/Market_Readiness_Assessment.docx
[299] http://www.nama-facility.org/projects/mexico.html
[300] http://nama-database.org/index.php?title=Mexico
[301]http://www.conavi.gob.mx/images/documentos/sustentabilidad/2_NAMA_for_Sustainable_New_Housing_with_Technical_Annex.pdf
[302] http://www.conavi.gob.mx/images/documentos/sustentabilidad/3_NAMA_for_Sustainable_Housing_Retrofit.compressed.pdf
[303] http://www.conavi.gob.mx/images/documentos/sustentabilidad/Urban_NAMA_ingl%C3%A9s.doc

The scheme showed in Table 3.21 demonstrates how different NAMAS can work at the same time for complementing each other in order to achieve the GHG emissions reduction goal compromised by Mexican Government for 2020, and 2050.

<table>
<tr><td rowspan="4">Urban NAMA</td><td>Water</td><td rowspan="4">Small and Medium Business (SME) NAMA

Low emissions school

Renewable Energies and Energy Efficiency in the Private Sector</td><td rowspan="4">Public Transport Route Optimization and Vehicle Fleet Renovation

Disposal and Use of Wastes and Solid and Biomass Residues</td></tr>
<tr><td>Drainage</td></tr>
<tr><td>Lighting</td></tr>
<tr><td>Facilities</td></tr>
<tr><td rowspan="4">Housing NAMA Whole House</td><td>Architecture</td><td rowspan="4">Existing</td><td rowspan="4"></td></tr>
<tr><td>Passive design</td></tr>
<tr><td>Technology</td></tr>
<tr><td>Appliances</td></tr>
<tr><td rowspan="4">NAMA for Sustainable Housing Retrofit</td><td>Retrofit</td><td rowspan="4"></td><td rowspan="4">Existing</td></tr>
<tr><td>Passive design</td></tr>
<tr><td>Appliances</td></tr>
<tr><td>Technology</td></tr>
<tr><td rowspan="2">Housing POA (Programmatic CDM activities)</td><td>Energy Efficiency</td><td rowspan="2">Existing</td><td rowspan="2">New</td></tr>
<tr><td>Renewable Energies</td></tr>
</table>

Table 3.21 NAMA scheme in the building sector

NAMA for Sustainable New Housing[304]

Mexico and its partners have developed three performance benchmarks that can be achieved by residential building developers and home owners. In order of increasingly aggressive efficiency standards they are: EcoCasa 1, EcoCasa 2, and the Passive House EcoCasa Max. (Robert Kaineg,Georg Kraft, Rolf Seifried, Werner Neuhauss, Heiko Störkel,Witta Ebel, Susanne Theumer, Maria del Carmen Rivero,Angelika Stöcklein, Salvador Rodriguez,Matthias Krey, Stefan Wehner, 2012)

NAMA approaches building efficiency from the **"whole house approach"**. Under this perspective, efficiency benchmarks are set for total primary energy demand, for each building type and taking into account climatic variables. The building developers and home owners are able to employ any suite of interventions that achieve the performance standard.

[304]http://www.conavi.gob.mx/images/documentos/sustentabilidad/2_NAMA_for_Sustainable_New_Housing_with_Technical_Annex.pdf

Efficiency potential of the NAMA program

The German Passive House Institute (PHI) has calculated the "Whole House" energy balance, which is scalable by unit sized, based on the four climate zones of Mexico for three unit types: vertical multi-family, single family detached, and single family row house. Three primary energy target values or "standards": Eco Casa 1, Eco Casa 2 and Passive House Standard, have also been developed for each building type and climate zone.

Eco Casa 1 represents the level of efficiency if all of the supported technologies under the current scheme, Hipoteca Verde, are adopted. This is equivalent to the level of energy efficiency achieved if 2,5cm of insulation are installed in the roof and a single wall, reflective paint, a tankless water boiler, solar water heater and an efficient A/C unit are installed.

Eco Casa 2 represents a further level of efficiency achieved through insulating all walls, installing better windows and other highly efficient appliances.
The Passive House Standard envisages optimization of all measures achieving the Passive House certification criteria, including extended overhangs, extensive insulation, and other design features achieving reduction of the primary energy demand.

Single & Row House	Hot & Dry Climate	Hot & Humid Climate	Temperate Climate	Semi-Cold Climate
Eco Casa 1	2	2	.8	.8
Eco Casa 2	2.7	3.5	0.9	0.8
Passive House	3	4	1	1
Vertical (multi-family)				
Eco Casa 1	1.7	2.0	0.9	0.8
Eco Casa 2	2.2	2.7	1.2	1.0
Passive House	2.6	4.0	1.2	1.1

Table 3.22 Annual emissions avoided (t CO2e) in a 40m2 house by building type / climate zone

Note: It is important to mention the stakeholders of the project The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (German Development Cooperation) has supported the development of this NAMA on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Environment Canada, The United Kingdom , and numerous development banks have also provided technical and financial support.

The ECOCASA Programme is a partnership with SHF that offers financial incentives for project developers, such as low cost bridge loans, in addition to providing green mortgages and grants to home buyers. The current investment goal is some 27,000 Eco Casa 1 houses and 800 Eco Casa Max homes.[305]

In the second phase, in the medium to long term, it is envisioned that there will be a consolidation of the voluntary programmes ('Green Mortgage' and 'Ésta es tu cas) and mandatory building codes and incentive programs, further decreasing emissions from new urban development.

[305] idem

The NAMA provides financial incentives to two distinct customer groups (i) house-buyers/owners and (ii) construction companies.

The financial incentive framework under the NAMA will ensure that:

The better the level of energy efficiency achieved, the more favourable the financial support conditions; house-buyers/owners will receive a subsidy to the loan granted by a financial institution (e.g. reducedinterest or lower reimbursement instalments, or redemption grant), if they purchases a house built in accordance with whole-house energy efficiency standards under the NAMA in order to cover a part of the additional investment costs; construction companies (developers) receive a subsidized 'bridge loan' provided they commit themselves to build a house according to one of the whole-house energy efficiency standards under the NAMA; this must be proven when the house is finished.

Main assets:

Information crossover from the NAMA database with RUV, CFE, and INEGI databases can be used to track key parameters such as location, square footage, type, level of efficiency, projected estimates of energy consumption and water, environmental technologies that allow us to design better construction models.

Transfer of knowledge and experience related to energy efficiency in buildings through specific training, broader educational experiences, and capacity building and outreach.

"A major milestone has been reached in 2012 through the implementation of pilot projects consisting of around 4,600 affordable housing units in 11 cities located in five of the seven identified bioclimatic regions, and involve seven different housing developers and OREVIs." [306]

NAMA for Sustainable Housing Retrofit[307]

This NAMA seeks to maximize the efficiency of water, electricity and gas consumption in existing homes. The housing retrofit NAMA is based on a **"whole house approach"** where efficiency benchmarks are set for total primary energy demand for each building type taking into account climatic variables. This approach includes a simple and cost-effective MRV system, and enables building developers and homeowners to employ a flexible range of interventions to achieve the performance standard desired. It enables a holistic and systematic methodology to energy efficient refurbishment of the building stock. Furthermore, it ensures the continuation of on-going activities and programs.

Similar to the new housing NAMA, the housing retrofit NAMA will be based on a "whole house approach" where efficiency benchmarks are set for total primary energy demand for each building type taking into account climatic variables. (see table 3.23)

- Conceptual Design of the NAMA on existing housing stock
- Identification of building typology for existing housing

[306] IDEM
[307] http://www.conavi.gob.mx/images/documentos/sustentabilidad/3_NAMA_for_Sustainable_Housing_Retrofit.compressed.pdf

- Energy Demand Assessment and Energy Performace Certificate by energy advisors
- Financing, linking existing promotional programmes to the "whole house approach"
- Implementation, installation of certified equipment and construction material
- Measuring, Reporting and Verification System (MRV)

The following measures are proposed by CONAVI to reach an optimum retrofit with all its benefits in the NAMA for Sustainable Housing Retrofit program

Measures towards an economic and energetic optimum	A successful housing retrofit will lead to the following benefits
1. Improved building envelope a. Roof insulation b. Energy-positive windows c. Wall insulation	Comfortable indoor temperatures and living conditions Constant fresh air supply Well-tempered surfaces No air draughts Sufficient release of humidity No mould formation (harmful to health) Substantially lower heating/cooling energy demand Lower water/energy consumption Reduction of CO_2-emissions Energy cost savings Increased housing value
2. Appropriate shading devices	
3. Efficient building services (Refurbishment of energy efficiency components)	
4. Installation of water saving appliances	

Table 3.23. Measures towards optimum with its benefits

Expected benefits

"It is assumed that through an investment of USD 1.000 in energy advice and energy/water efficiency at least 300 kg of CO_2 emissions per year can be avoided. Considering a period of 20 years, this equals a price of up to USD 150 per ton of CO_2 avoided, or accordingly, the (marginal) abatement costs should be less than USD150/T CO_2."[308]

Note: Today most of the highly efficient technologies, such as efficient windows and ventilation units with heat recovery, are hardly or not yet available on the Mexican market and, thus, are still expensive.

Urban NAMA[309]

The Urban NAMA covers community scale mitigation actions applied for new, green field residential communities across Mexico to achieve nation-wide emissions reductions through deployment of sustainable houses, solid waste, water, sewage and public lighting infrastructure funded partly through the development of carbon credits.

[308] http://www.conavi.gob.mx/images/documentos/sustentabilidad/3_NAMA_for_Sustainable_Housing_Retrofit.compressed.pdf
[309] http://www.conavi.gob.mx/images/documentos/sustentabilidad/Urban_NAMA_ingl%C3%A9s.doc

The Urban NAMA expands the operational and financial scope of the initiatives mentioned before to cover additional target areas covering the entire range of community development including building envelope, water delivery, sewage, public lighting, and municipal solid waste.

Low emission urban communities can help achieve sustainable and urban development goals through change in policy approaches and decision-making. This can be done by prioritizing life-cycle and performance metrics, and engaging in more integrated planning processes.[310]

The Urban NAMA as it is defined in this document covers community scale mitigation actions applied for new, green field residential communities across Mexico that (1) reduce demand for delivered services, or; (2) improve the emissions efficiency of delivered services. The sectors that comprise the community include: New Housing, Waste, Water and Public Lighting.

Note: There are not projects started according to NAMA-Database (See Timeline section)[311]

3.4.2.2. FIDE (Mexico Energy Savings trust)[312]

The FIDE´s objective is to develop actions focused on efficiency and energy conservation in the industrial, commercial and services sectors included Small and Medium Enterprises (MIPyMES in Spanish), Municipalities, residential agriculture sectors. The FIDE provides technical services to energy end users, to improve its productivity, and to contribute to economic, social development and environment preservation.

FIDE´seal it´s a badge awarded to products that impacts directly or indirectly energy conservation (mainly electricity). This seal works as a warranty of compliance with Mexican standards and regulations in the energy sector.

FIDE finance several energy saving technologies, FIDE only finance the implementation of FIDE approved products

The FIDE´s Energy efficiency programs are oriented to the Mexican productive sector, providing technical consulting, and funding for installations upgrading, new-technologies development and implementation in such way that both energy conservation and energy efficiency contribute to non-renewable natural resources conservation, and GHG emissions reduction. It´s also expected to create and develop new consulting and High-tech sector, and employment generation.

In 2007, CONAVI developed a Unified Building Code (CEV in Spanish) to be used as model by local authorities to set minimum building standards for new houses. Since then, CONAVI is working on the CEV with the objective to promote its adoption on municipality and state level.

CONAVI's objective for the building codes is to regulate the home construction process in an urban context to improve public health, safety and welfare. However, the enforcement of the code should

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[310] https://es-us.finanzas.yahoo.com/noticias/registrar%C3%A1-m%C3%A9xico-nama-urbano-mundo-192900253.html

[311] http://www.nama-database.org/index.php/Mexico

[312] http://www.fide.org.mx/index.php?option=com_content&view=article&id=121&Itemid=219

be done at the regional level, which makes it a difficult process to manage and monitor. In addition to the CEV, CONAVI developed 3 other construction guidelines.

3.4.2.3. Green Mortgages (INFONAVIT – MEXICO)[313]

The “**Green Mortgage**” (**Hipoteca Verde**) is a programme initiated in 2007, to provide an extra credit line on top of the original mortgage to member of INFONAVIT, which is one of the social security institutions interested to buy new houses which incorporate sustainable and energy efficient technologies, such as Solar Water Heaters (**SWHs**), Compact Fluorescent Lamp (**CFLs**), water saving faucets, and thermal insulation, among others. The programme is targeting state-aided house buyers with low-income. INFONAVIT is by far the largest mortgage provider of the country, with a market share of 80%, 400,000 annual mortgages. The Green Mortgage is a credit system based on the savings accumulated in the beneficiary’s social security account. When formally employed by a company, the worker is automatically registered in the social security system and receives a social security account number. Thereafter, 5% of his salary every month is deposited on his social security account and can be used to buy a house or as a retirement complement after a certain age. If used to buy a house, INFONAVIT will use the

The Green Mortgage Program applies to all cities in which Infonavit formalizes credits within the 32 states of Mexico. It’s worth mentioning that the Institute formalizes between 475 and 500 thousand credits a year. It is attached a table with credits formalized with Green Mortgage per State during 2011.

Main program´s hightlights:

Green-mortgages: 668, 962 between 2007 - 2011

During 2011 were formalized 376, 815, the 75% of originated loans.
Since 2011 all of the originate loans most be green mortgage

Accumulated Savings Equivalencies from 2009 to May 2011 [314]

Water: **34,081475 m3** required to supply during a year 199, 248 homes a year with water saving devices. Toluca has inhabited homes 188.948s.
Electric Energy / Electricity**: 393,181 MWh** required to illuminate 327, 651 homes for one year with saving lamps. In Quintana Roo, there are 330.147 inhabited houses
Gas: **479,967 MWh** needed to supply for one year 324.351 homes a year with solar and instant water heater. The Borough Gustavo A. Madero has 320.210 inhabited houses.

[313] GREEN MORTGAGE PROGRAM INFONAVIT – MÉXICO retiverd from:
http://www.ecpamericas.org/data/files/Initiatives/energy_efficiency_working_group/eewg_mexico_workshop/infonavit.pdf
[314] idem

Below is a table showing the environmental technologies that are financed within the program:

Electricity	Water
Saving lamps (compact fluorescent lamps)	Ecological level toilet 5 litres maximum
Combination of saving lamps (compact fluorescent lamps) and air conditioning	Ecological level sprinkler with integrated saving device
Refrigerator	Water saving devices valves in bathroom sinks
Sinksroof thermal insulation (with nom mx 460)	Water saving devices valves in the kitchen
Wall thermal insulation on	Isolating valves
Roof reflective coatingas final coat	Flow control valve forwater supply pipe
Wall reflective coatingas final coat	**Health**
Power saver by voltageoptimization	Purified water filters
Gas	At home purified water supply
Solar water heater with flat instant gas back up	Waste separation. Containers (in the household)
Solar water heater with vaccum pipes with instant gas backup	
Flat solar water heater wiithout backup	
Solar water heater with vaccum tubes without backup	
Gas instant water heater	
Gas instant water heater	

Table 3.24 Environmental Technologies that are financed within the program by INFONAVIT

The ***GIZ*** (Deutsche Gesellschaft für Internationale Zusammenarbeit) has also supported consulting on best water heating and photovoltaic practices and technical specifications. It played an important participation in the development of new technical specifications for the current Solar Water Heaters. Has also participated with resources in the development of the installation of training workshops on Solar Water Heaters and coordinates with Infonavit the certification of such equipment installers.

In order to assess the savings from eco-technologies and ensure the greatest benefits to the accredited, with the equipment that had the biggest impact on their consumption, eco-technology packages were established for each bioclimatic zone established by the National Ecology Institute as we see in the table below:

Ecotechnologies from Green Mortgage			
Ecotechnology	**Semi-cold weather**	**Temperate weather**	**Warm weather**
Saving valves	x	X	x
Shutter releaser sprinkler	x	X	x
Double discharge valve WC	x	X	x
Low consumption lamps	x	X	x
Solar water heater	x	X	
Instant water heater			x
Roof thermal insulation	X		x
higher insolation wall insulation			x
Air conditioning			x

Table 3.25 See section (3.4.2.6 Tools where the simulator tools are explained)

3.4.2.4. Esta es tu casa ('this is your house')

"The programme is focused on the low income population, therefore only workers who receive up to 4 times the minimum wage (approximately MX$6,000) qualify for the subsidy. In addition, the beneficiary should be registered in the social security system or at least have a banking track record and payment capability. These conditions exclude a significant share of the Mexican population"[315]

The "Ésta es Tu Casa" program started in 2007 implemented by the National Housing Commission (CONAVI), it´s a housing subsiy program for lowe income polulation with three different schemes: First, New or used dwelling acquisition, second, purchase of a lot with urban services for selfconstruction, and finally, a credit for existing dwelling renovation.

In 2009, IDEAS Foudation, and the British Embassy collaborated with CONAVI to introduce sustainability guidelines to the program concerning dwelling tipology, and bioclimatic zones.

These guidelines are:

Site assessment
Water efficiency use
Energy efficiency use
Waste management best practices
O & M programs

[315] Working Paper For Supported NAMA Design Concept for Energy-Efficiency Measures in the Mexican Residential Building Sector Version 01 Mexico City, 16 November 2010

This program Works under the umbrella of operation rules (The last update was in 2012), and use evaluation tools that determine the sustainability grade of sustainability under the guidelines mentioned before showed in table below. Between, 2003 and 2004, INFONAVIT develop the National Housing Register (RUV in Spanish) that aims to create a tool that assist in statistical data generation, decision- making process, and urban planning for housing financing.

All new homes are registered before construction begins, and tracked until the homes are sold by the **RUV** reflects the total number, characteristics, and location of new homes built and financed through individual mortgages granted by INFONAVIT and FOVISSSTE.

This is the “Esta es tu casa” (‘this is your house’) Assessment Criteria (Operations Rules, 2012)

Site location	Specific site location (See note below)
Urban	Proximity to: Health & Education infrastructure (Primary and Secondary schools)
Redensification	Dwelling typology (encourage vertical housing over single dwellings to improve efficiency of urban services. Residential density under the Urban Development Plan Living area
Competitiveness	Green areas Public transit Eco-technologies

Figure 3.13 Esta es tu Casa Focus areas

Note: The Site Location component takes into account three different urban polygons and site location, they are assessed according to GIS available information. First polygon must be placed close to employment sources, urban, and infrastructure services. Second polygon, the dwelling must be placed in urban consolidated area; finally for the third polygon, the dwelling must be adjacent to an developing uban zone, and be close to basic education services.

Sisevive, Mexico’s rating system for green housing was designed to inform on home energy efficiency and environmental performance, and aims to compare evaluation criteria in the Mexican housing sector. The national institute for workers housing (*Instituto del Fondo Nacional de la Vivienda para los Trabajadores*—Infonavit) requires Sisevive for all new homes and their registration in the housing registry (*Registro Único de Vivienda*), starting in January 2013. (Guide to Green Building Products in North America)

TOOLS[316]

IDG (Housing Global Performance Index) determines the financial incentives under the SISEVIVE-ECOCASA system, through which primary energy demand and water savings target values are set to define its performance from a sustainability point of view.

DEEVI (Energy-Efficent Housing Design) It´s a tool specially designed for simplified energy assessment calculations on new housing, easy to apply for social housing registration. It is based on the PHPP and plays a crucial role in the energy efficiency development of this sector in Mexico.

Note: PHPP calculation results were assessed and compared to DEEVi results, concluding that this tool needs to be adapted to be applied to the existing housing. Additionally, a cost efficient analysis was carried out considering lifecycle costs of a whole building.[317]

SAAVI (Housing Water Savings Simulation). This tool, estimates projected water consumption through household devices that use water, projected household water consumption per unit and inhabitant (liters/inhabitant/day), based on projected consumptions per device that use water. This Projected Water Consumption (CPA) is one of the three indicators that form the IDG and its value is weighted in the assessment, depending on the hydril pressure and its capacity installed for sewage treatment in the place of the unit to be assessed (SISEVIVE-ECOCASA model). As the SAAVi tool was also designed for new housing calculations, the minimum level of water saving meets the prevailing norms.

Note : Because the level of water saving for older equipments might be lower, its use on existing housing calculations may require adaptations.[318]

"It is estimated that the energy used in a water system to produce and distribute water among the population, as well as its treatment after use and final disposal, is 0.95 kWh/m3 [GIZ 2010]. Even this value may vary depending on the region, general average indicates that there is a GHG mitigation potential in housing water saving Currently, this energy equivalent of water saving is not included in the SISEVIVE-ECOCASA tools. However, it would be highly recommended to include it in the tools for calculation."[319]

SIMULATORS[320]

The simulator help to:

Eco-technologies simulator for new or existing housing in the Individual Open Market
Eco-technologies simulator for new or existing housing from housing developers

[316] Supported NAMA for Sustainable Housing Retrofit in Mexico - Mitigation Actionsand Financing Packages, Susanne Theumer et al (Mexico City 2014)
[317] idem
[318] idem
[319] IDEM
[320] Sustainable Housing in Mexico and Latinoamerica : The Green Mortgage retrieved from: www.bshf.org/scripting/getpublication.cfm?...

"To achieve this we have designed a Green Mortgage simulator that provided to the right holder to choose the ecotechnologies that will allow meeting the monthly savings established by income level and considering the bioclimatic zone in which the home is located, In this simulator you can enter your income data, the city where you live and the type of home you are purchasing (vertical or family) thus the simulator tells the bioclimatic zone where your home is, the approximate maximum amount granted of Green Mortgage at that income level to which you belong, and displays a catalogue of ecotechnologies that can be selected already in a package to meet the required saving or the list of those where you can choose the ecotechnologies and will give you the amount of savings each one of them generate and since you have complied with the saving, shows you the total cost of the same. "[321]

Note: View the simulator in
http://201.134.132.145:82/simuladorHVWeb/home/simulador.jspx?entrada=T

EnerPHit (International standard to certify energy retrofits with Passive House Components)[322]

The **EnerPHit** standard calculates target values for building heating, cooling and primary energy according to its climate zone. If heating and/or cooling target value may not be reached due to difficulties concerning refurbishment, characteristic values are determined for building components based on quality needed to achieve Passivhaus standard in each climate, considering profitability aspects as well. EnerPHit refurbishment may be carried out all at once or step by step.

"Achieving the Passive House Standard in refurbishments of existing buildings is not always a realistic goal, one of the reasons being that basement walls remain as barely avoidable thermal bridges even after refurbishment. For such buildings, the Passive House Institute has developed EnerPHit for certified energy retrofits with Passive House Components. This requires either a maximum heating demand of 25 kWh/(m²a) or alternatively the consistent use of Passive House components in accordance with the requirements for PHI certification of components. The heating demand calculated by the PHPP, and the quality of thermal protection of the individual components are indicated in the certificate."[323]

PHPP(Passive House Planning Package)

The Housing Sustainability Index (**ISV** in spanish) created by the Mario Molina Center assess the economic, environmental, and social impacts associated with residential dwellings and its surroundings in the low-cost housing sector aiming to balance all of them. The **ISV** is composed by 30 indicators, it´s designed based on a performance scale over long-term period. These indicators are weighted by 40 regional factors that are fixed according to the regional characteristics.

This tool is designed to facilitates to measure the progress, and determine the best opportunity areas for the social housing sector. The main difference with the Sisevive´s tools, is that the ISV reflects the sustainability scope for a residential area instead of an isolated dwellingy.[37]

It is expected that ISV is going to impact the creation of future residential complex by determining the incorporation of best construction materials, and construction procedures in public and private

[321]http://www.ecpamericas.org/data/files/Initiatives/energy_efficiency_working_group/eewg_mexico_workshop/infonavit.pdf
[322] http://www.passiv.de/downloads/03_certification_criteria_enerphit_en.pdf
[323] http://www.passiv.de/en/03_certification/02_certification_buildings/04_enerphit/04_enerphit.htm

sectors. In addition, It´s intended that the ISV implementation is going to boost the research for more eco-friendly material, eco-techniques, and construction procedures.

The 2012 report estimated that **ISV** for low-cost housing sector has a low-medium, somewhere between 41 to48 in a scale of 100.[324]

Mexico City´s Sustainable building certification Program (PCES)[325]

Given the demographic conditions of Mexico City, the pressure over conservation areas as well as the water scarcity issues, natural sources depletion and energy the **PCES** started in 2008, as a practical response to these issues. This voluntary program works in accordance with Mexico City´s policies under the scope of the Green Plan 2006 that aims to sustainability goals.

The PCES established a standard to assess residential and non-residential buildings by offering tax-cut benefits (Annual property tax, construction permits, payroll tax, and water services payment)

The main objective of the program is to foster GHG emissions reduction, promote efficient use of natural resources in design, construction, operation and maintenance stages of the construction process

The tax benefits of the program are established according to the tax code of Mexico City, depending to the eco-technologies implanted as described in the following tables below:

Environmental sector	Tax benefit reduction
Sustainable system application	Property taxation 10 %
Green roof	Property taxation 10 %
Solar cells and rainwater harvest systems	20 % water bill reduction
Green areas preserved (ejidal or communal property)	Property taxation 50 %
Green areas preserved (private property)	Property taxation 25 %
Waste management	20 – 40 % payroll tax
Water, energy fuels, and waste consumption reduction	20 – 40 % payroll tax

Table 3.26 Tax-cut benefits of PCES program according to tax code 2008.

Depending on the grade of compliance there are levels of certification

Compliance	21 to 50 points
Efficiency	51 to 80 points
Excelence	81 to 100 points

Table 3.27 PCES certification grades

The table (3.28) shows the PCES points system, and how the points are granted according with eco-techniques implemented in the building.

[324]Evaluación de la sustentabilidad de la vivienda en México, Centro Mario Molina (2012)
[325] http://www.sedema.df.gob.mx/sedema/images/archivos/tramites/auditoria-regulacion-ambiental/edificaciones-sustentables/programa-certificacion-edificaciones-sustentables.pdf

Construction Type	Residential Buildings		Offices Buildings	
Concept	**New construction**	**Existing Building**	**New construction**	**Existing Building**
<u>Energy</u> Energy Conservation Solar water. Heating systems	Up to 18 points depending on % potential energy savings 7 points for heating system installation 8 additional points for photo-voltaic panels installation		Up to 25 points depending on % potential energy savings according to chart 8 additional points for heating system installation 7 additional points for photo-voltaic panels installation	
<u>Water</u>	Up to 5 points for Rainwater harvest & use and Water infiltration systems, Up to 8 points for wastewater treatment plant Up to 12 points for include water conservation actions divided as follows 5 points for water conservation appliances use 5 points for accredited water leaks elimination 2 points for developed awareness campaigns with users/tenants			
<u>Life Quality & Social responsibility</u> Note: 4 additional points for bike-share programs implementation 4 additional points for green areas that improve comfort	Up to 8 points for green roofs Up to 4 points for bioclimatic design Up to 3 points for acoustic levels control Up to 2 points for bike racks installation 1 point for community outreach 4 points for abstain of use of public goods 3 points for best maintenance practices	Up to 8 points for green roofs Up to 3 points for acoustic levels control Up to 3 points for bike racks installation 2 point for community outreach 4 points for abstain of use of public goods 5 points for best maintenance practices 5 additional points for building retrofit under bioclimatic design principles	Up to 7 points for green roofs Up to 3 points for bioclimatic design 1 points for acoustic levels control Up to 2 points for bike racks installation 1 point for community outreach 3 points for abstain of use of public goods 2 points for best maintenance practices 3 points for Vehicular access bay construction 3 points for employee transportation programs	Up to 7 points for green roofs 1 points for acoustic levels control Up to 2 points for bike racks installation 1 point for community outreach 3 points for abstain of use of public goods 3 points for best maintenance practices 3 points for Vehicular access bay construction 5 points for employee transportation programs 5 additional points for building retrofit under bioclimatic design principles

<u>Urban and Environmental Impacts</u>	Up 6 points for additional parking lots without compromising open areas or using car elevators Up to 1,5 points for meet urban-land use regulation and urban planning programs, and 1 point for each of following concepts: Local materials use, short distance supply, biodegradable materials use, ecofriendly finishes materials use, recycled-content construction materials, and 1,5 for reuse of existing buildings 2 additional points for avoid cutting of existing trees	Up 9 points for additional parking lots without compromising open areas or using car elevators, and 1 point for each of following concepts: Local materials use, short distance supply, biodegradable materials use, ecofriendly finishes materials use, recycled-content construction materials, and reuse of existing buildings meet urban-land use regulation and urban planning programs	Up 6 points for additional parking lots without compromising open areas or using car elevators Up to 1,5 points for meet urban-land use regulation and urban planning programs, and 1 point for each of following concepts: Local materials use, short distance supply, biodegradable materials use, ecofriendly finishes materials use, recycled-content construction materials, and 1,5 for reuse of existing buildings 2 additional points for avoid cutting of existing trees	Up 9 points for additional parking lots without compromising open areas or using car elevators, and 1 point for each of following concepts: Local materials use, short distance supply, biodegradable materials use, ecofriendly finishes materials use, recycled-content construction materials, and reuse of existing buildings meet urban-land use regulation and urban planning programs
<u>Waste</u>	Up to 3 points for include in the project temporary waste disposal rooms, 0,5 points for proper signal, 1,5 points for proper furniture, 2 points for best waste management practices (diverting), and 3 points for appropriate final waste disposition.		Up to 2,5 points for include in the project waste temporary disposal rooms, 0,5 points for proper signal, 1,5 points for proper furniture, 2 points for best waste management practices (diverting), and 2,5 points for appropriate final waste disposition, and 1 point for diverting waste awareness programs with building users.	

Table 3.28 PCES rating point for sustainable building of Mexico City source: HOUSING NAMA SUMMARY

"Sustainable Kingston uses a four pillared approach to sustainability. The four pillars include Environmental Responsibility, Social Equity, Economic Health, and Cultural Vitality. While it is useful to organize sustainability in terms of these four pillars, it is the integration between them that will drive sustainability, highlight opportunities for innovation and reduce duplication of efforts."[326]

3.5. Introduction to the comparison section

In Chapter 4, a sustainability procedure is proposed, this procedure underline the importance of establishing clear policies, goals and objectives to enable sustainability in the construction process. Adding **Culture** as an important element of sustainability models. Cultural considerations in community development often emerge through discussions about social sustainability or community capital. [327]In this chapter, I want to introduce "**Culture**" as an element of sustainability, and also demonstrate the importance of the role of education institutions for achieving regional´s goals for sustainability.

This last section of chapter 3 is dived in three parts:

The first part presents "**The Talloires Declaration**", and performs a brief review of subsequent initiatives developed to address the global world environmental crisis. These sections state how Educational Institutions intend to tackle the problem by introducing both, cultural and education elements in local sustainability models.

The second part presents the STARS certification/assessment tool developed by AASHE[328], its scope, elements, and current partners. I decided to include this certification because during my school life, I had the opportunity to attend to three different institutions in Mexico and Canada that are current members of AASHEE. In this part, I present a **SWOT** analysis of their sustainability programs of two Canadian Institutions from Ontario (Niagara College and Mohawk College), and National Autonomous University of Mexico (UNAM in Spanish) and compare how they had implemented these programs and enlist their main achievements.

Finally, I mentioned two collaboration cases between educational institutions of both countries that are pursuing to create collaborative spaces towards sustainability. Firstly, the Sustainable Campuses Program between Dawson College (Quebec), and UPEMOR (Morelos), with the support IRDC[329], and secondly, the Universidad Veracruzana (UV) in Mexico has been selected to host the next Talloires Network Leaders Conference (TNLC) during the week of June 19, 2017."[330]

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[326] Four Pillars of Sustainability, retrieved from Sustainable Kingston (13/04/16) http://www.sustainablekingston.ca/our-community/sk-plan/four-pillars-of-sustainability/

[327] Creative City News Special Edition 4 http://www.creativecity.ca/database/files/library/Creative_City_News_E.pdf

[328] http://www.aashe.org/

[329] http://www.idrc.ca/EN/Themes/Environment/Pages/ResultDetails.Aspx?ResultID=223

[330] http://talloiresnetwork.tufts.edu/blog/2016/03/15/civic-engagement-movement-mexico-in-2017/

3.5.1. SCHOOL IMPACTS

"The role of public policy and leadership by example is vital in triggering the greening of the building sector. Government-owned buildings such as public schools, hospitals, and social housing units are ideal locations to begin implementing greener building policies, including green public procurement."[331]

From two different perspectives, educational institutions have a crucial role for sustainability goals achievement in local and national scale. In the first hand, the amount of different factors that affect the environment related with their construction, operations, and maintenance such as: GHG emissions produced by the purchased energy (fossil and non-fossil sources fuels), natural resources depletion (water, raw materials, food), and waste production (recycled and landfill waste) see figure 3.14. In the other hand, these institutions can be considered as "Game-changers" for both environmental policy-making and environmental programs implementation. They can play a role model in their community leading by example during the whole design-construction-operation process implementing the best possible sustainable practices, and also establishing institutional links with government, industry, and Non-for-profit organisations in the search for wellbeing. By introducing environmental literacy components in their curricula, these institutions contribute with new professionals required for programs implementation, even elementary schools could provide awareness raising for local sustainability culture.

"Green schools reduce the environmental impact of buildings and grounds, have a positive effect on student and teacher health, and increase environmental literacy among students and graduates."[332]

It is also well documented how by providing a better quality environment (indoor/outdoor) the education performance of students increases, and impact student´s behaviour.

There is a global tendency to transform regular schools into sustainable schools and campuses; this is the reason that I decided to include the Dawson College – UPEMOR project in section 3.7.

School districts are demanding green facilities that save money while protecting the environment, improving health and performance of students, and creating a better learning environment.[333] That are some of the reasons that LEED for Schools (New Construction and Major Renovations) was launched in 2009. This rating system recognizes the unique nature of the design and construction of K-12 schools. Based on LEED for New Construction, it addresses issues such as classroom acoustics, master planning, mold prevention, and environmental site assessment. By addressing the uniqueness of school spaces and children's health issues.[334]

[331] *http://www.unep.org/greeneconomy/Portals/88/documents/ger/GER_9_Buildings.pdf*
[332] http://www.centerforgreenschools.org/
[333] https://www.aianei.org/uploads/CES/2008/080724%20LEED%20for%20Schools%20Workshop%20-%20July%202008.pdf
[334] http://www.usgbc.org/Docs/Archive/General/Docs5020.pdf

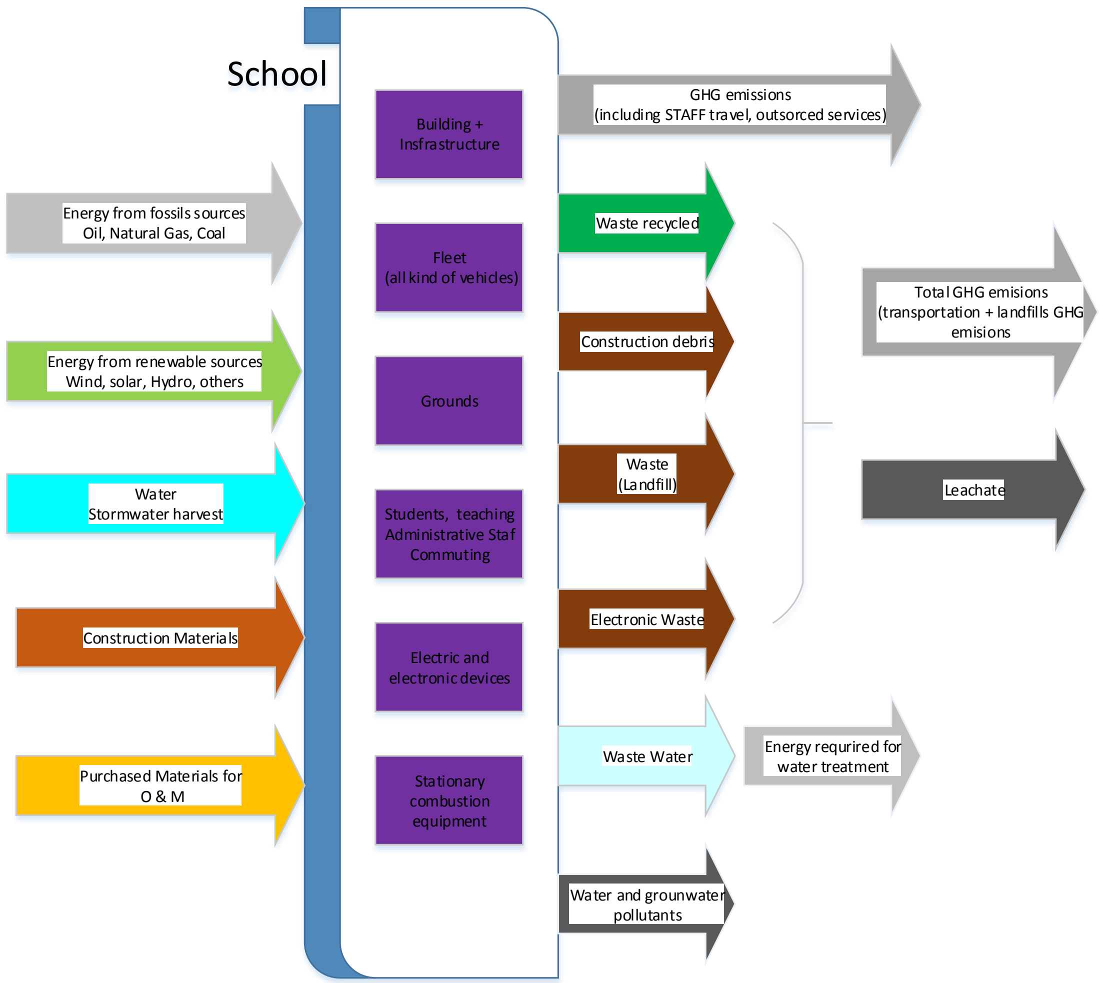

Figure 3.14 School Building pollution and emission impacts flowchart (self elaboration).

Note: In the information-collecting process it wasn´t possible to find updated information for energy and water consumption for Mexico and Canada.

CANADA´s CASE..[335]

"In 2003, the universities and colleges and hospitals surveyed consumed: 37 million GJ by the universities, 13 million GJ by the colleges (an amount equal to the annual average consumption of approximately 113 000 Canadian households, or of all the private dwellings in a city the size of Windsor, Ontario.), the energy consumption of universities alone produced more than 2 million tonnes of GHG emissions, which is equivalent to the average annual emissions of approximately 595 000 compact cars or 389 000 sport utility vehicles. Ontario universities accounted for 37 percent of the total emissions, compared with 25 percent for the Prairies, 18 percent for Quebec, 12 percent for the Atlantic region, and 8 percent for British Columbia and the Territories.In 2003, the energy consumption of colleges alone produced more than 700 000 tonnes of GHGs, which is equivalent to the average annual emissions of 207 000 compact cars or 136 000 sport utility vehicles."

MEXICO´s CASE[336]

In the report "Greenhouse Gas Emission Baselines and Reduction Potentials from Buildings in Mexico" developed by United Nations Environment Programme for the Sustainable Buildings & Climate Initiative coordinated by Odón de Buen R., M.Sc. in 2009 it was observed the following points:

It is important to note that there is a systematic lack of data on these matters in Mexico, particularly for the commercial sector but also on more specific issues (energy end use information) for both sectors. In ordert to deal with this lack of data, many assumptions were made by the author, most of them based on other related data but sometimes on his personal judgment.

According to Ministry of Education data, there are close to 242000 schools in Mexico. Close to 100000 are primary schools, 86700 for preschool, while more than 37000 are for secondary education (middle and high school). No data on built area was found so, assuming 500 m2 per school, an estimate of 121 million m2 for schools is considered.

The report remarks the following findings related to school buildings:

Type of building	Total building area (m2)	Unit consumption (kWh/m2-yr)	Total use (GWh)
Schools	121 000 000	90.11	10, 903

Table 3.29 Estimates by the author from a variety of data sources
Retrieved from: www.unep.org/sbci/pdfs/SBCI-**Mexico**report.pdf

[335]Consumption of Energy Survey for Universities, Colleges and Hospitals, 2003 retrieved from: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/consumption03/universities.cfm
[336]Greenhouse Gas Emission Baselines and Reduction Potentials from Buildings in Mexico(United Nations Environment Programme – Sustainable Buildings & Climate Initiative) Odón de Buen R., M.Sc.,2009

Growth per year of electricity consumption estimated

Estimated Rate of reduction (% per yr) **3.0 %**

Values for baseline conditions for commercial buildings in 2006.

Type of building	Area (10e3 m2)	Energy intensity (MJ/m2-yr)
Schools	121000	660

Table 3. 30 Values for baseline conditions for commercial buildings in 2006. sources Retrieved from: www.unep.org/sbci/pdfs/SBCI-**Mexico**report.pdf

Building type	MJ/m2	
	2005	2050
Schools	642	197

Table 3.31 Energy end-use intensities in scenario conditions for school buildings in 2006 and 2050. Retrieved from: www.unep.org/sbci/pdfs/SBCI-**Mexico**report.pdf

As a recommendation the author propose to Keep Minimum Efficiency Performance Standards (MEPS) of main energy using equipment harmonized with those of the US and Canada. Based on the fact that there are number of equipment (electric motors, refrigerators and AC units) that already have the same MEPS for the three North American countries, México should follow the lead of the US and Canada to strengthen its own standards.

3.5.2. Talloires declaration[337]

BRIEF HISTORY OF THE TALLOIRES DECLARATION

In 2009, in an attempt to define and promote sustainability in higher education the Talloires Declaration was launched. Twenty-two university presidents and chancellors participated in Talloires, France, to express their concerns about the state of the world and create a document that spelled out key actions institutions of higher education must take to create a sustainable future presenting the following statement:

"Universities educate most of the people who develop and manage society's institutions. For this reason, universities bear profound responsibilities to increase the awareness, knowledge, technologies, and tools to create an environmentally sustainable future"

The declaration recognized two major roles of higher education institutions. First, Enabling the "**Environmental Literacy"** among specialists in engineering, science, economics, social sciences, health and management. Practicing professionals, decision-makers at major institutions, and the general public must be given the training, expertise, and tools to encourage environmentally sustainable actions. And second, creating mechanisms for students and staff **"By practicing what it preaches, the university can both engage students in understanding the institutional metabolism of materials and activities, and have them actively participate to minimize pollution and waste"**.

[337] http://www.ulsf.org/programs_talloires_history.html

Finally, participants acknowledged that, as university leaders, they were uniquely positioned to bring together all the academic disciplines and professional schools on large, complex issues. It was therefore incumbent upon them to **"focus their schools' attention on the critical issues by speaking out, acquiring new and mobilizing existing resources, creating incentives and programs for faculty development, and fostering interest in these issues"** (See appendix 4).

The conference concluded with the creation of the Talloires Declaration, a ten-point action plan for colleges and universities committed to promoting education for sustainability and environmental literacy.

We, therefore, agree to take the following actions:[338]

1) Increase Awareness of Environmentally Sustainable Development

Use every opportunity to raise public, government, industry, foundation, and university awareness by openly addressing the urgent need to move toward an environmentally sustainable future.

2) Create an Institutional Culture of Sustainability

Encourage all universities to engage in education, research, policy formation, and information exchange on population, environment, and development to move toward global sustainability.

3) Educate for Environmentally Responsible Citizenship

Establish programs to produce expertise in environmental management, sustainable economic development, population, and related fields to ensure that all university graduates are environmentally literate and have the awareness and understanding to be ecologically responsible citizens.

4) Foster Environmental Literacy for All

Create programs to develop the capability of university faculty to teach environmental literacy to all undergraduate, graduate, and professional students.

5) Practice Institutional Ecology

Set an example of environmental responsibility by establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations.

6) Involve All Stakeholders

Encourage involvement of government, foundations, and industry in supporting interdisciplinary research, education, policy formation, and information exchange in environmentally sustainable development. Expand work with community and nongovernmental organizations to assist in finding solutions to environmental problems.

7) Collaborate for Interdisciplinary Approaches

Convene university faculty and administrators with environmental practitioners to develop interdisciplinary approaches to curricula, research initiatives, operations, and outreach activities that support an environmentally sustainable future.

8) Enhance Capacity of Primary and Secondary Schools

Establish partnerships with primary and secondary schools to help develop the capacity for interdisciplinary teaching about population, environment, and sustainable development.

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[338]**The Talloires Declaration 10 Point Action Plan retrieved from:** http://www.ulsf.org/programs_talloires_td.html

9) Broaden Service and Outreach Nationally and Internationally

Work with national and international organizations to promote a worldwide university effort toward a sustainable future.

10) Maintain the Movement

Establish a Secretariat and a steering committee to continue this momentum, and to inform and support each other's efforts in carrying out this declaration.

Talloires declaration lead the way for others initiatives such as:

- **Talloires Declaration of University Leaders for a Sustainable Future**, October 1990
- **Halifax Action Plan for Universities** of the conference on "Creating a Common Future," December 1991[339]
- **Swansea Declaration of the Association of Commonwealth Universities**, August 1993[340]
- **Copernicus University Charter for Sustainable Development of the Conference of European Rectors**, Autumn 1993[341]
- **Kyoto Declaration of the International Association of Universities**, November 1993[342]
- **American College and University Presidents' Climate Commitment**, 2007[343]

Note: The Talloires Declaration has been signed by more than 430 university presidents and chancellors at institutions in over 40 countries across five continents.

3.6. AASHE[344]

The Association for the Advancement of Sustainability in Higher Education (AASHE) is a non-profit organization that empowers higher education faculty, administrators, staff and students to be effective change agents and drivers of sustainability innovation. AASHE's roots go back to the Education for Sustainability Western Network (EFS West), established in 2001 with funding from the Compton Foundation and support from Second Nature. EFS West served college campuses in the western US and Canada, providing resources and support for their sustainability efforts.

AASHE enables its nearly 1,000 members to translate information into action by offering essential resources and professional development to a diverse, engaged community of sustainability leaders. (See scoring categories section, and table 3.32)

AASHE defines sustainability in an inclusive way, encompassing human and ecological health, social justice, secure livelihoods, and a better world for all generations.

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[339] Creating a Common Future http://www.iisd.org/educate/declarat/actionpl.htm
[340] Declaration of the Association of Commonwealth Universitieshttp://www.iisd.org/educate/declarat/swansea.htm
[341] Charter for Sustainable Development http://www.iisd.org/educate/declarat/coper.htm
[342] Declaration of the International Association of Universitieshttp://www.ulsf.org/www.iau-aiu.net/content/rtf/sd_bkyoto.rtf
[343] Presidents' Climate Commitmenthttp://www.presidentsclimatecommitment.org/
[344] https://stars.aashe.org/institutions/data-displays/dashboard/

AASHE Goals (through 2017[345])

Goal 1: Grow AASHE's membership to include at least 1,200 actively engaged colleges and universities, NGOs, government partners, and businesses

Goal 2: Empower members with indispensable resources to advance higher education sustainability

Goal 3: Catalyze sustainability leadership in higher education through increased visibility and recognition

Goal 4: Connect campus stakeholders with the training and professional development they need to be leaders for sustainability

Goal 5: Strengthen AASHE's organizational capacity

Subscriptions	1,378
Participants	759
Ratings	610

Table 3.32 Number of STARS full access subscriptions; number of institutions that have registered to use the STARS Reporting Tool; number of ratings awarded (cumulative). (April,2016)

According to AASHE 2015 annual report Canada, and Mexico are the second and third place of countries with more Higher Education Institutions participating in the program. (See table 3.33)

United States of America	641
Canada	56
Mexico	27

Table 3.33 Number of AASHE member in North America*(April,2016)*

<u>Mexico´s Highlight</u>

***"International interest in STARS continues to grow. In 2015, the first STARS Bronze ratings were awarded to international institutions":*[346]**

Universidad Autonoma de Tamaulipas

Universidad de Monterrey

[345] http://www.aashe.org/
[346]AASHE Annual Report 2015

3.6.1. STARS Certification[347]

The STARS sustainability rating system has been updated several times including the following versions:[348]

STARS 0.4 (2007) DRAFT
STARS 1.0 (2010)
STARS 1.2.(2011)
STARS 2.0 (2014)
STARS 2.1 (2016)

The Sustainability Tracking, Assessment & Rating System™ (STARS) is a voluntary, self-reporting framework for helping colleges and universities track and measure their sustainability progress. It is designed to:

- Provide a framework for understanding sustainability in all sectors of higher education.
- Enable meaningful comparisons over time and across institutions using a common set of measurements developed with broad participation from the campus sustainability community.
- Create incentives for continual improvement toward sustainability.
- Facilitate information sharing about higher education sustainability practices and performance.
- Build a stronger, more diverse campus sustainability community.

Ratings

STARS only provides positive recognition. Participating in STARS, which includes gathering extensive data and sharing it publicly, represents a commitment to sustainability. The table 3. Summarizes the scoring thresholdsof the four STARS ratings available (Bronze, Silver, Gold and Platinum).

Note: Only participants with a full access subscription may submit a report to earn one of these rating levels. There is a section for participants in STARS but does not want to pursue a rating or make their scores public may participate as a STARS Reporter (See table 3.32).

STARS Rating	Minimum Score Required
Bronze	25
Silver	45
Gold	65
Platinum	85

Table 3.34 STARS rating system

[347] https://stars.aashe.org/pages/about/technical-manual.html
[348] https://stars.aashe.org/pages/about/timeline.html

Platinum	1
Gold	95
Silver	137
Bronze	39
Reporter	18

Table 3.35 Number of current awards by category (April,2016)

Scoring Categories

An institution's score is based on the **percentage of points**it earns by pursuing credits across four categories: **Academics** (**AC**), **Engagement** (**EN**), **Operations** (**OP**), and **Planning & Administration** (**PA**).
Note: Some credits do not apply to all institutions; credits that do not apply to an institution are not counted against that institution's overall score.

In addition to the credits in the four categories outlined above, institutions may earn up to 4 **Innovation credits** for new and path-breaking practices and performances that are not covered by other STARS credits or that exceed the highest criterion of a current STARS credit..**Each earned Innovation credit increases an institution's overall score by 1 point.**

Note: A STARS rating is in effect for three years. All participants have continuous access to the STARS Reporting Tool and may update information at any time; however, the data that is shared publicly will only be updated when an institution formally submits a new report.

Institutional characteristics (IC) Requirement

Include data related to an institution's boundary (defining the campus for purposes of reporting), its operational characteristics (the context in which it operates) and its demographics and academics (programs, students, staff, and faculty). This information provides valuable context for understanding and interpreting STARS data.

Institutional Boundary
Operational Characteristics
Academics and Demographics

ACADEMICS (AC)
Curriculum
40 points available
This subcategory seeks to recognize institutions that have formal education programs and courses that address sustainability. By training and educating future leaders, scholars, workers and professionals, to address sustainability challenges and lead society to a sustainable future.
Research
18 points available
This subcategory seeks to recognize institutions that are conducting research on sustainability topics, developing new technologies, strategies, and approaches to address those challenges.

ENGAGEMENT (EN)
Campus Engagement
21 points available

This subcategory seeks to recognize institutions that provide their students with sustainability learning experiences outside the formal curriculum through co-curricular activities.. In addition, this subcategory recognizes institutions that support faculty and staff engagement, training, and development programs in sustainability. Enabling faculty and staff with the tools, and knowledge to adopt behavior changes that promote a sustainable campus.

Public Engagement
20 points available

This subcategory seeks to recognize institutions that help catalyze sustainable communities through public engagement, community partnerships and service with community members and organizations in the governmental, non-profit and for-profit sectors in a two ways collaborative dialogue to solve sustainability challenges. Institutions can contribute to their communities by harnessing their financial and academic resources to address community needs and by engaging community members in institutional decisions that affect them. In addition, institutions can contribute toward sustainability broadly through intercampus collaboration, engagement with external networks and organizations, and public policy advocacy.

OPERATIONS (OP)
Air & Climate
11 points available

This subcategory seeks to recognize institutions that are measuring and reducing their greenhouse gas and air pollutant emissions. In addition, institutions that inventory and take steps to reduce their air pollutant emissions can positively impact the health of the campus community, as well as the health of their local communities and regions.

Buildings
8 points available

This subcategory seeks to recognize institutions that are taking steps to improve the sustainability performance of their buildings. Institutions can design, build, and maintain buildings in ways that provide a safe and healthy indoor environment for inhabitants while simultaneously mitigating the building's impact on the outdoor environment.

Energy
10 points available

This subcategory seeks to recognize institutions that are reducing their energy consumption through conservation and efficiency, and switching to cleaner and renewable sources of energy such as solar, wind, geothermal, and low-impact hydropower. Implementing conservation measures and switching to renewable sources of energy can help institutions save money and protect them from utility rate volatility. Renewable energy may be generated locally and allow campuses to support local economic development. Furthermore, institutions can help shape markets by creating demand for cleaner, renewable sources of energy.

Food & Dining
8 points available
This subcategory seeks to recognize institutions that are supporting a sustainable food system. Institutions can use their purchasing power to require transparency from their distributors and find out where the food comes from, how it was produced, and how far it traveled. Institutions can use their food purchases to support their local economies; encourage safe, environmentally friendly and humane farming methods; and help eliminate unsafe working conditions and alleviate poverty for farmers. These actions help reduce environmental impacts, preserve regional farmland, improve local food security, and support fair and resilient food systems.

Dining services can also support sustainable food systems by preventing food waste and diverting food materials from the waste stream, by making low impact dining options available, and by educating its customers about more sustainable options and practices.

Grounds
3-4 points available
This subcategory seeks to recognize institutions that plan and maintain their grounds with sustainability in mind. Beautiful and welcoming campus grounds can be planned, planted, and maintained in any region while minimizing the use of toxic chemicals, protecting wildlife habitat, and conserving resources.

Purchasing
6 points available
This subcategory seeks to recognize institutions that are using their purchasing power to help build a sustainable economy. Each purchasing decision represents an opportunity for institutions to choose environmentally and socially preferable products and services and support companies with strong commitments to sustainability.

Transportation
7 points available
This subcategory seeks to recognize institutions that are moving toward sustainable transportation systems. Transportation is a major source of greenhouse gas emissions and other pollutants that contribute to health problems such as heart and respiratory diseases and cancer. Campuses can reap benefits from modeling sustainable transportation systems. Institutions may realize cost savings and help support local economies by reducing their dependency on petroleum-based fuels for transportation by supporting bicycling and walking.

Waste
10 points available
This subcategory seeks to recognize institutions that are moving toward zero waste by reducing, reusing, recycling, and composting. These actions mitigate the need to extract virgin materials from the earth, such as trees and metals. It generally takes less energy and water to make a product with recycled material than with virgin resources. Reducing the generation of waste also reduces the flow of waste to incinerators and landfills, which produce greenhouse gas emissions, can contaminate air and groundwater supplies. Source reduction and waste diversion also save institutions costly landfill and hauling service fees. In addition, waste reduction campaigns can engage the entire campus community in contributing to a tangible sustainability goal.

Water
6-8 points available
This subcategory seeks to recognize institutions that are conserving water, making efforts to protect water quality and treating water as a resource rather than a waste product. Pumping, delivering, and treating water is a major driver of energy consumption, so institutions can help reduce energy use and the greenhouse gas emissions associated with energy generation by conserving water. Likewise, conservation, water recycling and reuse, and effective rainwater management practices are important in maintaining and protecting finite groundwater supplies. Water conservation and effective rainwater management also reduce the need for effluent discharge into local surface water supplies, which helps improve the health of local water ecosystems.

PLANNING & ADMINISTRATION (PA)
Coordination & Planning
8 points available
This subcategory seeks to recognize colleges and universities that are institutionalizing sustainability by dedicating resources to sustainability coordination, developing plans to move toward sustainability, and engaging students, staff, faculty, and community stakeholders in governance. Staff and other resources help an institution organize, implement, and publicize sustainability initiatives. These resources provide the infrastructure that fosters sustainability within an institution. Sustainability planning affords an institution the opportunity to clarify its vision of a sustainable future, establish priorities and help guide budgeting and decision making. Strategic planning and stakeholder engagement in governance are important steps in making sustainability a campus priority and may help advocates implement changes to achieve sustainability goals.

Diversity & Affordability
10 points available
This subcategory seeks to recognize institutions that are working to advance diversity and affordability on campus. Members of racial and ethnic minority groups and immigrant, indigenous and low-income communities tend to suffer disproportionate exposure to environmental problems. This environmental injustice happens as a result of unequal and segregated or isolated communities.To achieve environmental and social justice, society must work to address discrimination and promote equality.The historical legacy and persistence of discrimination based on racial, gender, religious, and other differences makes a proactive approach to promoting a culture of inclusiveness an important component of creating an equitable society. Higher education opens doors to opportunities that can help create a more equitable world,and those doors must be open through affordable programs accessible to all regardless of race, gender, religion, socio-economic status and other differences. In addition, a diverse student body, faculty, and staff provide rich resources for learning and collaboration.

Investment
7 points available
This subcategory seeks to recognize institutions that make investment decisions that promote sustainability by using the tools of sustainable investing, institutions can improve the long-term health of their endowments, encourage better corporate behavior, support innovation in sustainable products and services, support sustainability in their community, and help build a more just and sustainable financial system. Throughout this subcategory, the term “sustainable investment” is inclusive of **socially responsible**, **environmentally responsible**, **ethical**, impact, and mission-related investment.

Wellbeing & Work
7 points available
This subcategory seeks to recognize institutions that have incorporated sustainability into their human resources programs and policies. An institution's people define its character and capacity to perform; and so, an institution's achievements can only be as strong as its community can. An institution can bolster the strength of its community by offering benefits, wages, and other assistance that serve to respectfully and ethically compensate workers and by acting to protect and positively affect the health, safety and wellbeing of the campus community.

INNOVATION & LEADERSHIP (IN)

The credits in this category recognize institutions that are seeking innovative solutions to sustainability challenges and demonstrating sustainability leadership in ways that are not otherwise captured in STARS. Institutions may earn up to four Innovation & Leadership points. An institution's overall, percentage-based STARS score is increased by the number of these bonus points it earns.
Exemplary Practice

Exemplary practice credits recognize specific initiatives that demonstrate sustainability leadership. Exemplary practices include:
Emerging best practices that are not otherwise recognized in STARS (e.g. seeking independent review ofSTARS data prior to submission).
Initiatives and outcomes that are a step beyond what is recognized in a standard credit (e.g. achieving third party certification for a program or exceeding the highest criterion of an existing credit).
Exemplary initiatives and outcomes that are only relevant to a minority of institution types or regions (e.g. participation in green hospital networks).Exemplary practice credits may be claimed in multiple submissions as long as the criteria are being met at the time of submission.

Innovation
4 credits available
Innovation credits are open-ended and reserved for new, extraordinary, unique, groundbreaking, or uncommon outcomes, policies, and practices that are not covered by an existing credit or exemplary practice option.

3.6.2. CANADIAN COLLEGES[349]

In 2015, the Sustainability and Education Policy Network performed (**SEPN**) performed a research in all Canadian Provinces (SEPN analyzed and scored all 220 accredited post-secondary institutions).

They presented two key findings: [350]

1. Signing a sustainability declaration does not always mean commitment to sustainability.

"Of the 99 institutions that signed a declaration since 1990, one third had not undertaken any other sustainability initiative"

2. A post-secondary institution's sustainability practices are strongly influenced by its provincial context.

"This raises interesting questions about the role of provincial policies and cultures around sustainability. In particular, it was the higher engagement levels in BC and Québec's smaller communities that resulted in those provinces having the highest average rates of sustainability initiatives."

Finally, as an outcome the researchers affirmed that the engagement with sustainability is on the rise among post-secondary institutions, with many institutions developing policies and practices to further sustainability.

As an example I introduce Ontario´s definition:

A **"green school"** is an energy efficient, higherperforming school that can be environmentally beneficial, economical to build and operate, and offer improved learning environments.[351]

3.6.2.1. Niagara College

"Ontario is investing $4.2 million to help build a permanent, high-tech facility for the Niagara College Advanced Manufacturing Innovation Centre at its Rankin Technology Centre in Welland.The facility will provide more than 15,000 square feet for lab space for faculty and student projects and services, innovation space for companies to work onsite and office space for Niagara students and industry staff"[352]

[349] https://news.ontario.ca/tcu/en/2014/11/support-for-the-niagara-college-advanced-manufacturing-innovation-centre.html
[350] http://sepn.ca/research_results/sustainability-canadian-post-secondary-institutions-leaders-laggards-live/
[351] GREEN SCHOOLS RESOURCE GUIDE A Practical Resource for Planning and Building Green Schools in Ontario
[352] https://news.ontario.ca/tcu/en/2014/11/support-for-the-niagara-college-advanced-manufacturing-innovation-centre.html

Institution Information			
School name: Niagara College Institution type: College Location: Niagara Region, Ontario, Canada. Public (X) Private ( ) Founded: 1967 Endowment: 32.2 M CAD		Campy:Welland Campus, NOTL Campus, and Niagara Falls Campus Total campus area: 100, 68, Students:12500 FT 400 PT Faculty: 350 Staff: 102 Website:http://www.niagaracollege.ca/	
Academic Information			
Academic courses: 174 post-secondary and graduate certificate in 18 divisions		Number of students involved in sustainability activities ** Up to 14 Programs related	
Sustainability related Academic Courses * Visit the website for further info		Sustainability related learning Outcomes Thesis ( ) Indexed Publications (X) Projects () Other (X)	
Sustainability Course Content*			
Sustainability Literacy Assessment		Academic Research Local Issues (**X**)	
Campus Characteristics			
Campus Description		**Sustainable Practices**	
Conservation Area (**X**)Greenbelt, Ontario Cultural heritage ( ) Library (X) Research Center (**X**) Hospitals ( ) Sports facilities (**X**) Student Residence (**X**) Laboratories (**X**) Canteen & Cafeteria (**x**) Other: NOTL **Vineyard**, **Organic Garden** **First Nations, Metis and Inuits Gardens**		Renewable energy systems (**X**) Compost Plant (**X**) Watertreatment Facilities ( ) Greenhouse (**X**) Community Garden (**X**) Bicycle racks + Shower facilities (**X**) Sustainable heating systems (X) HVAC (**X**) Xeriscaping (x) (INFO) Passive Buildings ( ) Carbonzero Building (**X**) Green Rooftops (X) Other:	
Sustainability membership/award			
Talloires member	STARSBronze,2013	LEED	BREEM
Greenmetrics	Regional OCOSUP	National	Other: (X)
Sustainability Highlights			
The first Canadian post-secondary institution to have a Carbonzero Certified building. Sustainability Students Representation		Sustainability website: http://sustainability.niagaracollege.ca/content/ Sustainability Manager: Taryn Wilkinson Sustainability Grants: (X) Sustainability Investment (x) GHG emission Inventory: The corporate carbon inventory totalled 5,650.00 tonnes of CO2e (tCO2e)	
SWOT Analysis			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
-Smart investment in sustainable buildings. -Participation in Niagara Region	-Poor building design in old buildings need to implement retrofitting.	-Green Procurement (Please see opportunities section of document P. 8)	-Lack of interest from Students. -NOTL Vineyard pollution from Landfill

Conservation Projects. -Synergies with International students	-Lack of carpooling & smart commuting programs -Lack of wastewater treatment facilities. -Lack of Canteen services options for Vegan People	-Enhance community outreach projects RAMSAR Niagara River -Renewable Energy Systems -Offsetting Programs for GHG emissions -Organic Products for farmers Market	-Increase of Energy Peaks & Hydro Bill in Niagara Peninsula
Sustainability Assets			
Energy	**Water**	**Materials**	**Transport**
Energy conservation program (X)	Water conservation program (X)	Green Procurement SOP/Poilicies( ) See Sustainable Environmental Policy and Finances and Purchasing Practices	Shuttle (X) See intercampus transit Schedules
Energy Metering (X)	Low-flow plumbing fixtures including dry urinals (x)	Biodegradable ( )	Carpooling ( )
Renewable Energy (**X**)	Stormwater Management (x)	Recycled content ( )	Public transit Hub (X)
Energy-efficient lighting and controls(X)	Groundwater recharge ( )	LCA ( )	Electric Vehicles ( )
Green retrofits (X)	Wastewater treatment ( )	Low Carbon foot Materials ( )	Other Clean Vehicles ( )
Energy Star Appliances (x)	Condensate re-use ( )	Local content ( )	Business travel offsetting
Daylight Harvesting (X)	Water metering(X)	Certified Materials Purchasing ( )	Student & Employee Commute Modal Split ( )
LED lighting appliances (x)	Faucet troughs Refill Stations (X)		
Waste	**QA & QC**	**Innovation**	**Offsetting Programs**
Waste Management Program (X) Hazardous Materials Control (X) Compost (X) Metering & Monitoring Programs	Third Party Certification : In partnership with Niagara Sustainability Initiative (NSI), Niagara College has undertaken the process of calculating its	Demand Response DR3 program for both the Welland Campus and NOTL Campus (OPA Demand Response Programs) *NC Solar Panels (SolarVu)* The first Canadian post-secondary institution to	Niagara College has partnered with Walker Industries to participate in the Walker Industries Carbon Neutral Building Project. **Purchased Offsets** 507.00tCO2e 7.61%

<table>
<tr><td>for diversion rate (<u>X</u><u>) website</u></td><td rowspan="4">corporate carbon footprint. The purpose of this report is to update and inform Niagara College regarding the results of the 2012 reporting year under the Carbon Project.</td><td rowspan="4">have a Carbonzero Certified building</td><td rowspan="4"></td></tr>
<tr><td>Construction and Demolition Waste Diversion (<u>X</u>)</td></tr>
<tr><td>Electronic waste diversion (<u>X</u>) See Question 12</td></tr>
<tr><td>Other:</td></tr>
<tr><td colspan="4">Community Engagement</td></tr>
<tr><td colspan="2">Student & Employee Orientation (<u>X</u>)</td><td colspan="2">Community Stakeholder Engagement (<u>X</u>)
<u>Co-Curricular Record</u></td></tr>
<tr><td colspan="2">Outreach campaigns (<u>X</u>)</td><td colspan="2">Participation in Public Policy ( )</td></tr>
<tr><td colspan="2">Community & Volunteering service (<u>X</u>)</td><td colspan="2">Openhouse events (<u>X</u>)</td></tr>
<tr><td colspan="4">Comments</td></tr>
<tr><td colspan="4">To fill this template I prepare a questionnaire answered by the Sustainability Manager, and use information taken from Niagara College´s website, and on-line documents. It was useful for me to have the opportunity as a student to verify and assess the performance on site of some of the assets mentioned during the fall term of 2013 and some visits between 2014 and 2015.

After having evaluated STAR´s rating credits, I can confirm that Niagara College is in the Path to improve the category from bronze to silver.

Finally, I would like in my opinion to underline the main asset of Niagara College´s sustainability program: College Energy Matrix: The variety of resource implement on campus: Efficient Design (Carbonzero) + Energy Conservation + Renewable Energies</td></tr>
</table>

Table 3.36 Niagara College Sustainability Highlights

3.6.2.2. MOHAWK COLLEGE[353]

<table>
<tr><th colspan="4">Institution Information</th></tr>
<tr><td colspan="2">School name:Mohawk College
Institution type:College + Apprenticeship
Location:Hamilton/ Ontario/ Canada
Public (X) Private ( )
Founded:<u>1966</u>
Endowment:$ 15,135,514CAD
Website:http://www.mohawkcollege.ca</td><td colspan="2">Campy: Fennell Campus, Stoney Creek Campus, Institute for Applied Health Science at McMasters
Total campus area:<u>76 Acres</u>
Students:<u>15,882 FTE 4000 Apprenticeships</u>
Faculty:1,100
Staff:372</td></tr>
<tr><th colspan="4">Academic Information</th></tr>
<tr><td colspan="2">Academic courses:<u>127</u> Careers , <u>2619</u> <u>Courses/</u></td><td colspan="2">Number of students involved in sustainability activities: Number of students who graduated from a program that has adopted at least one sustainability learning outcome <u>29,728</u></td></tr>
<tr><td colspan="2">Sustainability related Academic Courses: 121</td><td colspan="2" rowspan="2">Sustainability related learning Outcomes
Thesis ( ) Indexed Publications ( )
Projects ( ) Other ( )</td></tr>
<tr><td colspan="2">Sustainability Course Content</td></tr>
<tr><td colspan="2">Sustainability Literacy Assessment
Note: The institution declared that wasn´t pursuing this credit.</td><td colspan="2">Academic Research ( ) Local Issues ( )</td></tr>
<tr><th colspan="4">Campus Characteristics</th></tr>
<tr><td colspan="2">Campus Description</td><td colspan="2">Sustainable Practices</td></tr>
<tr><td colspan="2">Conservation Area ( )
Cultural heritage ( )
Library (X)
Research Center ( )
Hospitals ( )
Sports facilities (x)
Student Residence (x)
Laboratories (x)
Canteen & Cafeteria (x)
Other:</td><td colspan="2">Renewable energy systems (x)
Compost Plant (X)
Watertreatment Facilities ( )
Greenhouse (X)
Community Garden (x)
Bicycle racks + Shower facilities (x)
Sustainable heating systems (x)
Xeriscaping (x)
Passive Buildings ( )
Green Rooftops (x)
Other: In-floor Radiant Heating</td></tr>
<tr><th colspan="4">Sustainability membership/award</th></tr>
<tr><td>Talloires member</td><td>STAR<u>(Silver,2016)</u>S</td><td>LEED (<u>X</u>)</td><td>BREEM</td></tr>
<tr><td>Greenmetrics</td><td>Regional</td><td>National</td><td>Other:</td></tr>
<tr><th colspan="4">Sustainability Highlights</th></tr>
<tr><td colspan="2"><u>The Mohawk College Sustainability Office created the LEED® Tours to introduce students and visitors to the many design components within both facilities and to highlight the LEED®</u></td><td colspan="2">Sustainability website:http://www.mohawkcollege.ca/environmental-sustainability.html
Sustainability Manager:Alan Griffiths
Sustainability Grants:</td></tr>
</table>

[353] http://www.mohawkcollege.ca/environmental-sustainability.html

Gold certification awarded to the buildings.Mohawk College is home to two LEED® Gold certified buildings that enable the College to provide state of the art facilities, while reducing its carbon footprint and energy demand through increased efficiency. David Braley Athletic &Recreation Centre (DBARC), The Learning Exchange		Sustainability Investment GHG emission Inventory**2012 (10,454 tCO_2e)**	
SWOT Analysis			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
-Budget and government support to Sustainable Buildings -budget is balancedCapital focused on multi-year planning -LEED installations -Technician and apprenticeships -International enrolment	-Internal communication -Students commuting -Students sustainability awareness -Poor commuting	-Community engagement In local environmental challenges like Randle Reef Develop of Brownfield redevelopment projects for Hamilton	-Lack of interest from students -Regional transport -Energy Matrix (Nuclear source)
Sustainability Assets			
Energy	**Water**	**Materials**	**Transport**
Energy conservation program (**X**)	Water conservation program (**X**)	Green Procurement SOP/Poilicies (**X**)	Shuttle ( )
Energy Metering (**x**)	Low-flow plumbing fixtures including dry urinals(x)	Biodegradable (**X**)	Carpooling (**X**)
Renewable Energy (**X**)	Stormwater Management (**X**)	Recycled content (X)	Public transit Hub (**X**)
Energy-efficient lighting and controls(**X**)	Groundwater recharge ( )	LCA ( )	Electric Vehicles ( )
Green retrofits (**X**)	Wastewater treatment ( )	Low Carbon foot Materials (X)	Other Clean Vehicles ( )
Energy Star Appliances (**X**)	Condensate re-use ( )	Local content (**X**)	Business travel offsetting

Daylight Harvesting (X)	Water metering (X)	Certified Materials Purchasing (**X**)	Student & Employee Commute Modal Split Smart Commute ( )
LED lighting appliances(X)	Faucet troughs Refill Stations (X)		
Waste	**QA & QC**	**Innovation**	**Offsetting Programs**
Waste Management Program (**X**)	**Third Party:** CertificationEmissions Inventory Prepared by StantecConsoulting Program Quality Assurance Process Audit by PQAPA'sexternal audit panel in May 2014.	Renewable Energy appliances Wind turbines Rooftop Features Solar heating panels Building Automation System Heating, cooling, ventilation and lighting are programmed to operate based on occupancy and usage schedules.	None
Hazardous Materials Control (**X**)			
Compost (**X**)			
Metering & Monitoring Programs for diversion rate ( )			
Construction and Demolition Waste Diversion (**X**)			
Electronic waste diversion (**X**)			
Other:			
Community Engagement			
Student & Employee Orientation ( )	Community Stakeholder Engagement (**X**)		
Outreach campaigns (**X**)	Participation in Public Policy ( )		
Community & Volunteering service (**X**)	Openhouse events (**X**)		
Comments			
To fill this template I use information retrieved from Mohawk College´s website, and on-line documents. As a student I take courses in both winter and summer time that allows me to have an idea of O & M practices, and expend time in the facilities. Although, I don´t have first source information I visited the certified LEED buildings in the Campus After having evaluated STAR´s rating credits (before it was released in January of 2016), I found out that Mohawk College was in the Silver Category. Note: I submitted by e-mail a questionnaire without haven´t been answered.			

Table 3.37 Mohawk College Sustainability Highlights

3.6.2.3.DAWSON COLLEGE[354]

Facts: 11 000 students (Pre-university/Technical) , Established in 1969 Located in Westmount Quebec

Since I don´t have the opportunity to visit Dawson College Campus during my research, I decided to contact the professors that are already working in Cuernavaca in the Sustainable Campuses Project supported by IDRC described later in this chapter because I wanted to contrast the sustainability approach of a College in the second largest city of Canada (Montreal has 3.3 M inhabitants) that has a different culture (French speaking). At his regard, I interviewed Professor Chris Adam to find out some differences with Ontario´s Colleges. I will only mention the highlights of its sustainability program:

- Carbon Neutral Project *"Dawson College produced **915 metric tons of greenhouse gases** (carbon-based gases) through non-commuting transportation, energy use and waste production in 2012. We have reduced our carbon footprint by 64% in the last 5 years and have purchased carbon credits to offset its CO2 emissions."*[355] GHG emissions inventory completed 761 tCO_2e (Greenhouse gas assessment summary for Dawson College premises–July1,2011 to June30,2012)performed by Ecometrica[356]

- Peace Garden: If you Google Dawson College the fourth link proposed by the motor search connects you to Shooting event occurred in September 13th , 2006[357]. ***"One victim died at the scene, while another 19 were injured, eight of whom were listed in critical condition, with six requiring surgery. The shooter later committed suicide by shooting himself in the head, after being shot in the arm by a police officer."Since the creation of the memorial space "The peace Garden"[358] had become a safe space for reflection and tolerance. Sustainability it is also about to create community without discrimination.***

- Community engagement: Dawson College act as an incubator of ideas and programs for schools, NGO´s and other institutions of higher education. Such as: Biodiversity zones, Bee Hive Projects, Rooftop Gardens.[359]

Dawson College has stared an offsetting project in Nicaragua where they can involve not only offsetting GHG emissions actions, but also support communities in developing countries to close social gap by preserving local environment.

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[354]https://www.dawsoncollege.qc.ca/sustainable/
[355] https://www.dawsoncollege.qc.ca/sustainable/projects/carbon-neutral-project/
[356] https://www.dawsoncollege.qc.ca/sustainable/wp-content/uploads/sites/85/Dawson-College-Premises-GHG-Assessment-Report-v2.0.pdf
[357] https://en.wikipedia.org/wiki/Dawson_College_shooting
[358] https://www.dawsoncollege.qc.ca/sustainable/projects/peace-garden/
[359] https://www.dawsoncollege.qc.ca/sustainable/projects/

3.6.3. UNAM[360][361][362]

Institution Information			
School name: *Universidad Nacional Autónoma de México* (UNAM in Spanish) Institution type: Graduate and Postgraduate Location: Mexico, City Public (X) Private ( ) Founded: 1954 Campus CU Endowment: 2,785,000,000 CAD		Campy: Central University City Campus (0nly campus evaluated) + 7 Campy Total campus area: 176.5000 Ha, 123,2402 ha Constructed Area + 1,102 Ha Buffer Zone Students: 342,542 Faculty:38,793 (4,202 NRS) Staff: 3,000 Website: https://www.unam.mx/	
Academic Information			
Academic Programs 321		Number of students involved in sustainability activities	
Sustainability related Academic Courses 43 (PUES) +		Sustainability related learning Outcomes Thesis (X) Indexed Publications (X) 3252 Articles Projects (X) Other (X)	
Sustainability Course Content SCHOOLS 24 Master degree +72 bachelor degree			
Sustainability Literacy Assessment		Academic Research Local Issues ( )	
Campus Characteristics			
Campus Description		**Sustainable Practices**	
Conservation Area (X) 237 ha Ecological Reserve Cultural heritage (X) 2007 UNESCO (i)(ii)(iv) Library (X) 134 libraries, 7M Books Research Center (X) Hospitals (X) Sports facilities (X) Student Residence (X) Laboratories (X) Canteen & Cafeteria (X) Other: Stadium, Aquatic Center, Museums, Botanic Garden		Renewable energy systems (X) Compost Plant (X) Watertreatment Facilities (X) 3 Plants Greenhouse (X) Community Garden ( ) Bicycle racks + Shower facilities (X) Sustainable heating systems (X) Only Aquatic Center Xeriscaping (X) Passive Buildings ( ) Green Rooftops (X) Other:	
Sustainability membership/award			
Talloires member **X**	STARS **X**	LEED	BREEM
Greenmetrics: 21, 6430 points	Regional	National	Other:
Sustainability Highlights			
Transport Bicipuma 1500 Share bicycles Pumabus 50 buses + 12 routes Aquatic Center (Solar wáter heating) ECOPUMA/PUES Sustainability Program		Sustainability website: http://www.puma.unam.mx/?p=d_sustentabilidad Sustainability Manager: Mireya Imaz Sustainability Grants:	

[360] http://ecopuma.unam.mx/movilidad.php
[361] http://ecopuma.unam.mx/movilidad.php
[362] http://www.dforcesolar.com/energia-solar/la-alberca-olimpica-de-la-unam-caliente-gracias-a-la-energia-solar/

PUMAGUA Water Conservation Program Electricity Grid Retrofit 23 KV (Energy efficiency) LANCIS National Laboratory for Sustainable Sciences	Sustainability Investment GHG emission Inventory 48.8 MtCO$_2$e, 2001

SWOT Analysis

Strengths	**Weaknesses**	**Opportunities**	**Threats**
-Transport HUB (Metrobus + Metro) The Campus is well connected -Water quality and water metering 75 % of data is geo referenced -UNAM´s Environmental Award Program Sustainable assessment of Campus (48 University Entities assessed) -Research focused in sustainability (LANCIS+Institutes) -Media Platforms Radio, TV, Internet, and Social Media	- Poor Community environmental awareness -See QA&QC -There is a lack of Stormwater management -Insufficient Budget for O & M -Waste Management - High % of Water Leaks	-Engage the community in Volunteering programs yo impact the whole city. -Conclude the Water metering Program (17% left) -It´s important to renovate the Water drinking system to reduce water leaks, and enhance the Water Observatory -Recalibrate the Environmental Award Comparing with STAR rating system, and perform an Energy Assessment under ISO 50001 with CEC -There is a huge potential for offsetting programs related with transport and carbon sequestration in the Campus. -Use more intensively the webpage to increase students participation in sustainability projects (The UNAM´s website is ranked 2nd over all in Latin America, and 62 world wide)	-It´s important to prevent outbreaks produce by groundwater pollution -The three wells that provide Campus Water share the water with the buffer zone community there are Potential Water Scarcity in the future -The Campus Growth is on its limit. -The continuous water extraction is in the process to produce Ground subsidence

Sustainability Assets

Energy	**Water**	**Materials**	**Transport**
Energy conservation program (X)	Water conservation program (X)	Green Procurement SOP/Poilicies (X)	Shuttle (X) Pumabus

		<u>Sustainable Construction Guidelines</u>	
Energy Metering (X)	Low-flow plumbing fixtures including dry urinals (X)	Biodegradable (X)	Carpooling ( )
Renewable Energy (X)	Stormwater Management ( )	Recycled content (X)	Public transit Hub (X) Subway, Metrobus
Energy-efficient lighting and controls (X)	Groundwater recharge (X)	LCA ( )	Electric Vehicles ( )
Green retrofits ( )	Wastewater treatment (X)	Low Carbon foot Materials ( )	Other Clean Vehicles ( )
Energy Star Appliances ( )	Condensate re-use ( )	Local content ( )	Business travel offsetting
Daylight Harvesting ( )	Water metering (X)	Certified Materials Purchasing (X)	Student & Employee Commute Modal Split ( )
LED lighting appliances (X)	Faucet troughs Refill Stations (X)		
Waste	**QA & QC**	**Innovation**	**Offsetting Programs**
Waste Management Program (X)	Third Party Certification: The GHG emissions is a requirement in most of the sustainability rating systems, a third party assessment by certified body provides certitude and credibility to the process.	The <u>Online Water Quality Monitoring</u> Platform is a unique way to rnhance water conservation program, and to promote water culture in the Community.	
Hazardous Materials Control (X)			
Compost (X)			
Metering & Monitoring Programs for diversion rate ( )			
Construction and Demolition Waste Diversion ( )			
Electronic waste diversion (X)			
Other:			
Community Engagement			
Student & Employee Orientation (X)		Community Stakeholder Engagement (X)	
Outreach campaigns (X)		Participation in Public Policy (X)	
Community & Volunteering service (X)		Openhouse events (X)	
Comments			
To fill this template I conduct three intervies with the PUES Coordinator and Project Manager and PUMAGUA Coordinator, have a meeting with the PUMABUS-BICIPUMA Coordinator, and perform the heritage tour of Central Campus. I retrieved online documents from university´s websites.			

After having evaluated STAR´s rating credits, I believe that the sustainability program is in the path to have a silver award. Greenmetric´s assessment can supports this assessment. Finally, I would like in my opinion to underline the main asset of UNAM´s sustainability program: The research focused on sustainability areas.

Table 3.38 UNAM Sustainability Highlights

3.6.4. COMPARISON BETWEEN COLLEGES

"As centers of innovation, Canada's colleges and institutes are actively addressing environmental challenges by building state of the art facilities that minimize their environmental footprint and foster the development of green technologies. Thanks to ambitious sustainability plans, many have become leaders in environmental action, while providing training programs that produce graduates who are environmentally aware and able to tackle pressing sustainability concerns"[363]

I would like to introduce the comparison through the following factors:

Budget

In recent days it has been announced a $2-billion investment in post-secondary infrastructure over the next three years in sustainable facilities through the Post-Secondary Institutions Strategic Investment Fund that aims to modernize facilities on campuses with an emphasis on improving environmental sustainability.[364]

In the first hand, it isn´t new to find out that budget issues compromise in most of the cases sustainability programs, as quoted before Canadian government has labeled part of College´s budget in Sustainability practices. In the other hand there are a wide spread of College´s vision in the way to implement and embrace sustainability in their policies. In Mexico, budgetary limitations are severely compromising sustainability goals. It will be interesting to verify the impact of Low emission Schools NAMA as source of funding in the upcoming years.[365]

Cultural aspects

Undoubtedly, Culture is a game changer in sustainability. It´s not a question of knowledge but of respect of habitat, nature, traditions and the community. Sometimes, foreign students are more involved in volunteering than locals, which was my feeling as a Newcomer in Canada. This is a reason why Higher education institution need to bridge the gap between its community and local issues.

Focused areas

Each institution must answer local or regional issues; in UNAM´s case it has an extended compromise not only with Mexico City, but also with Mexico. As a National Institution with a great human research potential. UNAM has the opportunity to address all the aspects involved with sustainability and work in focused areas such as Planetary Boundaries, Sustainable Construction, equity, and other aspects. Canadian Colleges must be regional focus like sustainable tourism,

[363] http://www.collegesinstitutes.ca/news-centre/perspective/perspectives-april-18/
[364] idem
[365] http://www.nama-database.org/index.php/Low_Emission_Schools

brownfield development, water scarcity, food shortage and should reflect these problems in their policies and programmes.

Community Engagement

Concerning to this apect, both Canadian Colleges and UNAM have a lack of interest on local environmental issues and cultural components that can help to understand better how deeply affected is the habitat. Volunteering activities has an old tradition in Canada. In the opposite site is Mexico. The larger is the community the less is people´s engagement.

Environmental awareness and literacy. None of the schools mentioned has an environmental literacy assessment, in my opinion this is one of the factor of the lack of awareness to current situation.
Innovation

We cannot compare the four schools in this aspect, but it is interesting how creativity enable undertaking in each area of specialisation. We can take Sustainability Campuses as an example.

3.7. COLABORATION BETWEEN THE COLLEGES[366][367]

The Talloires declaration and AASHE´s precepts brought to sustainability implementation two factors: Engagement (Public and Campus), and link between the institutions. At this regard, all rating systems mentioned in this thesis intend to promote new technologies and innovation practices by sharing experiences and information exchange between the institutions. I would like to introduce the following exhibits of collaboration:

Civic Engagement Movement Leaders to Convene in Mexico in 2017 "*Universidad Veracruzana (UV) in Mexico has been selected to host the next Talloires Network Leaders Conference (TNLC) during the week of June 19, 2017. The Talloires Network Steering Committee voted to bring the global civic engagement and leadership gathering to the Western Hemisphere for the first time."*[368]

Sustainable Campuses Dawson College and UPEMOR.
On November 2012, Dawson College and the Instituto Mexicano para el Desarrollo de CiudadesVerdes in collaboration with the Universidad Pedagógica Nacional of the State of Morelos and the Escuela Particular Normal Superior Lic. Benito Juarez began the research project *"Sustainable Campuses: A North-South Research and Action Community". It is designed to provide a space to acknowledge and value a diversity of knowledge systems and practices that have the potential to support the construction of sustainable campuses. It also identifies and recognizes institutions that generate knowledge, model sustainability values through their operation, and that share best practices*.[369][370]

[366]https://issuu.com/dawsoncollegeqcca/docs/sc_final_report_online_version/1?e=2458721/32139909
[367] https://www.dawsoncollege.qc.ca/sustainable/projects/mexico-project/
[368] http://talloiresnetwork.tufts.edu/blog/2016/03/15/civic-engagement-movement-mexico-in-2017/
[369] https://www.dawsoncollege.qc.ca/news/uncategorized/art-science-and-tradition-for-sustainability-a-forum-for-campus-sustainability/
[370] http://idl-bnc.idrc.ca/dspace/bitstream/10625/52672/1/IDL-52672.pdf

"In a McGraw-Hill Construction survey, U.S. corporations revealed that green building strategies decrease operating costs by 8-9 per cent, increase building value 7.5 per cent, achieve a 6.6 per cent return on investment, increase occupancy ratio 3.5 per cent and increase rent ratios 3 per cent. By Incorporating sustainable building practices in schools will likewise reduce operational costs, potentially allowing the savings to be reallocated for teachers salaries, supplies and other critical needs."

Chapter Four

4.- Sustainability Procedure in Construction

4.1 General scope for: Legislations, Policies, standards, and regulations[371][372][373]

As mentioned, in the first three chapters due to fast urbanisation and population growth, addressing sustainability has become almost an obligation not only in the construction sector but also for all human activities related with the environment. For all the professionals involved in the construction process as part of their own professional ethic, adoption of new policies, implementation of best environmental standards and practices. Finally, compliance with all regulations should be part of all professional codes, instead of voluntary programs. The Corporate Social Responsibility of construction companies, developers, design studios, and contractors should be environmentally oriented towards community development.

From single dwellings to urban infrastructure It´s important to stablish guidelines, and follow precepts such as:

Economic sustainability – increasing profitability by making more efficient use of resources, including labour, materials, water and energy

Environmental sustainability – preventing harmful and potentially irreversible effects on the environment by careful use of natural resources, minimizing waste, protecting and where possible enhancing the environment

Social sustainability – responding to the needs of people at whatever stage of involvement in the procurement process (from commissioning through operation to demolition), providing high customer satisfaction and working closely with clients, suppliers, employees and local communities

Understanding priorities and potential profits. Pursuing both building must **maximize the sustainability benefits** achieved in the buildings sector.

[371] http://www.wbdg.org/resources/greenprinciplesresdesign.php
[372] http://dcra.dc.gov/page/green-construction-code
[373] http://publicecodes.cyberregs.com/icod/igcc/2012/icod_igcc_2012_3_sec002.htm?bu=IC-P-2012-000023&bu2=IC-P-2012-000019

Contributing to **poverty eradication**, creating and maintaining green jobs, **increasing urban integration**, **improving quality of life in urban and rural areas**, enhancing economic opportunities, and achieving significant **financial savings**.

Providing for social needs, implementing greater resource efficiency and capitalising on the known technologies and **sustainable building practices** that will provide cost savings, better shelter, job growth and an improved ability to sustain lives and livelihoods.

By enacting sustainable building policies and applying integrated urban planning approaches, local governments can reduce infrastructure needs and costs.

Developing a **local approach** allows to maximise the benefits achieved. Actions based on the environmental and social context that make use of local assets, resources and opportunities,

Cooperation among stakeholders is necessary to ensure performance and commitment

Terminology[374]

Mandatory requirements— Requirements that must be met by every building unless there is a specific exception in the code.
Prescriptive requirements— Requirements that must be met by every building unless an approved trade off is utilized or unless there is a specific exception in the code.
Performance approach— An overall performance requirement for the building that replaces the individual prescriptive requirements for building systems and components.
(See table 4.1)

Section Section of ASHRAE Standard 90.1-2007 or ASHRAE Standard 90.1-2010	Compliance Path
5. Building Envelope (5.2)	1. Mandatory + prescriptive (R-value) 2. Mandatory + prescriptive (U-factor) 3. Mandatory + envelope trade-off
6. Heating, Ventilating, and Air Conditioning (6.2)	1. Simplified Approach Option 2. Mandatory + prescriptive
7. Service Water Heating (7.2) 1.	1. Mandatory + prescriptive
8. Power (8.2)	1. Mandatory
9. Lighting (9.2)	1. Mandatory + building area 2. Mandatory + space-by-space
10. Other Equipment (10.2)	1. Mandatory
11. Energy Cost Budget Method (11.1.4)	1.Mandatory requirements from Sections 5-10 plus use of Energy Cost Budget (ECB) Method

Table 4.1 Compliance Path ASHRAE Standard 90.1-2010[375]

[375] https://www.energycodes.gov/resource-center/ace/compliance/step2

4.2. Approaching for New and existing building projects

The building's energy life cycle reflects that buildings consume energy in different ways during their life cycles. Five life cycle phases can be distinguished. The first phase is termed "**embodied energy**" and corresponds to the manufacturing of building materials and components. The second and third phases correspond to the **energy used to transport materials** from production plants to the building site and the energy used in the actual construction of the building, which are respectively referred to as **grey energy** and **induced energy**. In the fourth phase, energy is consumed at the operational phase (**operation energy**), which corresponds to the running of the building when it is occupied. Finally, in the fifth phase, energy is consumed in the demolition process of buildings as well as (when this is promoted) in the recycling of their parts (**demolition-recycling energy**).[376]

The project's life cycle refers to the actions and processes associated with the building's life, from pre-design to deconstruction. In order to improve the sustainability of the building, and select the focus area to improve, it is important to consider its complete life cycle, include the people involved and the implications of the decisions taken at each stage in later phases

The Table 4.2 shows a four steps process to implement energy management for buildings.from designing, construction, commissioning and operations. This process intends to provide objectives while giving recommendations for each step.

Energy Management	
Objectives	**Recomendations**
Step 1 Mapping and Assessment	
Assess and understand current conditions, capacity and potential in preparation for selection of project focus and site(s); document pre-project conditions to be used in monitoring and evaluation.	• Identify the priority areas where the most impact can be achieved through efficient alternative solutions understanding the local context (culture, geography, climate, population growth). **Sustainability priorities understand the energy matrix of the country and implications for climate impact as well as the relative share of the building sector.** • Understanding the current practices and state of affairs in social housing. • Assessing market demand –awareness and need • Assessing market supply – technologies and capacity. It is also important to trace the source of the product and material (e.g. illegal timber) and compliance with work and health legislations. • Defining the project baseline Available indicators include the following categories: • Energy intensity; • Resource efficiency (including land occupation); • Carbon intensity; • Indoor air quality; • Air and water pollution;

[376]Jones, 1998 Cited in UNEP, 2007, p. 7

	• Social integration; and • User satisfaction. They can be based on surveys or on the accessibility (physical or social) to urban services such as transport, sanitation, education, public spaces, cultural or recreational facilities.
Step 2 Establishing the Project Agenda and Scope	
Select actions and solutions based on the project agenda and plan for implementation.	• Articulating the project agenda. At this stage, the housing authority must identify the key elements of the project (location, budget, timeline, requisites and challenges). • Selecting focus area(s), which will be the targeted areas for performance improvement. • Selecting appropriate solutions. **The selection of sustainable solutions is to be based on consideration of their cost, efficiency, acceptability and ease of implementation and maintenance.** Costs -requirements–benefits analysis should be carried out in order to rank solutions according to the benefits to the project. Costs over the life cycle should also be considered (namely maintenance and operation requirements). • Defining objectives and targets for each focus area. The targets should be based on the priorities and focus areas previously set must be achievable within a specific period and based on well-measured data collection.
Step 3 Raising Awareness and Building Capacity	
Ensuring coherence in implementation through engaging and preparing stakeholders for participation, based on the results of the mapping and selection of alternatives.	Technical training for architects, construction companies and developers. Training is intended as a professional capacity-building activity; while workshops targeting non-technical decision makers are also necessary. Awareness-raising for users of social housing. These activities are aimed at users and people in charge of maintenance to create awareness on the behavioural patterns and use of the facilities during occupation. Home user guide: A home user guide is a tool that provides useful information for home occupants and operators that can minimize operation costs and improve the environmental performance of a building through occupant and operator engagement. House handover induction: The house handover orients the user to the equipment and functioning of the home and is led by the customer service office/commissioning department of the housing authority. The handover process can be useful in addressing and raising awareness of sustainability topics and features of operation, such as: • Space use and future expanding potential;

	• Design and operation of environmental features, explanation of control interfaces; • Energy and water efficiency behaviour and appliances; • Deliveries, recycling and waste disposal management; • Soft and hard landscape maintenance; • Security access, safety and emergency issues; • Personal transport options; • Access to additional financial credits for energy-efficient appliances, e.g. stove or refrigerator; • Regular maintenance issues, e.g. frequency, • costs and access requirements; and • Availability of future help and guidance.
Step 4 Monitoring and Evaluation	
This section aim to provide guidance on assessing the results of implementation, including actual performance and user satisfaction.	• Selecting an evaluation protocol • Performance evaluations and energy audits • Resource and water consumption • Monitoring of environmental quality and user comfort (temperature, humidity, air quality) • User evaluations • Resident satisfaction questionnaire Survey • Walkthrough and semi-structured Interview • Appliance energy-usage questionnaire • Disseminating the Outcomes and Building Support

Table 4.2 Energy Management objectives

4.3. Adopting a Sustainability Statement

The growing need of green buildings with lower environmental impacts over the life-cycle for this reason is important to adopt policies, strategies, and set targets. The outcomes of this process is unstructured knowledge about design, production efficiency, better building life-cycle performance and reducing material wastage (S. Binnemars,J.I.M. Halman, E. Durmisevic, September, 2012).

In the article, authors divide materials in regenerative and no regenerative underlining that in some case regenerative materials are used in a faster pace that the regeneration rate creating problems not only to the construction supply chain, but also to the environment. If this path continues scarcity of materials would create huge problems in the construction industry.

Sustainability statement allows to all the members of the team project to meet client´s requirements by setting requirements and objectives under regulations compliance. The responsible of the project must enable policies and verify during the life cycle of the project. At least the statement need to cover tree main aspects:

Environment

As mentioned in the Brundtland report in 1987 that popularize the term "Sustainable development" there were several elements that are warning the environment. In 2009, a group of researchers presented an article entitled **"Planetary Boundaries: Exploring the Safe Operating Space for Humanity"**(see table 4.3 Amd figure 4.1) (Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer,, 2009). Four of nine planetary boundaries have now been crossed as a result of human activity, says an international team of 18 researchers in the journal Science. The four are (coloured in red): climate change, loss of biosphere integrity, land-system change, altered biogeochemical cycles. The scientists say that two of these, climate change and biosphere integrity, are "core boundaries" significantly altering either of these would "drive the Earth System into a new state". [377] . For these reasons, in order to prevent further warns to environment, it´s important to evaluate how every project impacts these 9 boundaries, and implement policies, regulations and adopt the best environmental practices.

In the aggregate and at a globalscale, there are five indirect drivers of changes in ecosystems and their services: population change, change in economic activity, sociopolitical factors, cultural factors, and technological change. Collectively these factors influence the level of production and consumption of ecosystem services and the sustainability of production.[378]

Planetary Boundary	**Control Variable(s)**	**Boundary** The value in brackets indicates the estimated zone of uncertainty	**Current Value**
Climate change	Atmospheric CO_2 concentration, ppm Energy imbalance at top-of-atmosphere, (Watts per metre squared, Wm^{-2})	350 ppm CO_2 (350-450 ppm) Energy imbalance: +1.0 W m^2 (+1.0-1.5 W m^{-2})	396.5 ppm CO_2 2.3 W m^{-2} (1.1-3.3 W m^{-2})
Change in biosphere integrity	Genetic diversity: Extinction rate Functional: diversity: Biodiversity Intactness Index (BII)	Genetic: less than 10 extinctions per million species-years (E/MSY), (10-100 E/MSY) Functional: Maintain the Biodiversity Intactness Index at 90% (90-30%) or above, assessed geographically by biomes/large regional areas (e.g. southern Africa), major marine ecosystems (e.g., coral reefs) or by large functional groups	100-1000 E/MSY 84%, applied to southern Africa only
Stratospheric ozone depletion	Stratospheric O_3 concentration, Dobson Units	<5% reduction from pre-industrial level of 290 Dobson Units (5%–10%), assessed by latitude	Only transgressed over Antarctica in Austral spring (~200 DU)
Ocean acidification	Carbonate ion concentration, average	≥80% of the pre-industrial aragonite saturation state of mean surface	~84% of the pre-industrial

[377] https://www.pik-potsdam.de/news/press-releases/four-of-nine-planetary-boundaries-now-crossed
[378] Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.

	global surface ocean saturation state with respect to aragonite (Ωarag)	ocean, including natural diel and seasonal variability (≥80%– ≥70%)	aragonite saturation state
Biogeochemical flows: (Phosphorus and Nitrogen cycles)	*Phosphorus cycle*: Global: Phosphorus flow from freshwater systems into the ocean Regional: Phosphorus flow from fertilizers to erodible soils *Nitrogen cycle*: Global: Industrial and intentional biological fixation of nitrogen.	*Phosphorus cycle*: Global: 11 Tg P yr^{-1} (11-100 Tg P yr^{-1}) Regional: 6.2 Tg yr^{-1} mined and applied to erodible (agricultural) soils (6.2-11.2 Tg yr^{-1}). Boundary is a global average but regional distribution is critical for impacts. 62 Tg N yr^{-1} (62-82 Tg N yr^{-1}). Boundary acts as a global 'valve' limiting introduction of new reactive nitrogen to the Earth System, but regional distribution of fertilizer nitrogen is critical for impacts.	~22 Tg P yr^{-1} ~14 Tg P yr^{-1} ~150 Tg N yr^{-1}
Land-system change	Global: area of forested land as % of original forest cover Biome: area of forested land as % of potential forest	Global: 75% (75-54%) Values are a weighted average of the three individual biome boundaries and their uncertainty zones Biome: Tropical: 85% (85-60%) Temperate: 50% (50-30%) Boreal: 85% (85-60%)	62%
Freshwater use	Global: Maximum amount of consumptive blue water use (km^3yr^{-1}) Basin: Blue water withdrawal as % of mean monthly river flow	Global: 4000 km^3 yr^{-1} (4000-6000 km^3 yr^{-1}) Basin: Maximum monthly withdrawal as a percentage of mean monthly river flow. For low-flow months: 25% (25-55%); for intermediate-flow months: 30% (30-60%); for high-flow months: 55% (55-85%)	~2600 km^3 yr^{-1}
Atmospheric aerosol loading	Global: Aerosol Optical Depth (AOD), but much regional variation Regional: AOD as a seasonal average over a region. South Asian Monsoon used as a case study	Regional: (South Asian Monsoon as a case study): anthropogenic total (absorbing and scattering) AOD over Indian subcontinent of 0.25 (0.25-0.50); absorbing (warming) AOD less than 10% of total AOD	0.30 AOD, over South Asian region
Introduction of novel entities	*No control variable currently defined*	*No boundary currently identified, but see boundary for stratospheric ozone for an example of a boundary related to a novel entity (CFCs)*	

Table 4.3 Planetary Boundaries facts 2013

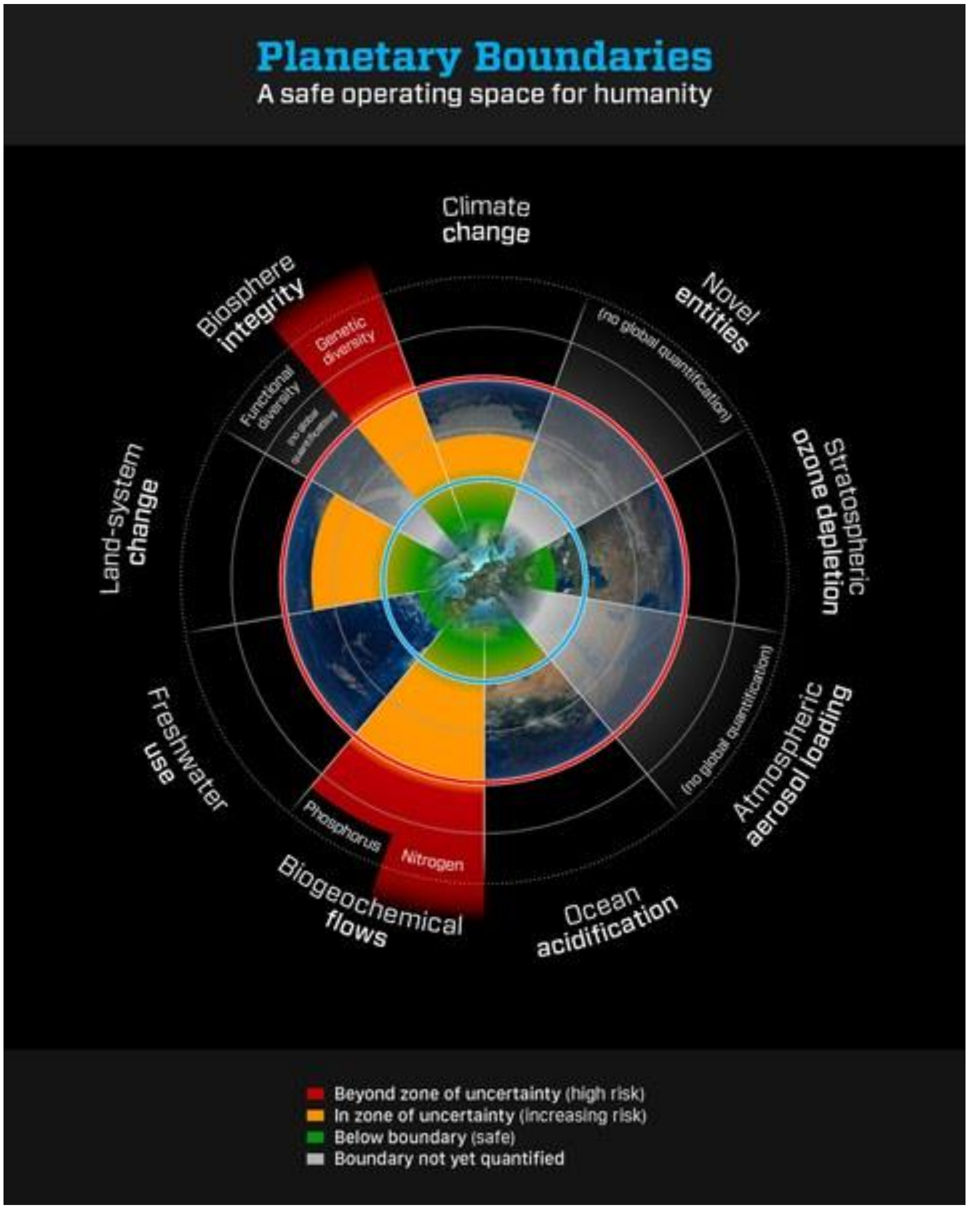


Figure 4.1 Planetary Boundaries 2013

Society

Maslow´s Pyramid determines 5 hierarchy levels of needs (See figure 4.2): physiological, safety, love belonging, esteem, and self-actualization. The construction industry should fulfill not only client´s requirements but also include the needs of people living or working, and respect neighbours rights. Local needs might change through the time, which implies that urban planners, architects, and engineers most adapt to new conditions and collaborate with local authorities to create a better social environment, and improve the quality of life always respecting the habitat. Natural ecosystems perform fundamental life-support services upon which human civilization depends. Life itself, as well as the entire human economy, depends on goods and services provided by earth's natural systems

Cultural Capital: Provide a building that is consistent with the cultural and historic context of the site and that displays an aesthetic appropriate to the dignity of the federal government and the type of facility required

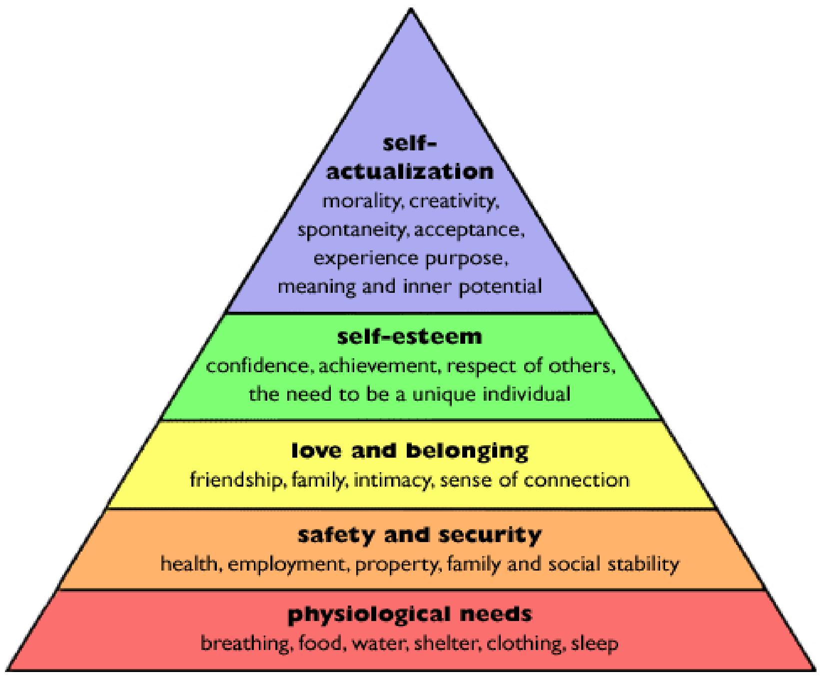


Figure 4.2 Maslow´s Pyramid

Retrieved from: http://theskooloflife.com/wordpress/self-actualization-in-the-maslow-hierarchy/

Economy

"In Maslow's hierarchy of needs once physiological needs are met, safety, belongingness, and esteem needs are the next series of needs that human strive to acquire to develop a strong sense of well-being. For many, particularly in the Western World, these levels are attained via economic advancement. While in concept these levels of needs involve many other inputs and achievements, both psychological and social, much of Western well-being at these levels relates to perceived economic needs" [379]

The European Union is experimenting with the use of payments for the loss or gain of ecosystem services based on valuation systems or examining assessing values and trade-offs for fisheries, biodiversity, coastal areas and coral reefs, noise pollution, wildfires, environmental indices, sustainability, and overall costs of inaction.

[379] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3393065/

As mentioned in chapter three. The construction sector several times has been pointed for its lack of commitment to preserve environment.
As part of my professional experience, I form part of a Non-For-Profit committed with renewable energies implementation in rural communities, and environmental restoration. During five years, we have developed along with communities our own conception of sustainability, and its elements.

Our definitions are:

Sustainability is the way to link our community development on time, in an integral an organic way with the ecosystem that surrounds us:

Livelihood –We produce and consume responsibly, projecting needs and future development.
Quality–Our use of natural resources is efficient, and doesn´t produce negative impacts to the habitat.
Legality –We meet regulations in order to preserve the ecosystem in which we live.
Ecosystem -The ensemble of plants, wildlife, and habitat in which humankind is a part.
Time –A resource that we need to take into account in planning and execution process opportunely.
Adaptability –We adapt our actions to the changing conditions of the habitat, and not all the way around.
Community –Past, present and future generations.
Solidarity –The protection of habitat is the common interest.
Equality –The natural resources will be available to all the members of the community equally.

4.4. Determining objectives and indicators

Green building most aim better well-being by generating less pollution to the environment, creating more jobs with better job security, creating better indoor climate, improving neighborhoods, and adding higher quality into procedures implemented in the construction building process, implementing innovations.

Table 4.4 Includes 8 criteria proposed for differents authors ((1) *LEED 2009*; (2) Ali and Al Nsairat 2009; (3) Alwaer and Clements-Croome 2010; (4) Shen et al. 2011; (5) Kai Juan et al. 2010; (6) Mwasha et al. 2011; (7) Ying Chen et al. 2010.))

Sustainable site
Waste efficicency
Materials and resources
Energy efficiency
Indoor quality
Innovation
Social
Economical

	Criteria		Criteria
Sustainable Site	Site selection (1,2,3,4)	Water efficiency	Water use reduction (1,2,5)
	Reduce pollution generation (2,4,5,6)		Water efficient landscaping (1,2,5)
	Transport and accessibility (1,2,5)		Wastewater technology (1,5)
	Construction activity pollution prevention (1,5)		Water conservation (2,3)
	Reduce heat island effect (1,5)		Water treatment (4,5)
	Development density and community connectivity (1)		Pollution effect on water quality (4)
	Brownfield redevelopment (1)	Materials and resources	Reduce waste generation (2,3,5,6,7)
	Site development (1)		Renewable material use (1,2,3,6)
	Surface water runoff control (1)		Material reuse (1,2,7)
			Local material use (1,2,4)
Energy efficiency			Storage and collection of recyclables(1)
	Minimum energy performance (1,6,7)		Material durability (3,6,7)
	Reduce green house gas emission (2,3,4,6)		Recycled material use (1)
	Fundamental commissioning of the building energy systems (1,2,6)		Building reuse (1)
	Building envelope performance control (2,6)	Indoor Quality	Indoor air quality management (1)
	Energy efficient heating, cooling and air conditioning systems (2,5)		Outdoor air delivery monitoring & increased ventilation (1,2,3,6)
	Energy savings (4,6)		Daylighting and views (1,2)
	Green power (1)		Indoor chemical & pollution sources control(1)
	Fundamental refrigerant management (1)		Tobacco smoke control (1,5)
Economical	Enhanced commissioning (1)		Control lability of systems (1)
	Measurement and verification (1)		Minimum indoor air quality (1)
	Optimize energy performance (1)		Thermal comfort (1)
	Life-cycle cost (3,4,6,7)		Low-emitting material (1)
	Life-cycle profit (2,3,4,6,7)		Acoustic & noise control (2)
	Project budget (4,7)	Innovation	Innovation in design (1,2,3,5)
Social	Aesthetic options (3,6,7)		
	Effect on local development (4,7)		
	Protection to culture heritage (3,4)		

Table 4.4 Key performance criteria for sustainable buildings Retrieved from: http://rebar.ecn.purdue.edu/crc2012/papers/pdfs/-107.pdf

4.4.1. Land Use

In the late eighties, the concept of embodied energy in building materials was first adopted in the United States. According to this concept, the extraction of raw materials, the production and transportation of construction materials, and the building construction could be translated into energy expended during all these processes. As a result of studying this concept, we started to realize that one of the most effective ways to save energy was to preserve and reuse existing buildings. (Bruno Marques and Carlos Rafael Loureiro, April 2013)

ASTM E2114-08 (Standard Terminology for Sustainability Relative to the Performance of Buildings), provides an overview of the industry accepted terminology as pertaining to sustainable development and sustainability in relation to the performance of buildings. Some of the terms with the highest relevance to this research were the following: (Alborzfard, 2010). (See figure 4.3)

- **Energy Input**: All forms of energy necessary for the accomplishment of the particular building life cycle process under consideration.

- **Environmental Releases**: All air, water, and solid emissions, which are given off by the building life cycle process under the consideration that they return to the natural environment.

- **Furnishing and Outfitting**: The complete series of activities and actions that begins with a building structure and results in a complete building. Interior Furnishings: Those temporary and semi-permanent systems and components, which generally are required for the normal utilization of the building for its intended purpose including decorative components.

- **Obsolete Building**: A building that has reached the end of its useful life.

- Sustainable design principles include the ability to:[380]

    - **Optimize site potential;**
    - **Minimize non-renewable energy consumption;**
    - **Use environmentally preferable products;**
    - **Protect and conserve water;**
    - **Enhance indoor environmental quality; and**
    - **Optimize operational and maintenance practices.**

[380]http://www.gsa.gov/portal/content/104462

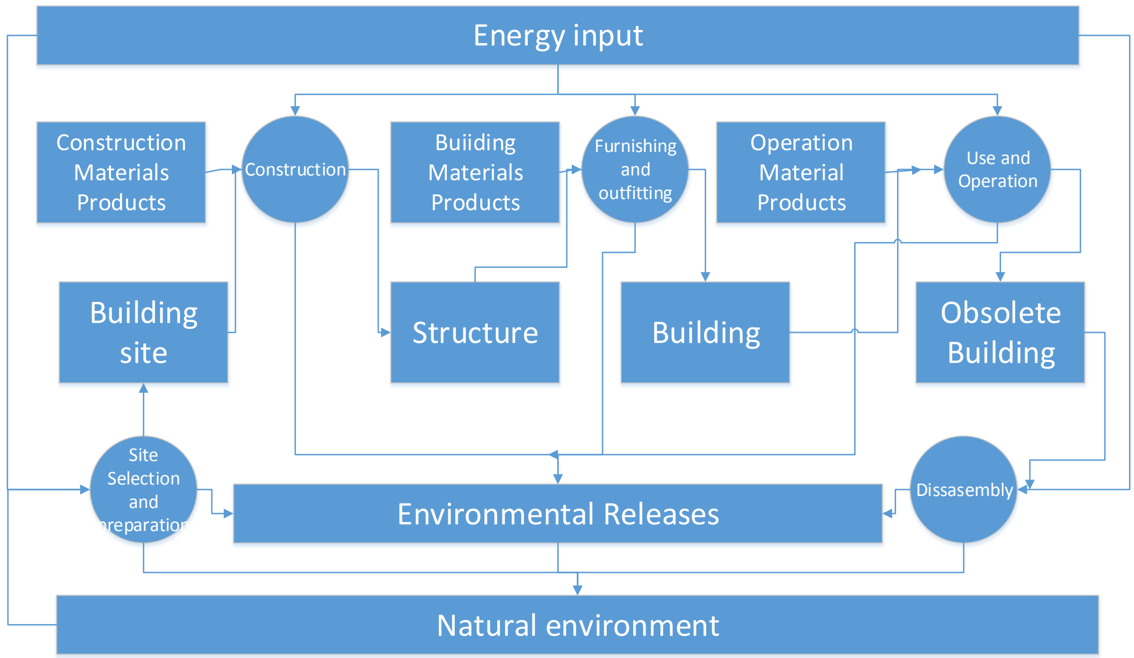


Figure 4.3 Flow of Building Materials/Products into Building Life Cycle

The following selection complement the criteria described in chapter One to use as a tool for the Sustainability Standard Operating Plan (**SSOP**) in section 4.14, each table include: Element description, Standards related, Residential & Commercial best practices, links to refer, verficication and enforcement points and recommendations.

Element: **Site Selection and Development**	Site selection and development have broad environmental and community impacts. They determine access to public transportation, parks and recreation, bike paths and walkways; whether environmentally sensitive areas are avoided; how water can be conserved; and how buildings are oriented to reduce heating and cooling demands.	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
	Select site in redevelopment or brownfield location Select site which is walkable and/or bikeable Configure occupied spaces so as to maximize natural ventilation and daylighting, Connect occupants to the natural environment whenever possible via operable windows and daylight- make sure that	Select site in redevelopment or brownfield location Mitigate heat island effect: hardscape, shaded exterior walls, cool roofs or vegetated roofing systems Optimize the building shape and orientation to maximize the benefits of the solar and wind characteristics of site, including cool breezes in summer avoidance of cold winds in winter

	this can be accommodated by the HVAC design	Incorporate ground source heat pumps where feasible, Provide inviting, pleasant staircases to encourage use of stairs rather than elevators in low-rise building;
Links	Verification and Enforcement	RECOMMENDATION
http://sustainablesources.com/site-selection-and-analysis/ http://www.sustainablesites.org/	Depends on site location the Project most be in accordance Urban Development Plan	**Design for the Climate, Flora, Fauna & Soils**

Table 4.5. Site Selection Best Practices

4.4.2. Energy

Element **Energy Efficiency**	On an individual basis, even human health can be affected by building energy use when rising energy costs render a conditioned, comfortable, healthy indoor environment unaffordable. On a larger scale, carbon emissions, which are directly tied to building energy use, affect the health of our planet.	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
The adoption and enforcement of the most recently published versions of the IECC and ASHRAE 90.1 in communities 30% weighted average energy savings across all building types over Standard 90.1-2007 (9% from renewable and 21% from efficiency)	Demand-Side Management <u>Retrocommissioning</u> <u>Lighting</u> <u>Supplemental Load Reduction</u> <u>Air Distribution Systems</u> <u>Heating and Cooling Upgrades</u>	In large buildings, consider distributing power at 480/277 volts raher than at 208/120 volts; Specify energy-efficient office equipment, including computers, printers and copy machines; Improve the power factor by specifying appropriate equipment as required; Use k-rated transformers to serve non-colinear equipment; Utilize direct current (DC) from photovoltaic or fuell cel power sources for use in application where DC is more appopiate than AC.

		Energy Load Management Provide an energy management and control systems that collects and displays data in graphical form and can automatically operate HVAC equipment; Use only those control systems that allow the desired temperatures to be adjusted without complete reprogramming.
Links	Verification and Enforcement	RECOMMENDATION
http://www.energymanagement.com/ http://www.energylens.com/articles/energy-management	Enforcing Proceedings and Procedures	Develop a verification program, working with jurisdiction staff and local building professionals. Ensure verification standards and procedures are reasonable and enforceable. Power: •Peak load reductions Lighting: • Power allowance • Occupancy sensor controls • Occupancy sensor controls with multi-level switching or dimming • Automatic controls for egress and security • Automatic controls for lighting in daylight zones • "Manual on" occupancy sensors • Controls for outdoor lighting

Table 4.6. Energy Management Best Practices

The Human comfort expresses how the body interacts with the indoor environment. During housing design, understanding the basics of human comfort combined with strategies to achieve it with a high-energy performance will create quality spaces and better levels of user satisfaction.[381]

Energy conservation is directly relationed with the designing approach and the path follow to achieve energy conservation. Those paths can be described according with resource efficiency[382]

[381]ISO 7730 Cited in UNEP, 2011a, p. 12
[382]Building Design and Construction: Forging Resource Efficiency and Sustainable Development (http://www.unep.org/sbci/pdfs/UNEP_SBCI_PositionPaperJune2012.pdf)

Passive:**55-60 per cent**-The reduction in energy consumption in office buildings in the UK after introducing natural ventilation (Through passive design, buildings employ design strategies that take advantage of the characteristics of the building site, insolation, microclimate, and other factors to meet lighting, heating and cooling needs UNEP, 2011).

Active:**64 per cent**-The reduction in energy use in new commercial buildings in the U.S. by employing energy-efficient lighting, heating, ventilation, air conditioning and shading, includes active systems, for instance technologies that reduce the impacts of energy production or consumption, such as photovoltaic or thermal solar panels or energy efficient appliances, to achieve greater overall operational efficiency (UNEP, 2011).

A passive house is a building in which a comfortable interior climate can be maintained without active heating and cooling systems. Passive design is considered as a solution involving the design of properly oriented, shaped, ventilated and shaded buildings suited to the bioclimatic features of the site.

Bioclimatic architecture seeks to promote a greater thermal performance of buildings through design strategies that take in consideration building materials, form and thermal mass, and solar exposure to optimize the external climatic conditions.

Thermal comfort means that the person does not feel too cool or too hot. The feeling of comfort is affected by six variables organized into two categories (thermal environment and personal factors):(1) air temperature, (2) relative humidity (RH) of air, (3) air velocity, (4) mean radiant temperature(MRT) or simply denoted as inside surface temperature, (5) clothing insulation and (6) physical activity.

Recommendations for passive design.[383]

Envelope
Optimize the thermal envelope before relying on building space conditioning systems
Specify high-performance windows (U-value, spectral solar properties);
Specify high wall and ceiling insulation and light roof colour
Use building mass to moderate temperature swings;
Use brick-cavity walls or pressurized curtain walls in preference to solid masonry;
Implement procedures to ensure very low envelope air leakage

[383] A Handbook on Low-Energy Buildings and Distric-Energy Systems, L.D. Danney Harvey, EARTSCAN (2006)

4.4.3. Water and waste Water

Element: **Water Efficiency**	Addressing the water issue by designing buildings to be as water conservative as possible is becoming imperative for both residential and commercial construction, as is defining water conservation practices. Jurisdictions have several options for including water efficiency in their beyond code programs.	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
Single Flush Toilets ASME A112.19.2. Dual Flush Toilets ASME A112.19.2 and ASME A112.19.14. lavatory faucets ASME A112.18.1/CSA B125.1	Mandatory low flow appliances and fixtures Efficient toilets • Efficient faucets • Efficient showerheads • Efficient irrigation design Graywater re-use • Rainwater harvesting • Reclaimed water re-use • Installed landscape • Installed irrigation • Additional water certification requirements	Submeters for buildings over 50,000 ft2 • Efficient toilets • Efficient urinals • Submeters for irrigation • Efficient irrigation design Water efficient landscaping • Rainwater channeling • Building water use reduction
Links	Verification and Enforcement	Recommendation
http://www.waterconservationtrust.ca/ http://www.awwa.org/	International Plumbing Code Uniform Plumbing Codes 2006	• Indoor water use reduction through use of high efficiency plumbing fixtures, fittings, and appliances • Increased water efficiency of equipment such as HVAC, commercial kitchen, and medical/laboratory equipment • Outdoor water use reduction through water efficient landscaping and high efficiency irrigation systems • Alternative water sources such as rainwater harvesting • Water metering and automatic controls

		Interior water use: equipment water efficiency requirements in EPA Water Sense New Single Family Homes Specification, ASHRAE 189.1, IGCC, or GPMCS • Exterior water use: 50% reduction in potable water consumption for landscaping; limited turf area, efficient irrigation design, and advanced controls

Table 4.7. Water and Waste Water Management Best Practices

4.4.4. Materials

There are several practices enabling the optimization of construction materials, including selective demolition and waste recycling, which are certainly the most efficient, since they promote the extension of the materials life cycle, reducing the dependence of pure raw materials in the industry.

4.4.5. Waste Management and Minimisation Best Practice

Element: Managing Construction Waste	Optimizing the volume of materials required is key for construction; this includes coordinating efforts to ensure excess materials are not purchased when they are not needed. Re-using materials from other on-site projects, whether excess or from deconstruction activities, will limit the amount of materials purchased.	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
Common C&D materials include lumber, drywall, metals, masonry (brick, concrete, etc.), carpet, plastic, pipe, rocks, dirt, paper, cardboard, or green waste related to land development. Of these, metals are the most commonly recycled material while lumber makes up the majority of debris that still goes to a landfill. • Excerpts from Best Practices in Waste Reduction Video • Reuse and Recycling	Choose materials with the lowest possible embodied energy that will accomplish the task; Specify locally manufactured materials and products to minimize transportation energy use; Use salvaged materials whenever possible	Source reduction • Design/purchase products or packaging to reduce the quantity of the materials used • Choose products that are designed for re-use • Design for longer product life so fewer products need to be • produced and therefore fewer products need to be disposed • Purchase only what is needed, do not overstock

• Tools for architects, builders, local governments, and C&D processors		• Choose products made from readily recyclable materials to ensure that diversion is possible once the life of the product is complete • Recycling To support operation, each facility should have an easily accessible, dedicated area or areas for the entire building's collection and storage of materials for recycling. • Re-use/re-purposing • Composting • Composting involves collecting organic waste, such as food scraps and yard trimmings, and storing it under conditions designed to help it break down naturally. This resulting compost can then be used as a natural fertilizer.
Links	Verification and Enforcement	Recommendation
Solid Waste Management on Tribal Lands Managing and Reducing Waste	*Canadian Environmental Protection Act, 1999* (CEPA 1999) *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (EIHWHRMR)* *Polychlorinated Biphenyls (PCB) Waste Export Regulations* *Interprovincial Movement of Hazardous Waste Regulations*	Meet at least four of the following five requirements and publicize their availability and benefits:[384] Include as part of the project at least one: recycling or reuse station, drop-off point compost station On every mixed-use or nonresidential block or at

[384] http://www.usgbc.org/credits/mr21

	Interprovincial Movement of Hazardous Waste Regulations	least every 800 feet (245 meters) Recycle and/or salvage at least 50% of nonhazardous construction and demolition debris. Develop and implement a construction waste management plan

Table 4.8 Materials Best Practices

4.4.6. Construction debris

Element: Deconstruction and Demolition	When removing old structures, deconstruction techniques allow re-use and recycling of materials rather than demolishing the structure, which can often destroy potential resources. Much of the waste generated during construction can be recycled or re-used, and can reduce costs for transporting waste and reduce strains on landfills. Re-use of materials can include renovating an existing building rather than building an entirely new structure.	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
	Recycled Content. For EPA-designated products, use products meeting or exceeding EPA's recycled content recommendations. Biobased Content. For USDA-designated products, use products meeting or exceeding USDA's biobased content recommendations.	Reduce Environmental Impact of Materials Construction Waste. During a project's planning stage, identify local recycling and salvage operations that could process site related waste. Program the design to recycle or salvage at least 50 percent construction, demolition and land clearing waste, excluding soil, where markets or onsite recycling opportunities exist.

Links	Verification and Enforcement	Recommendation
Chapter 8: Deconstruction and Wood Waste http://www.wbdg.org/references/mou.php http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=FB8E9973-1 http://www.wbdg.org/resources/cwmgmt.php	Mexico City´s environmental standard for setting forth specifications for classification and handling **NADF-007-RNAT-2004**	Some materials are generally unique to the C&D waste stream. The following list includes a sample of those. • Carpet • Wood • Aggregate • Paint • Shingles • Wallboard

Table 4.9 Construction Debris Control Best Practices

4.4.7. Waste divertion

Element: **Materials Conservation and Waste Avoidance**	Waste reduction strategies such as reuse and recycling, as promoted in green buildings, divert some waste from being disposed of in landfills. Diversion strategies save money on disposal costs and reduce societal costs of landfill creation and maintenance. In addition to diverting waste from landfills, recycling and reuse can catalyze further economic growth in industries that reprocess diverted waste and use recycled raw materials. Landfill diversion rates are typically at least 50- 75% in green buildings *(SWEEP 2008)*	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
C&D Waste Management performance Indicator Selection [385] • Defining the system • Indicator selection • Data collection	*Getting to 50% and Beyond:* Waste Diversion Success Stories from Canadian Municipalities	• Provide adequate space inside each tenancy or retail unit for temporary storage • Provide suitable containers to tenants to allow them to store separated garbage and recycling within tenancies • Display signs in back-of-house areas that clearly identify garbage and recycling bins and storage areas • Provide signs, in community languages if

[385]https://www.researchgate.net/publication/257478981_An_overview_of_construction_and_demolition_waste_management_in_Canada_A_lifecycle_analysis_approach_to_sustainability

		necessary, with instructions on how to use the garbage and recycling • facilities, including identifying what is and what is not recyclable
Links	Verification and Enforcement	RECOMMENDATION
"Discarding The Idea of Waste: The need for a zero waste policy Now", Zero Waste Services, Nelson, Canada. **BACKGROUND INFORMATION ON RESIDENTIAL CURBSIDE RECYCLING** **Waste management plan SEDEMA** Solid Waste Management SEDEMA	Supply bins and signage using colour coding according to *AS4123.7-2006 Mobile Waste Containers – Part 7: colours, markings and designation requirements*	Designing with less material • Deconstruction and demolition • Material selection • Managing construction waste • Facilitating and encouraging occupant recycling

Table 4.10 Waste Management Best Practices

4.5. Purchasing

Element: Sustainable procurement. Green procurement is the purchase of environmentally friendly products and services, the selection of contractors and the setting of environmental requirements in a contract.	Environmentally preferable goods and services are those that have a lesser or reduced impact on the environment over the life cycle of the good or service, when compared with competing goods or services serving the same purpose. Environmental performance considerations include, among other things: the reduction of greenhouse gas emissions and air contaminants; improved energy and water efficiency; reduced waste and support reuse and recycling; the use of renewable resources; reduced hazardous waste; and reduced toxic and hazardous substances.[386]	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
	Get top level support • Assess your internal resources	Unsustainable Products • Hazardous ingredients

[386] http://www.tpsgc-pwgsc.gc.ca/ecologisation-greening/achats-procurement/politique-policy-eng.html

	• Assemble a "Green Team" • Create a process for working together • Adopt EPP policy with goals and reporting requirements • Establish communication and outreach • strategies	• Poor energy, fuel or water efficiency • Wasteful (rapidly disposable, little or no recycled content, difficult to recycle) • Unsustainable production, use, transportation, and disposal impacts ENERGY STAR-rated LED Lamps • Energy-efficient (75% more efficient than incandescents) • Long life (15X longer than incandescents; >25,000 hours rated life) • Mercury-free (unlike CFLs)
Links	Verification and Enforcement	RECOMMENDATION
Business and Sustainable Development: A Global Guide - Green Procurement Business and Sustainable Development - Ikea Case Study Buy Green ICLEI - Green Purchasing Good Practice Guide Fujitsu Green Procurement Tour Operators Initiative for Sustainable Tourism Development - Case Studies OECD - Greener Public Purchasing. Issues and Practical Solutions	*Qualified list: www.energystar.gov*	save money by significantly reducing utility bills and operating costs Achieve social goals such as employment generation and improved working conditions along supply chains Improve your public image Contribute to tackling climate change Use procurement to meet the environmental objectives of your organisation Support the implementation of sustainability policies and procurement law[387] Identify Green focus areas then implement key strategies and practices Implement a Lean/Six Sigma program and ISO 14000 to compliment GreenCost Led Procurement

[387] http://www.sustainable-procurement.org/fileadmin/files/Other_publications/ICLEI-SP-Services-leaflet-2014-FINAL-WWW.pdf

		Applying the Cost Led Procurement[388] process, a client can use their knowledge of costs to set a challenging cost ceiling and output specification against which the supply chain can bring experience and innovation to bear in a competitive framework environment.

Table 4.11 Purchasing Best Practices

4.6. Indoor quality

Element:Indoor Environmental Quality	The tenants must also have a safe and comfortable indoor environment. Indoor environmental quality, or IEQ, refers to both the air quality inside the building and the physical comfort of the tenants while in the building.	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
ASHRAE 62.1 provides ventilation rates for commercial buildings based on occupancy and use of the building. The purpose this standard is to "specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize the potential for adverse health effects."	• Indoor air quality including elements of ventilation rates, filtration, outdoor air delivery, and tobacco smoke controls • Thermal comfort of occupants, regulating both temperature and humidity • Specifying less harmful materials, minimizing the harmful chemicals and potentially irritating emissions • Acoustical control from both external and internal sources • Daylighting to provide additional controlled lighting of areas • Isolation of the building from pollutants in the soil	Indoor air quality: • Minimum ventilation rates • Outdoor air delivery monitoring • Filtration and air cleaner requirements • Environmental tobacco smoke • Building entrances Thermal environmental conditions for human occupancy Acoustical sound: • Exterior sound • Interior sound • Outdoor-indoor transmission class and sound transmission class Daylighting by toplighting: • Minimum daylight zone by toplighting • Skylight characteristics Daylighting by sidelighting: • Minimum effective aperture • Office space shading

[388]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/325012/Cost_Led_Procurement_Guidance.pdf

		Daylighting simulation Isolation of the building from pollutants in soil Lighting Maximize the use and penetration of natural light, via light shelves, fibre-optic light pipes, and low partitions in offices next to windows; Use light sensors in conjunction with dimmable lights in order to capture the benefits daylighting Use occupancy sensors to turns lights off when a room is occupied; Use interior colours and finishes that minimize the need of artificial light; Provide lumen maintenance controls so that excess output is not needed when lighting system is first installed in order to compensate for degradation in light output that otherwise occurs over time.
Links	Verification and Enforcement	RECOMMENDATION
		Materials: • Adhesives and sealants • Paints and coatings • Floor covering materials • Composite wood, wood structural panel and agrifiber products • Office furniture systems and seating • Ceiling and wall systems
		Establish a program that promotes healthy indoor air quality. For customized programs, require the EPA Indoor airPLUS program or ASHRAE 62.1.

Table 4.12 Indoor Air Quality Best Practices

4.7. Community outreach & Environmental literacy/training workshops

Element:Operation, Maintenance, and Owner Education		
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
International Code Council, ICC 700-2008 *National Green Building Standard*	• Operation and maintenance plan • Building owner's manual for one- and two-family dwellings • Construction, operation, and maintenance manuals and training for multi-unit buildings	
Links	Verification and Enforcement	RECOMMENDATION
		Include a requirement for an owner's manual in both residential and commercial programs. The builder provides this to the owners when they take possession. This should be a mandatory element, not an optional point.

Table 4.13 Community Outreach Best Practices

4.8. Transport

Element: Green and Inclusive Transport	Transport plays a central role for societies that seek to ensure economically and environmentally sustainable prosperity, and that strive to share benefits more equitably among all citizens.	
Standard of Measurement and Target Level of Efficiency	Residential Best Practices	Commercial Best Practices
	7 Best Practices in Transportation Demand Management Transportation Demand Management (TDM) Parking Management Programs that Promote Transit Use and Carpooling	Provide fuel saving tips to drivers of fleet vehicles. Use Global Positioning Systems (GPS) and integrated software to control fleet vehicles, reduce misuse and increase efficiency through trip planning and location information.

	Land Use Management and Urban Design Employer-Based TDM Strategies Congestion Pricing	Replace buses with smaller, more fuel efficient, buses for light-traveled transit routes. Evaluate natural gas fueling infrastructure and sharing of facilities with other public agencies to help pay for installation and ongoing costs. Establish a crew-based maintenance plan (such as with parks employees) instead of individual assignments, to create a "carpool effect" that lowers the annual miles traveled for maintenance staff. Utilize technology options (such as digital service requests accessible by mobile devices) for field personnel to avoid extra trips back to the office.
Links	Verification and Enforcement	RECOMMENDATION
[Transit Sustainability Guidelines](#) [Toronto Green Standard & Transportation Planning](#)		The impact of self-driving shared fleets is significant but is sensitive to policy choices and deployment scenarios Actively managing freed capacity and space is still necessary to lock-in benefits Road safety will likely improve Environmental benefits will depend on vehicle technology New car models and business models will be required Public transport, taxi operations and urban transport governance will have to adapt Mixing shared self-driving fleets with traditional cars will not deliver the same benefits as full fleet deployment, but remains attractive [389]

Table 4.14 Transport Best Practices

[389] http://internationaltransportforum.org/cpb/projects/urban-mobility.html

4.9. Carbon Emissions and benefits

GHG Emissions and Green Building benefits[390]

Environmental impacts

Overall, average annual temperatures are expected to increase. Snow, sea ice and glacier coverage will decrease because of higher temperatures, resulting in rising sea levels and increased coastal flooding. Rising temperatures will also thaw permafrost in the Arctic.

Overall precipitation levels are expected to increase across most of the country and during all seasons, except for parts of southern Canada where there are indications of an expected decrease in summer and fall precipitation.

The increase in precipitation is expected to be combined with more frequent heavy precipitation events, resulting in higher risks of flooding.

Heat waves are likely to increase in frequency and severity, resulting in higher risks of forest fires. Many wildlife species will have difficulty adapting to a warmer climate and will likely be subject to greater stress from diseases and invasive species.

Human health impacts

Higher temperatures and more frequent and severe extreme weather events may increase the risk of deaths from dehydration and heat stroke, and of injuries from intense local weather changes. There may be a greater risk of respiratory and cardiovascular problems and certain types of cancers, as temperatures rise and exacerbate air pollution. The risk of water-, food-, vector- and rodent-borne diseases may increase.

People living in Canada's northern communities, and vulnerable populations such as children and the elderly, are expected to be the most affected by the changes.

Economic impacts

Agriculture, forestry, tourism and recreation may be affected by changing weather patterns.

Human health impacts are expected to place additional economic stress on health and social support systems.

Damage to infrastructure (e.g., roads and bridges) caused by extreme weather events, thawing permafrost and rising sea levels is expected to increase, impacting local populations and resource development.

[390] http://www.buildingecology.com/articles/calculating-greenhouse-gas-emissions-from-buildings/

4.10. CO2 emissions calculator

CO2 emissions calculator[391]
Calculating Greenhouse gas emissions from buildings
Most calculations in the U.S. and throughout the world are based on an average annual value for the grid region, sub-region, or nation as a whole. Looking at the annual reporting under the UNFCC, there is a huge range of values used for conversion of electric consumption to GHG emissions, and some of the values are clearly highly inaccurate. Even where reasonably accurate annual average values are used, they do not reflect the variations in building operation in response to weather and over the course of the day, week, and year.

Furthermore, the electric grid itself has large temporal variations by hour, day of the week, and season. Different plants are on-line as "baseload" and are always on and others come on as needed. In some locations, the baseload generation is relatively "clean" (hydro and nuclear), and the peak load is relatively dirty (coal). In other locations it is exactly the opposite. Wind, solar, geothermal, and gas also play their roles to varying degrees.

The largest uncertainties in estimating GHG emissions from buildings come from the differences between design assumptions and actual building use and energy use intensity/performance. These could easily be on the order of a factor of 2 if they differ too much. For existing buildings, making retrofit or operational decisions, those uncertainties are far smaller and then the accuracy of the calculation of GHG emissions from electricity production probably contains the next highest source of uncertainty, although I have no data to support that assertion.

4.10.1. Canada´s case

Drivers and Impacts of Greenhouse Gas Emissions[392]
Most greenhouse gases (GHGs) have both natural and human sources. According to the Intergovernmental Panel on Climate Change (IPCC), human-caused GHG emissions disrupt the natural processes occurring in the atmosphere and are extremely likely to be the dominant cause of the observed warming that has occurred since the mid-20th century. Globally, almost 80% of GHG emissions from human sources come from the burning of fossil fuels and industrial processes. Specific activities include the following: driving vehicles, electricity production, heating and cooling of buildings, operation of appliances and equipment, production and transportation of goods, and provision of services and transportation for communities. In 2013, about 25% of Canada's total GHG emissions came from the oil and gas sector, 23% from transportation, 12% from electricity generation and 12% from buildings.

GHG emission impacts:
Comparing the GHG emissions from the buildings sector under the three scenarios - 'Deep Green,' AIA/RAIC 2030 Challenge, and BAU – in relation to the 1990 levels referenced by the Kyoto Protocol, a significant demand for onsite renewables and clean power procurement is revealed:

[391] http://www.wbdg.org/resources/greenhousegasemissions.php
[392] https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=1357A041-1

Even in 2030, Canada's residential sector will need to offset about 12 MT of carbon emissions via onsite renewable energy or via buying clean power to achieve the 2030 Challenge goals, but nevertheless are well below 1990 levels.

In 2010, Canada's commercial sector will need to offset about 11 MT of carbon emissions via onsite renewable energy or via buying clean power - just to achieve levels immediately below those in 1990. However, by 2030, CO_{2eq} emissions in both the Deep Green scenario and the 2030 Challenge have dropped to 1990 levels. So there is still a long way to go to achieve levels *under* 1990's.

4.10.2. Mexico´s Case

In addition, Mexico plans to revamp how it handles forests, which store carbon, proposing a replanting program and a reduction in logging, hoping to bring its overall rate of deforestation to zero by 2030.Doug Boucher, a forestry expert with the Union of Concerned Scientists, calls Mexico's aggressive plans "striking." [393][394]

4.11. Green Building benefits

Examples retrieved from: **State Agency Greenhouse Gas Reduction Report Card (http://www.climatechange.ca.gov/climate_action_team/reports/2015_CalEPA_Report_Card.pdf)**

*The Building Energy Efficiency Standards are designed to increase the efficiency of all newly constructed residential and nonresidential buildings and additions and alterations to existing buildings in California. The strategy is to develop, implement, and enforce standards that require and result in reductions in energy and water use in buildings. Estimates use a CO2 emissions factor for each MWh of electricity avoided of 0.267 MTCO2e.2 Estimates use a CO2 emissions factor for each MMBtu of natural gas combustion avoided of 0.00529 MTCO2. Using the CED 2013 final forecast and 2007 as a base year, cumulative electricity savings for 2008 through 2012 was 2,315 GWh. Electricity savings in 2013 was estimated to be 466 GWh. Natural gas savings was estimated to decline in 2013, but cumulative natural gas savings from building standards between 2008 and 2013 was estimated to be 77 million therms. (***Emission Reductions, MMTCO2e 2012= 1.2, 2013=1.3)** *Green Buildings – Existing State Buildings Retro-Commissioning This measure reduces GHG emissions associated with the optimization of energy systems and improvement of environmental performance in existing buildings. No Retro-commissioning projects have taken place since 2011 due to budget constraints, however, DGS is now moving forward with developing a monitoring-based commissioning (MBCx) program. The first MBCx project is scheduled to be installed in 2015.*

[393] http://www.igreenbuild.com/_coreModules/content/contentDisplay_print.aspx?contentID=3123
[394] http://news.nationalgeographic.com/2015/11/151118-ten-countries-pledges-paris-climate-talks-warming-carbon/

4.12. Cost benefit evaluation[395]

According to Hongmei Liu, Green building is emphasized in the whole life cycle of building. It includes building materials production, planning, design, construction, operation and maintenance and removal, recycling scrap the whole process, all links can be efficient use of building resources, land saving, energy saving and water saving (O. Tatari and M. Kucukvar, 2011).The author also states that when Green building achieves the relevant performance requirements, it will increase investment of initial construction, but from the perspective of whole life cycle, the future operation and maintenance costs will be reduced. (Liu, 2015) The author in accordance with other authors mentioned that green building need to use green materials and green technology, etc. so that the initial cost will increase 5%-10%, but will save the long-term running costs for 50%-60% (F. Li and T. Yan, 2014)

In the Study of different EMS with SWOT, energy and cost benefit analysis and star rating system for integrated EMS with gap analysis for sustainable development in construction sector developed by Prof. Mrs.Gayatri Rajendra Vaishampayan different EMS such as LEED India (IGBC), Ec ohousing assessment criteria (IIEC and SciTech park and PMC) TERRI/GRIHA, EMS ISO 14001; were compared under SWOT analysis and present Table 4.16 . I use the same information to remark differences between Mexico and Canada, underlining , and bold type respectively. As showed in the table the Green Building Industry in Mexico is in a difficult position, not only for the lack of resources (Human, Materials, Policies) but also for the lack of engagement of society.

Strengths	Weaknesses	Opportunities	Threats
1. Durability 2. Increased aesthetic view 3. Pollution Control 4. Waste control 5.Energy savings 6. Economy **7.Good for health**	1. More documentation 2. More difficult to understand and implement, record ,control 3. More Cost of certification 4. Legal requirements are more **5. Complex nature due to special characteristics**	1. **Pollution Control, waste Management** 2. Environmental economical Designing, supervision **3. Energy auditing** 4. Weather forecasting, reporting 5. Conducting environmental awareness programs **6. EIA testing environmental lab checking** 8.Landscaping 9.Eco advertising tourism, Eco labeling, eco product supply	1. Lack of government support, 2. Corruption 3. Lack of worker support 4. Lack of eco friendly materials and techniques 5.**Increase in cost** 6. Legal problems 7.Maintenance problems 8. More time 9. No synchrozation, more complex 10.**Messy constructions if EMS not maintained and implemented properly**

395Evaluating Construction Cost of Green Building Based on Life-cycle Cost Analysis: An empirical analysis from Nanjing, China, Hongmei Liu , International Journal of Smart Home Vol. 9, No. 12, (2015), pp. 299-306

		10. Developing environmentally friendly technologies **materials and other products**.	**11.Lack of spciety environmental consciousness**

Table 4 15 SWOT ANALYSIS OF EMS Comparison between Mexico and Canada

The benefits to green building are manifold, and may be categorized along three fronts: **environmental**, **economic**, and **social**.[396](See table 4.16)

Environmental Benefits	Economic Benefits	Social Benefits
Emissions Reduction. **Water Conservation.** **Stormwater Management.** **Temperature Moderation.** **Waste Reduction.**	**Energy and Water Savings**. **Increased Property Values**. **Decreased Infrastructure Strain.** **Improved Employee Attendance**. **Increased Employee Productivity.** **Sales Improvements.** **Development of Local Talent Pool.**	**Improved Health.** **Improved Schools.** **Healthier Lifestyles and Recreation.**

Table 4 16 Environmental, Economic, and social benefits of green construction

Types of Economic Analysis Methods

There are three types of economic methods commonly applied to assessing transportation infrastructure investments. They are designed to answer a range of questions: [397]

Benefit-Cost Analysis (BCA) – What is the value of benefits compared to costs?
Economic Impact Analysis (EIA) – What is the effect on the economy?
Financial Impact Analysis (FIA) – What are the implications of expenditures on tax, revenue and other financial measures?

[396] http://bloomington.in.gov/green-building-benefits
[397]

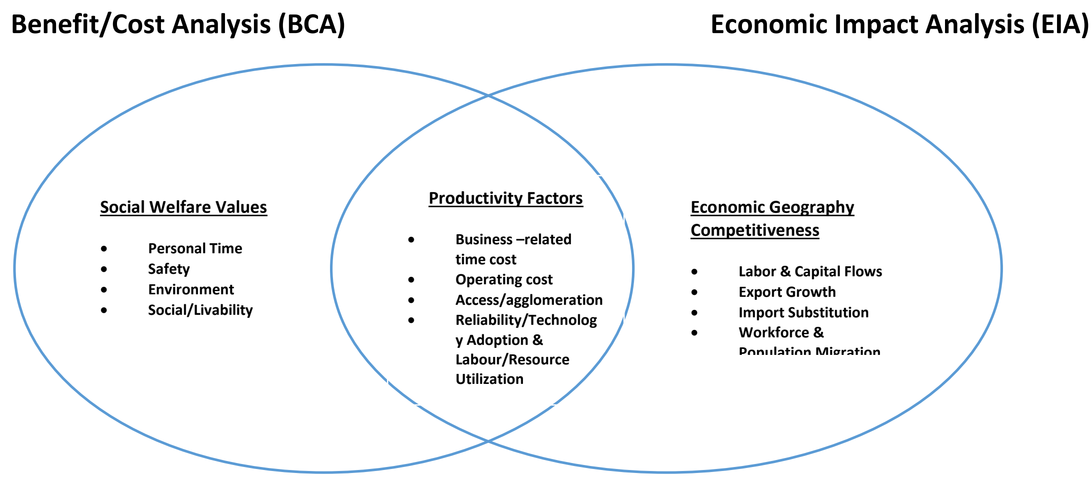


Figure 4.4 Factors considered in economic analysis methods

The Economic Analysis Process[398][399]

The evaluation is based on a comparison of discounted costs and benefits over a fixed time period of time. Alternatives can be summarized in terms of the ratio of total benefits to total cost (benefit-cost ratio) or equivalently, the total net benefits (net present value).(Showed in figure 4.4)

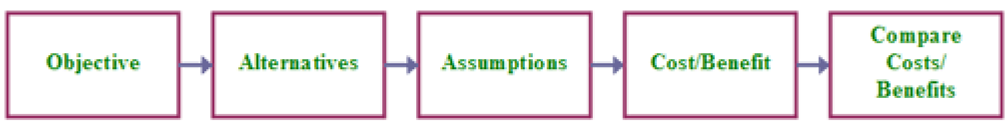


Figure 4.5. The steps to estimate the economic consequences of a decision
(Ruegg, R.T., and H.E. Marshall , 1990)**.**

The process proposed in figure 4.5 is described below.

- Define the problem and the objective.
- Identify feasible alternatives for accomplishing the objective, taking into account any constraints.
- Determine whether an economic analysis is necessary, and if so, the level of effort which is warranted.
- Select a method or methods of economic analysis.
- Select a technique that accounts for uncertainty and/or risk if the data to be used with the economic method are uncertain.

398http://www.wbdg.org/design/use_analysis.php
399http://www.wbdg.org/design/utilize_management.php

- Compile data and make assumptions called for by the economic analysis method(s) and risk analysis technique.
- Compute a measure of economic performance.
- Compare the economic consequences of alternatives and make a decision, taking into account any non-quantified effects and the risk attitude of the decision maker.
- The process described above is cost-benefit analysis, and is appropriate where both the costs and benefits can differ among alternatives. When the benefits are equivalent, the evaluation of alternatives is simplified to a cost comparison, or cost- effectiveness analysis
- Building Sustainability Assessment (BSA) methods can be oriented to different scales of analysis: building material, building product, construction element, independent zone, building and the neighborhood. By analyzing the scopes of the most important sustainability support and assessment systems and tools, it is possible to distinguish three types of assessment methods:

Systems to manage building performance (Performance Based Design);
Life-cycle assessment (LCA) systems;
Sustainable building rating and certification systems.

Life-Cycle Cost Analysis (LCCA) Method[400][401]

"In the past, the green building movement has taken a prescriptive approach to choosing building materials. This approach assumes that certain prescribed practices such as the use of local materials or products with recycled content are better for the environment regardless of the product's manufacturing process or disposal. Fortunately, it is being replaced by the scientific evaluation of actual impacts through life cycle assessment (LCA)." [402]

LCA comprehensively quantifies and interprets the energy and material flows to and from the environment. It´s important to assume that all building materials have some environmental impact. Greater use of LCA will allow building designers to specify a combination of materials that balances the desire to minimize environmental impacts with the need to meet functionality and cost requirements. The complete Building Sustainability Assessment (BSA) comprises the ways in which built structures and facilities are procured and erected, used and operated, maintained and repaired, modernized and rehabilitated, and finally dismantled and demolished, or reused and recycled. [403]

"Demand for sustainable construction is influenced by buyer perception of the first costs versus the life cycle costs of sustainable alternatives" [404]

The Commissioning Process is defined as:

400 http://www.c2es.org/technology/overview/buildings
401 http://www.awc.org/greenbuilding/factsheets
402 http://www.awc.org/greenbuilding/factsheets
403 ISO 14040:2006 and ISO 14044:2006
404 Kibert, C.J. Forward: Sustainable construction at the start of the 21st century. *IeJC* **2003**, *Special Issue: The Future of Sustainable Construction*, 1–7.

"A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements."[405]

4.13. Compliance, final evaluation and outcomes

Compliance, Final evaluation and outcomes[406]

Final Certificate of Compliance
The Project Manager (**PM)** must submit a Certificate of Compliance signed by the Control Quality Assessment Manager (**CQAM)**and the PM indicating that all materials incorporated in the project conform to the contract requirements.

The Sustainable Objectives, as defined in the Sustainable Plan (Annexe 2), provide the necessary supervision, quality control and quality assurance processes (inspection and testing) of all items of work, including that of all subcontractors and suppliers, which will ensure compliance with the specified requirements.

CQAM provides Certification of Compliance (**COC**). The COC will include:

- Entering Final Materials Quantities.
- Inclusion of Quantities added during construction.
- Breakout and inclusion of Quantities not listed separately in the original Schedule.
- Verification that minimum testing frequencies have been accomplished.
- Explanation of Exceptions for Material Specification Deviations.
- Documentation of Exceptions for comparison differences between QA (QA) Test results and Owner Verification Test (**OVT**) and Independent Assurance Test (**IAT**) results.
- Documentation of Exceptions for an insufficient number of tests.
- Documentation of Exceptions for a lack of tests for items included in extra work.

4.13.1. Reporting

The Quality Objectives will maintain and post digital records showing that all required activities and/or tests have been performed, including the following:

---

[405] ASHRAE Standard 202-2013

[406] **DESIGN-BUILD QUALITY MANAGEMENT PLAN OUTLINE Retrieved from: http://r.search.yahoo.com/_ylt=AwrBTvxBLvpWc2QAfPnD8Qt.;_ylu=X3oDMTEybGI2NjAxBGNvbG8DYmYxBHBvcwMxBHZ0aWQDQjAzMThfMQRzZWMDc3I-/RV=2/RE=1459265218/RO=10/RU=http%3a%2f%2fwww.wsdot.wa.gov%2fNR%2frdonlyres%2f27A54B86-9825-4E81-9DEE-138823B4ED86%2f56842%2fQMPOutline0504091.pdf/RK=0/RS=UW_dtwotB2zx0joTntVTTcpCHCY-, https://mx.search.yahoo.com/search?p=DESIGN-BUILD+QUALITY+MANAGEMENT+PLAN+OUTLINE&fr=yfp-t-726**

- Type, number, and results of all current quality management activities, including reviews, inspections, materials analysis, tests, audits, and monitoring of work performance
- Closely related data, such as the qualifications of personnel and the procedures and equipment used
- Identity of the inspector or data recorder, the type of test or observation used, the results and acceptability of the work
- Minutes of all QC meetings
- The nature of any non-conforming work, causes for rejection of work, etc by maintaining a non conformance report log.
- Proposed corrective actions(s) for any non-conforming work, corrective action(s) taken, and results of corrective action(s)

Non-Conformance Reports for the Quality Process

Should the auditor find areas of non-conformance within any of the quality process areas, a non-conformance report (**NCR**) will be written and processed. The non-conformance will be described and documented by the auditor. The **CQAM** and CM for construction non-conformances, or DQAM and DM for design non-conformances, will review and sign off on the NCR. All NCR's will be processed through the CQAM since the CQAM will be responsible for maintaining an NCR log. If trends (four occurrences or less) continue in non-conformance, the CM, DM, CQAM, or DQAM will develop a plan and/or process changes to eliminate the non-conformance in the future, a schedule for implementation, required training, and a follow-up review once the new procedure is in place.

4.13.2. As built

The design team prepares As-Built drawings for the project. As-Builts will be compiled towards the end of the project. Changes to the designs will be tracked via the Request for Information/Field Design Change/Notice of Design Change

Note 1: It´s important to ensure As-builts are accurate.. As-Built drawings will provide sufficient detail for to use the drawings for future activities along the operation and maintenance process.

Data Gathering

The Design-Builder will prepare field notes and sketches during construction of all project elements. These field notes will include enough survey data to locate the features within the project coordinate system.

Note 2: Field notes will be checked before incorporation into the As-Built drawings. A Checker will check the as-built information, with the field books, to confirm the accuracy of the As-Built drawings, following the procedures for checking design drawings. The responsible person will provide periodic audits of the As-Built drawings to evaluate compliance.

Note 3: Field records will be maintained for all plan changes and will be submitted to the Design-Builder for inclusion in the electronic files.

4.14. Procedure to achieve sustainability in a construction project

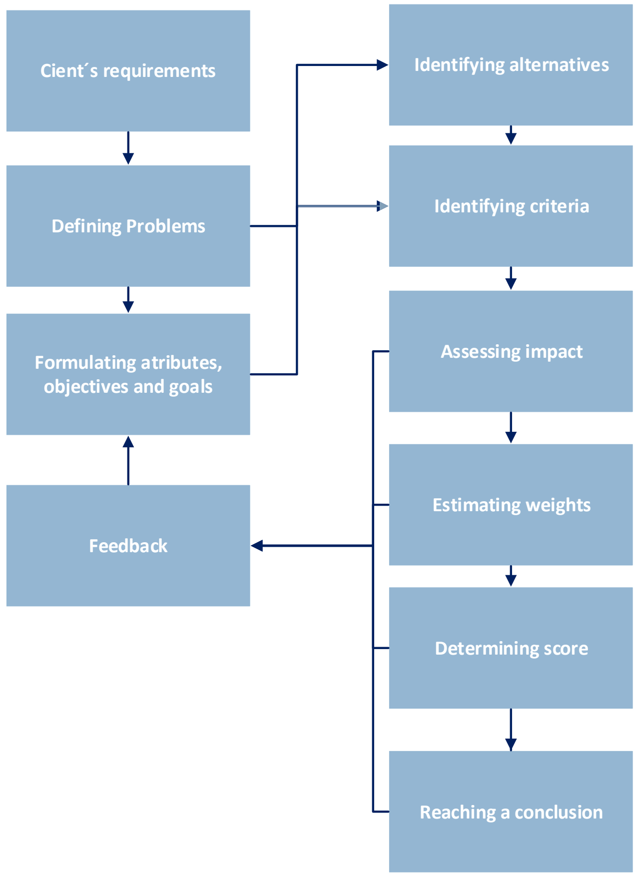
Procedure to achieve sustainability in a construction project

The main objective of this thesis is assist people interested to implement sustainability policies and the best feasible practices in construction projects (new construction, reconstruction, renovation, and alteration) in commercial and residential sectors. In this section, I intended to compile all the information of previous chapters by developing a Sustainability Standard Operating Plan (**SSOP**).

The SSOP provides guidance to project teams to stablish sustainability as a core value by determining indicators, parameters, and policies. This plan is composed by four elements

Sustainable Plan Lifecycle (Annexe 1)
Sustainable Procedure Lifecycle (Annexe 2)
Sustainable Plan Lifecycle´s Punch List (Annexe 3)
Glossary (Annexe 4)
(See Annexes 1, 2, 3, and 4)

The Methodology of the process starts by determining client´s requirements, and identifying potential issues regarding with technical regulations and local policies. In this step of the process, the SSOP allow us to find alternatives to solve problems. In order to implement the SSOP is necessary to formulate objectives and goals to mark criteria for decision process. At this level, we can setup indicators to approach to different standards such as ASHRAE or IGCC, and then we can assess every aspect of the construction project in the lifecycle the figure 4.1 demonstrates how the process works under a continuous improvement process. As mentioned several times in this thesis it is important to underline the participation of all stakeholders of the project and the community engagement represented in the process by the feedback in the figure 4.6.

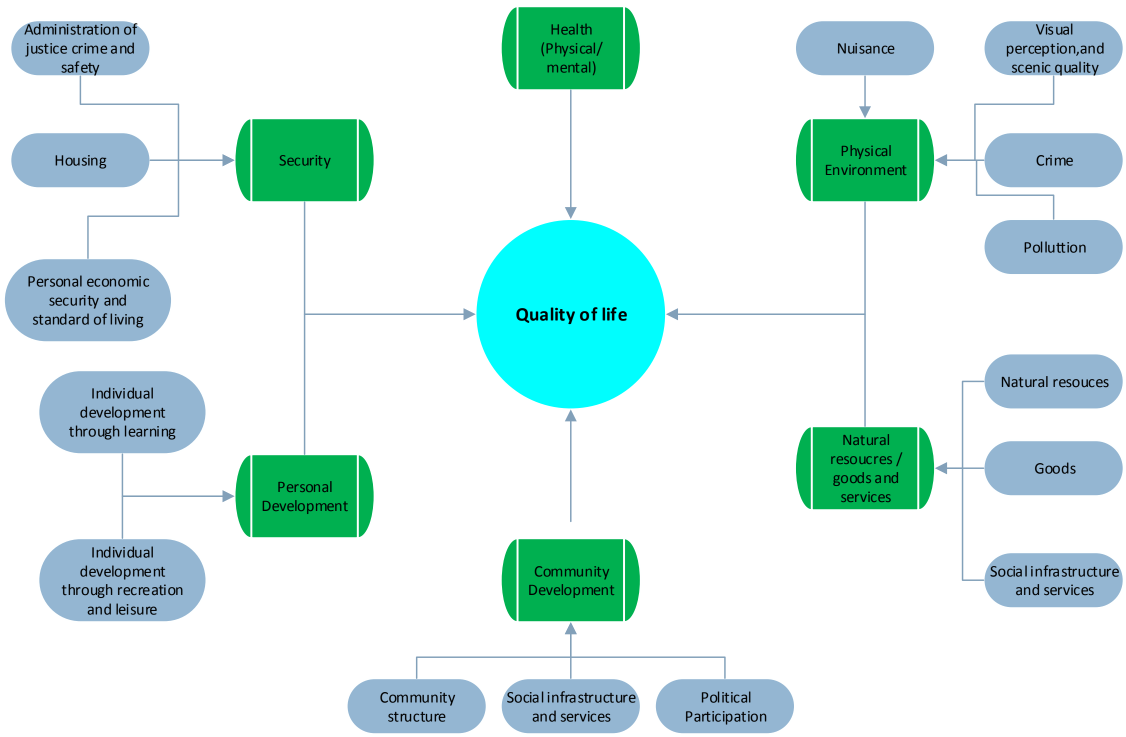


Figue 4.6 Modified from multiple dimensional decision model of project appraisal (Nijkamp et al, 1990)

Although, the SSOP is based on sustainability principles mentioned in this thesis it´s important to states that the procedure pursuits adaptability as one of the nine pillars mentioned in the section 3 of this chapter. For this reason, I suggest to employ the following scheme showed figure 4.7 , and adopt a holistic methodology to determine project´s goals and objectives. Achieving sustainability implies a total commitment from all team members, in order to involve the main elements coloured in green. These elements represent the first two levels of Maslow´s hierarchy pyramid mentioned in section three of this chapter. It depends on project´s complexity how many factors are involved in this process, and finally included.

This process is focused in “Quality of life”, not only in economic benefits, and revenues. For this reason, it will often be necessary to prioritise the factors coloured in blue in order to be effective. I consider that one of the advantage of this scheme is the way to incorporate external elements to the projects, although these aspects are not covered by client´s requirements, and local regulations.

Physical Well-being



Psychological Well-being

Figure 4.7 A classification of quality-of-life components

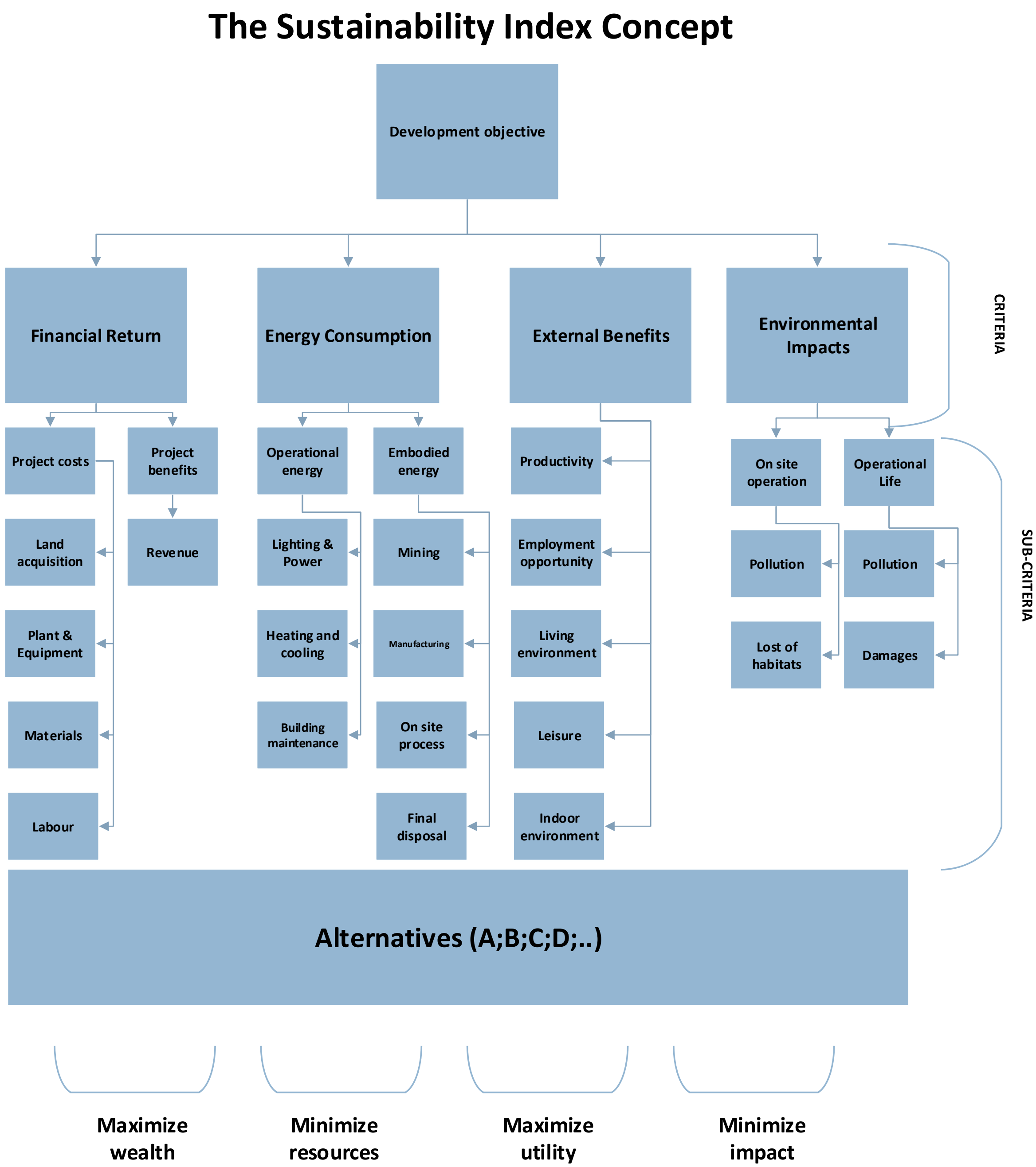


Figure 4 8 The Sustainability Index Concept Retrieved From: SUSTAINABLE CONSTRUCTION THE ROLE OF ENVIRONMENTAL ASSESSMENT TOOLS Grace K C Ding (2007)

I would like to quote the Close to Home report of Pembina Institute to demonstrate how every aspect of planning process impacts nature habitat, urban areas, and dynamics: ***"Close to Home: The benefits of compact, walkable, transit-friendly neighbourhoods highlights the benefits of density and illustrates how building complete communities can make life more affordable and enjoyable for its residents."***[407]

Based on the principle of multiple dimensional decision model (Ding, G.K.C. & Langston, C., 2002) developed a multi-dimensional model for the measurement of sustainability that has the advantage of relative simplicity and the inclusion of CBA calculation. The model determines a sustainability index, and can be used not only to compare options for a given problem but also to benchmark projects against each other. The model applies to both new design and refurbishment situations, and can be used to measure facility performance.

The sustainability index has four main criteria (see Figure 4.8)[408]

Maximize wealth. Profitability is considered part of the sustainability equation. The objective is to maximise investment return. Investment return is measured as benefit-cost ratio (BCR) and therefore includes all aspects of maintenance and durability.

Maximize utility. External benefits, including social benefit, are another clear imperative. Designers, constructors and users all want to maximize utility. Utility can relate to wider community goals. A weighted score can be used to measure utility.

Minimize resources. Resources include all inputs over the full life cycle, and can be expressed in terms of energy (embodied and operational). When viewed simplistically, resource usage needs to be minimized as much as possible. Energy usage can be measured as annualised Gj/m2.

Minimize impact. Loss of habitat encompasses all environmental and heritage issues. The aim is to minimize impact. Assessment scorecards are a useful method to quantify impact. Impact can be expressed as a risk probability factor

Although, the Sustainability Index Concept emphasises on energy consumption, financial return, environmental impacts, this methodology allow us to submit external benefits related the community. According with the author suggest to introduce environmental evaluation as earlier as possible before the appraisal stage. Otherwise, it will be possible not to achieve sustainability goals, creating economical impacts. Environmental assessment is most efficient during the identification and preparation stages of a proposed project.

The purpose of sustainability assessments is to gather and report information for decision-making during different phases of the construction, design, and use of a building. The sustainability scores or profiles, based on indicators, result from a process in which the relevant phenomena are identified, analyzed, and valued.[409] Some assessment tools such as BREEAM, BEPAC, LEED and HK-BEAM do not include financial aspects in the evaluation framework. For this reasons it is important that each design company develop their own methodology to assess projects and stablish as many

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[407] **Nithya Vijayakumar, Dianne Zimmerman Pembina Institute** March 2016 Retrieved from: http://www.pembina.org/media-release/building-complete-communities-benefits-everyone

[408] **SUSTAINABLE CONSTRUCTION THE ROLE OF ENVIRONMENTAL ASSESSMENT TOOLS** Grace K C Ding (2007)

[409] **Building Sustainability Assessment Luís Bragança, Ricardo Mateus (2010) retrieved from:** www.mdpi.com/journal/sustainability

procedures, plans, and policies as are necessary not only to meet client´s requirements but also, sustainability goals.

As mentioned in previous chapters, assessment tools evaluate indicators by using prescriptive and performance paths for different criteria. Another important factor that determines the performance of the procedure is how these criteria are weighting; it should change from project to project according with their characteristics. At this regard, the consultant expertise become very important, some certification systems award points for the participation of accredited professional such as LEED AP.

The sustainability assessment concept in Figure 4.10 (CEN/TC350 Sustainability of construction works). Showed different stages of the decision making process, the way that client´s and regulator's requirements interact in different levels starting with environmental, social, and economic requirements, followed by functional and technical criteria When all four criteria are combined, an indexing algorithm is created that can rank projects and facilities on their contribution to sustainability. The algorithm is termed the "sustainability index" similar to the. Methodology for the Relative Sustainability Assessment of Residential Buildings

One European system for the sustainability assessment of buildings covering:
- Assessment of Environmental Performance based on the Life Cycle Assessment (LCA) methodology
- Assessment of Economic Performance based on the Life Cycle Costing methodology
- Assessment of Social Performance based on the existing performance based standards on the building characteristics and on the "Check List Approach" used by different building assessment schemes

Development of CEN/TC350 standards (see figure 4.10) has taken into account the needs of the relevant EU policies related to the Construction Products and Sustainable Construction relying on the performance based approach & the level of works integrating:

Construction Products Regulation,
Eco-design, Public Procurement,
Resource Efficiency, Low Carbon Economy
Energy-label, Eco-label

The use of a sustainability index will greatly simplify the measurement of sustainable development, and thereby make a positive contribution to the identification of optimum design solutions and facility operation.

The sustainability index (SI) model can be expressed as follows:

$$SI_i = \sum_{j=1}^{J} e_{ji} W_j \quad (i=1, \ldots\ldots\ldots\ldots I) \quad (1)$$

$$e_{ji} = f\,\{ \text{BCR, EC, EB, EI} \} \quad (2)$$

The symbol SIi denotes the sustainability index for an alternative I; Wj represents the weight of criterion j; and eji indicates value of alternative i for criterion j. The result will indicate that higher values for eji and Wj imply a better score, and that alternative i will be judged as better than alternative i' if the score of SIi is greater than the score of SIi'. The BCR is benefit-cost ratio where EC denotes energy consumption, EB external benefits, and EI environmental impact.

The tool that is used to graphically integrate and monitor the different parameters is the "radar" or Amoeba diagram figure 4.9 Two sustainable profile graphical representations that result from the application of the Sustanability Index Concept (**SIC**) to two hypothetical solutions.. This diagram has the same number of rays as the number of parameters under analysis and is called the sustainable profile. In each sustainable profile, the global performance of a solution is monitored and compared with the performance of the reference solution.

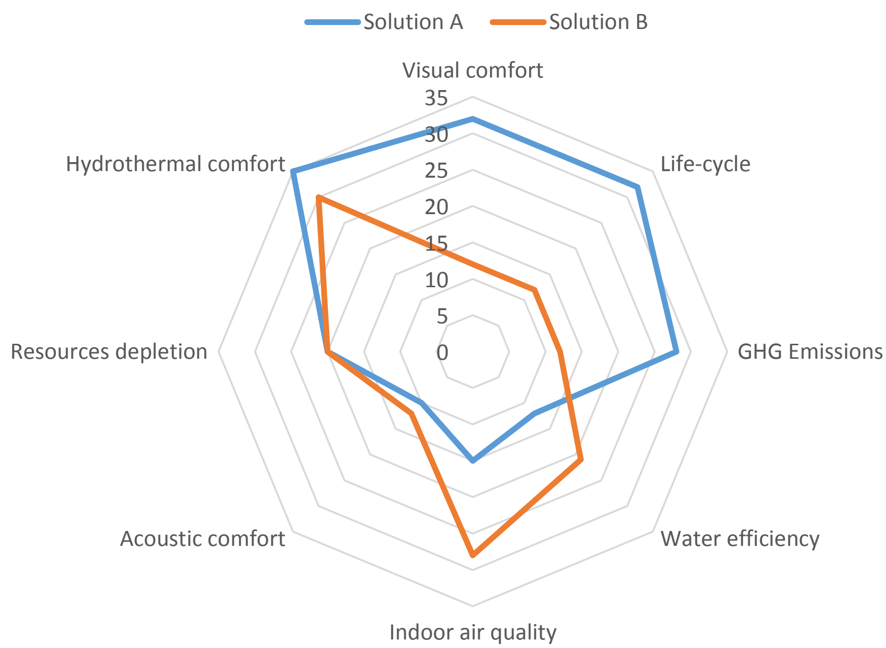

Figure 4.9 Two sustainable profile graphical representations that result from the application of the Sustanability Index Concept (SIC) to two hypothetical solutions.

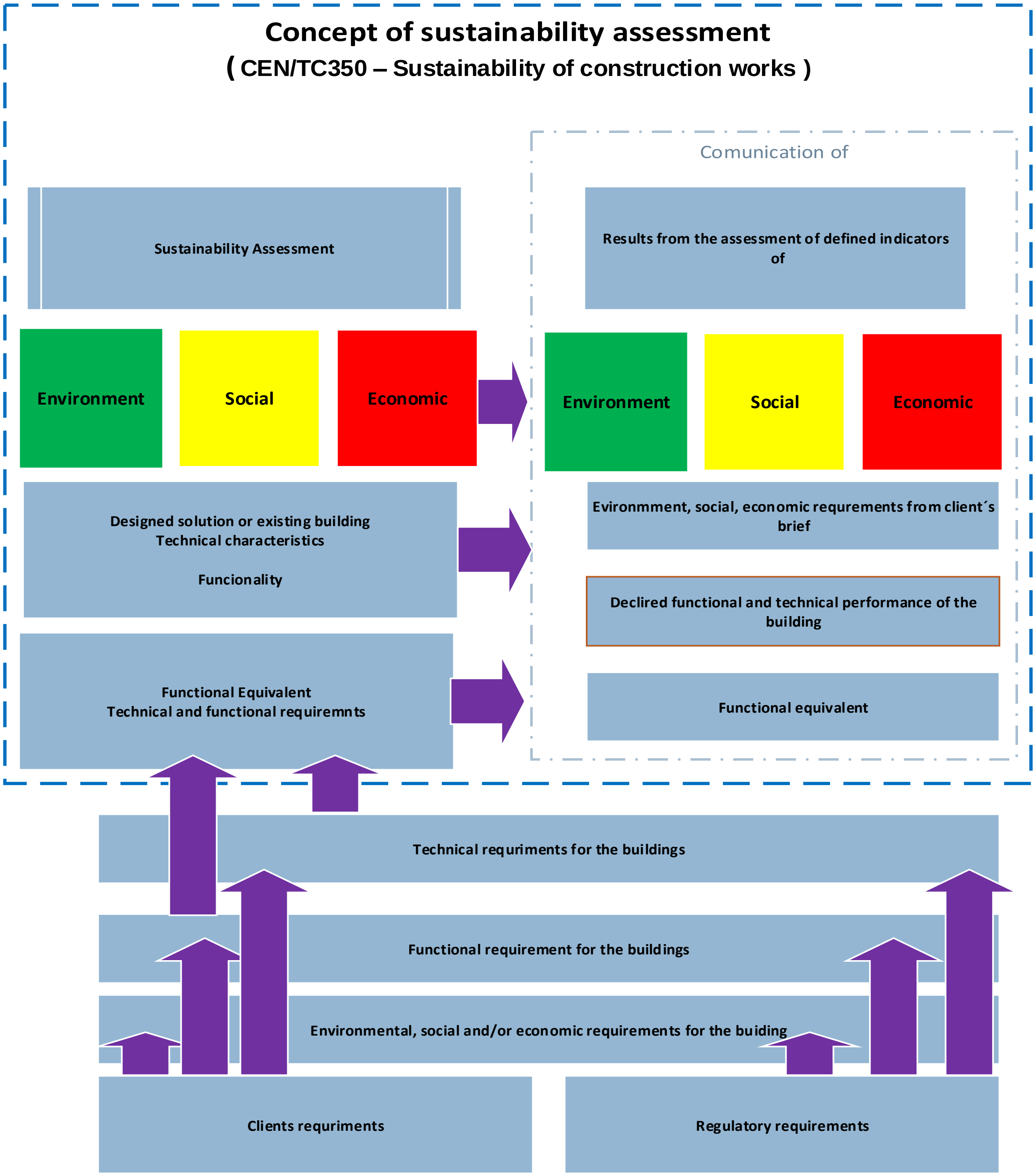

Figure 4.10 European Sustainability Assessment Concept CEN/TC350

Finally, after had determined policies, goals, objectives, and indicators using the previous tools. I propose to implement a punch list system by following the Sustainability Standard Operating Plan (**SSOP**) that provides different actions during the different stages in the construction process from design to decommissioning. The **SSOP** works together with the section 4 of this chapter that provides information of the main international standards and official websites.

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6.14 Users engagement & Community Outreach
7. Register

Title: **Achieving sustainability procedure through the whole life of a construction project**

1.0 Purpose: The Sustainability Procedure (SP) outlines the scope and plans for implementation and enforcement. The SP provides ongoing operational procedures for project development and design, climate impact, community outreach and environmental culture, energy and water conservation, purchasing eco-efficient materials, transportation, by minimizing waste production and recycling maximize durability, ensuring safety conditions, minimizing lifecycle cost of materials maximizing durability.[410]

1.1 To define a procedure for environmental, health, and safety practices in construction activities. The procedure encompasses development of policy; materials use (reduction, reuse, and recycling); energy saving; environment and water conservation; housekeeping and air quality; accessibility; health and safety provisions; control of noise and vibration; communication; workforce management; use of innovation; and participation in recognition or awards.

1.2 To prevent or minimize the environment, health, and safety hazards that may be present or develop during construction activities.

1.3 To conform to environmental, health, and safety regulatory requirements, and customer concerns.

1.4 To provide a mechanism for continual improvement in environmentally sustainable and best practices in construction activities.

2.0 Scope: The procedure is applicable to all construction projects and activities.

3.0 References:

ASHRAE Standard 189.1*Standard for the Design of High-Performance Green Buildings*
ASHRAE Transactions 106(2),
ASHRAE Standard 62.1-2010 -- Ventilation for Acceptable Indoor Air Quality.
ASHRAE 90.1-2007 as the minimum commercial energy code
ENERGY STAR. Under the ES Version 3 (ES v3) program for residential construction
ICC 700 National Green Building Standard
ISO 14040:2006-Environmental management-Life cycle assessment-Principles and frame work
ISO 14044:2006- Environmental management-Life cycle assessment-Requiremens and guideleines
ISO/TS 14048:2002(E). Environmental Management — Life Cycle Assessment — Data Documentation Format. Standard Reference Number:
ISO 14001:2004. Environmental management systems -- Requirements with guidance for use. Standard Reference Number:
ISO 7730 Ergonomics of the thermal environment -- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria
ISO 21931-1:2010 Sustainability in building construction - Framework for methods of assessment of the environmental performance of construction works - Part 1: Buildings
ISO 50001:2011 Energy management systems -- Requirements with guidance for use
NMX-AA-164-SCFI-2013 Sustainable building criteria and minimal environmental requirements

[410] https://www.wbdg.org/design/sustainable.php

4.0 Definitions:
(See annexe 3)
5.0 Responsibilities:
Responsibilities for specific personnel have been described in each clause.

6.0 Procedures:

This operating procedure helps all people involved in project, construction, commissioning and maintenance by:

Providing recommendations and guidance for the successful adoption, integration, and implementation of locally and nationally developed programs

Addressing critical issues that jurisdictions must consider when adopting or developing a green building or beyond code program

Detailing the elements that promote sustainable development in a typical beyond code program

Analyzing savings and cost effectiveness of green building

This procedure divides the Construction Lifecycle in five phases, and stablishes eight different actions in order to support all the persons involved during the whole project life, they are listed as follows:

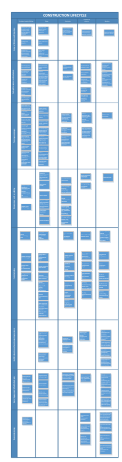
Phases Pre-design: Inception & Briefing Design Construction Completion &Handover Operation Actions Set up of Policies and Objectives Set up of Procedures and indicators Planning and design Procurement and traceability Commissioning Audit Evaluation and continuous improvement Users Engagement & Public Outreach Decommissioning	 Note : The diagram procedure is included in annexe 2

Table 4. 17 Construction Phases Punch List

6.1 Development of Project Policy

6.1.1. Determining Policy

The management shall develop corporate policy based on assessment of current practices, and good practices in the industry.

(See section 1. Determining objectives and indicators, chapter four)

6.1.2. Determining Objectives

The management shall develop and set out project objectives for whole life with respect to the environment and seeks to reduce the overall impact of the built environment on human health and the natural environment by:

- Optimize site potential
- Minimizing the ecological footprint
- Achieving sustainable building and community design
- Enhancing the air and water quality
- Optimize energy use
- Protect and conserve water
- Optimize operation and maintenance practices

(See section 4. Set up objectives and indicators, chapter four)

6.1.3. Determining Indicators

The management shall develop and set up indicators according with standards and regulations.

Establish project specific goals and indicators.
Adjust project goals and indicators to local conditions
Test and refine project goals and indicators.
Use project indicators during project implementation, operation and decommissioning.

(See section 4. Set up objectives and indicators, chapter four)

6.1.4. Planning Practices

For planning development, the management shall incorporate sustainability policies into comprehensive plans and design and construction guidelines. All members of project team shall follow the Sustainable Design Practices in order to ensure consistency, compliance, where applicable, and to assist in attaining the goals. Taking into account:

- Ventilation systems designed for efficient heating and cooling
- Energy efficient lighting and appliances
- Reduction of greenhouse gas emissions and reduced water use
- Reduction of heat island reflection effect
- Water saving plumbing fixtures
- Building orientation and landscaping planned to maximize passive solar energy
- Minimal harm to the natural habitat
- Use of alternate and renewable power sources
- Use of non-synthetic and non-toxic materials
- Use of locally obtained woods and stone

- Use of responsibly-harvested and certified woods
- Use of recycled content materials
- Adaptive reuse of older buildings and materials
- Use of local recycled architectural salvage
- Efficient use of space
- Safe and comfortable indoor environment

Develop a project schedule that incorporates the additional steps of an environmentally responsive design process. The schedule should be sensitive to additional research, unconventional techniques or materials, additional systems testing, pre-occupancy commissioning, or other green practices that may be used for the project in connection with its green design criteria.

The design team can establish and enforce environmental guidelines for construction by doing the following:
Incorporating such guidelines into the construction drawings and specifications and monitoring the contractor's compliance during construction.
Incorporating environmental responsibilities into the construction contract and monitoring the contractor's specific compliance during construction.
Indicating, in the above guidelines or statements of responsibility, practices required by local, state, or federal environmental regulation.

In some cases, contractors/sub-contractors may need education about sustainable preferable practices. ***The design team can help the contractor understand that an environmentally preferable process can be more economical than—or equivalent in cost to—a conventional one, and can be implemented without a regulatory or contractual requirement.***

6.1.5. Codes and regulation Inventory

Explore options for adoption, compliance, verification, and enforcement of codes and regulations (Local, provincial, Federal, and international level for the following areas:

Prepare and review a list of the appropriate and applicable laws, codes, local ordinances, statutes, and industry-related standards relevant to the project. In addition to the typical laws and guidelines followed on most projects, some will be relevant specifically to a green building. Examples include:
Local or state environmental quality and energy efficiency laws, such as the California Environmental Quality Act (CEQA), which requires an environmental analysis for any project that may have a significant effect on the environment.
Standards produced by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), which address energy efficiency, indoor air quality, thermal comfort, ventilation rates, and building commissioning, and are useful when developing designs and specifications for systems and products related to space conditioning.
Other standards, such as the American Society for Testing and Materials (ASTM) life-cycle standards and the Illuminating Engineering Society's lighting standards.

6.2 Use of Materials (Reduce/Reuse/Recycle)

Regulations regarding building materials used during and after construction

6.2.1 Planning for Construction Waste

6.2.1.1 Concrete Wastage

The responsible person (engineer / supervisor) shall determine the volume of concrete, in addition to determining the last balance area, to be used before placing an order. A material wastage control form shall be attached while ordering concrete.

6.2.1.2 Rebar Wastage

The responsible person (engineer / supervisor) shall ensure that the quantity of rebar delivered is in conformance with the order. Sub-contractors shall use cut and bent rebar on site as far as practicable.

6.2.1.3 Timber Formwork
Sub-contractor shall apply formwork oil after each casting or dismantling of formwork to ensure that formwork surface remains in good condition, and can be used for the next casting.

6.2.1.4 Metal or Aluminium Formwork
Sub-contractor shall use metal or aluminium formwork instead of timber formwork wherever possible.

6.2.1.5 Pre-packed Cement Shelter must be erected at site for safe storage of pre-packed cement by prevention of direct contact with sunlight or rain water. The responsible person (engineer / supervisor) shall monitor the quantity ordered and delivered on site.

6.2.2 Control of Waste

Provides regulations regarding the construction phase of a project and is intended to ensure proper storage and handling of materials to guarantee safety and avoid damage.

Requires that materials stored and handled during construction should comply with the manufacturers' instructions

Requires that space is provided for use by building occupants for storage and recycling of materials in accordance with local regulations. If local regulations do not exist, recycling areas should be provided to accommodate materials based on existing or planned recycling services.

The responsible person shall monitor and control construction wastes. Material shall be ordered to minimize waste. Construction waste shall be segregated according to separate categories.

6.2.3 Construction Approach

6.2.4.1 Use of Formwork System
Metal formwork that can be re-used for several projects shall be used. Formwork shall be supported by aluminium "I" beams and steel rectangular hollow sections instead of timber sections. Precast

pre-tensioned slab or hollow core slab shall be used as an integral slab system that also acts as a formwork system.

6.2.4.2 Use of Platform System

Mobile working platforms shall be used for external work. Gondolas, scissor lifts, or boom lifts shall be used where practicable.

6.2.4.3 Control of Masonry Waste

Precast lightweight panels, dry wall system, or precast partition wall shall be used wherever practicable.

6.2.4 Construction Practices

Use of **Eco-concrete** made of recycled concrete shall be used for non-structural items such as drains, drain bases, and footings for fence posts and road curb bases.

Hazardous Materials The ECM (Environmental Compliance Manager) will document any hazardous material uncovered at the construction site. The documents will include notification to the agency .

Use metal or aluminium formwork instead of timber formwork wherever possible.

6.3 Saving Energy

Requirements for the design and construction of buildings that promote energy conservation and reduction in CO_2 emissions Chapter 6 of the IgCC defines requirements for the design and construction of buildings that promote energy conservation and reduction in CO_2 emissions.

Design Phase

The decision process for construction and remodels includes energy life cycle costing analyses:

New construction and remodels use high-efficiency lighting and lighting controls, including emerging technologies, where the life cycle cost is favorable.

Decrease energy consumption through alternative energy sources, such as solar water heating, day lighting, and other strategies.

Give primary consideration to connecting and/or extending central utility systems for heating, cooling and other mechanical systems.

Meet year-round cooling needs by utilizing the most energy efficient systems (e.g. free cooling or economizer cycles based on life cycle cost analysis).

Promote energy management through the strategic use of metering.

Lighting

Keep interior decorative lighting to a minimum and minimize exterior decorative lighting.

Utilize in-board and out-board switching for lighting fixtures.

Increased use of day lighting and day lighting controls as an integral part of project design.

Disconnect all beverage vending machine lamps and specify use of energy saving vending miser device

Heating and cooling set points

Set heating and cooling set points to minimize energy use while maintaining occupant comfort.
Set temperatures for occupied space to temperatures that range from 68°F to 71°F for heating and 72°F to 75°F for cooling.
Set unoccupied building setback features through the building automation system to range from 55°F to 60°F for heating and 80°F to 85°F for cooling.
Set Heating, Ventilation and Air Conditioning (HVAC) occupancy schedules through discussions with Facilities Operations and Facilities Liaisons. In general, the setback schedule takes effect when the majority of the building is unoccupied. During setback periods, utilize override push button applications where available.
Exceptions to HVAC occupancy schedules include special areas such as libraries, animal care units or research facilities that require constant or specific temperatures.
Facilities Operations evaluates requests for temperature set point and occupancy schedule exemptions on an individual basis.
Facilities Operations utilizes the most energy efficient means of supplying heating or cooling for approved off-hour/holiday requests.
Use window air conditioners only in areas that lack central cooling or proper air balance, and operate the units consistent with energy conservation.
Report areas that are too cold or too hot to the Facilities Customer Service Center.

Construction Phase

6.3.1 Project Planning

A kwh meter shall be installed at sub-board for monitoring monthly usage on construction site.

6.3.2 Control of Energy Use

Ensure that monthly energy usage does not exceed the monthly allocated amount and designate a worker to record meter reading on a monthly basis. Preventive or corrective action in place whenever energy consumption exceeds the monthly allocated budget.

6.3.3 Energy Saving Approaches

The responsible person shall ensure that energy saving bulbs or tubes are used for site offices or meeting rooms. Low energy consumption air conditioning units shall be used. Low wattage spotlights (such as 500w instead of 1000w) shall be used for site use.

6.3.4 Energy Saving Practices

The responsible person shall make considerations for energy use as the power grid cannot supply all the energy needs of a new project such as HDB project (supply is AC ranging from 200-600A). The responsible person (engineer / supervisor) shall ensure that generator power requirement for each purpose or equipment such as powering tower crane use is determined. The time for generator use shall be set. The responsible person shall consider the use of alternate energy such as solar power wherever practicable.

Operation and Maintenance phase

The operation and maintenance of buildings and grounds promotes and improves **energy** efficiency. Proper use of material resources provides occupant health and well-being through healthy and safe workspaces and residences.

6.4 Environment and Water

Regulates methods of conserving water, protecting water quality, and providing safe water consumption. Lower water costs, by monitoring consumption and reusing stormwater and/or construction wastewater where possible;

The operation and maintenance of buildings and grounds promotes and improves **water** efficiency.

Design Phase

Water efficiency

Utilize water capturing and/or reuse systems, such as storm water collection and HVAC condensate recovery, for non-potable uses.
Use low water use flush valves and flow restrictors on faucets and showers in shower facilities, and restrooms.
Do not use single-pass cooling water for mechanical equipment in new construction or remodels.
Eliminate existing equipment that use single-pass cooling water systems.
Report water leaks, dripping faucets and fixtures that do not shut off to the responsible person.

Construction Phase

6.4.1 Planning for Environment and Water Use

The responsible person shall designate someone to monitor the use of water on site. A record of utilities bill from SP services shall be maintained. The use of utilities shall be monitored and analysed based on readings and construction activities.

The responsible person shall conduct routine checks on the bulk meter, underground water supply and taps around the site.

The responsible person shall ensure that supervisors and workers are briefed on the use of potable water and non-potable water on site.

The responsible person shall inspect the peripheral drain daily, and assigned workers shall clear the silt trap regularly to prevent choking.

6.4.2 Control of Environment and Water Use

The responsible person shall monitor water consumption rate on site on a monthly basis against the monthly budget allocated before commencement of the project. Water use shall be monitored against site activities. Deficiencies observed shall be reported to responsible person, and corrective measures applied. The responsible person shall ensure containment, storage, and treatment of water before discharge into the open public drain.

The responsible person shall ensure that no discharge of total suspended solids into storm water drainage shall exceed 50 mg/L.

6.4.3 Sustainable Approaches

The responsible person shall ensure the use of chemical treatment together with traditional segmentation.

The responsible person shall ensure that the water treatment plant use a sump, filtration tank, and water tank to store treated water. The whole site water discharge shall be channelled to this plant

The responsible person shall ensure that recycled water is used for washing bay, washing of tools and equipments, and site dust pollution control.

6.4.4 Environment Friendly Practices

The responsible person shall ensure that environmentally friendly products are used for dish washing and hand washing liquids at the site office and canteen.

The responsible person shall ensure that pesticides used have environmentally friendly properties.

Operation and Maintenance phase [411]

Water Management Planning
Information and Education Programs
Distribution System Audits, Leak Detection, and Repair
Water-Efficient Landscaping
Water-Efficient Irrigation
Toilets and Urinals
Faucets and Showerheads
Steam Boiler Systems
Single-Pass Cooling Equipment
Cooling Tower Management
Commercial Kitchen Equipment
Laboratory and Medical Equipment
Other Water-Intensive Processes
Alternative Water Sources

6.5 Housekeeping, noise, vibration and Air Quality

[411] http://energy.gov/eere/femp/best-management-practices-water-efficiency

Regulates indoor air quality, HVAC control, acoustics and daylighting.

Chemicals
• Use products that meet or exceed standards set forth by the United States Green Building Council (USGBC), Green Seal and the U.S. Environmental Protection Agency Environmental Choice.
• Use products that contain no carcinogens, reproductive toxins, heavy metals or phosphates; have low VOC content; are readily biodegradable and nontoxic to human and aquatic life.
• The University Housekeeping Chemical Committee reviews all chemicals, researches available alternatives and prevents unauthorized chemicals from being introduced into the Green Cleaning Program.
• Use chemical dispensing stations that pre-measure chemicals and mix with water intended for equipment to protect worker safety and reduce water use.

Equipment
• Use cleaning equipment that reduces noise levels, improves overall indoor air quality, and improves worker safety. .

Supplies
• Supplies will be selected to minimize waste at the source, promote use of recycled material, and to allow the materials to be recycled following use.
• Supplies will be selected to reduce the use of potable water.

Training
• Provide on-the-job training for housekeeping staff to ensure continuous delivery of a clean and healthy environment for building occupants.

Contracts
• Write the above housekeeping practices into contracted housekeeping services.

6.5.1 Housekeeping and Vector Control

The responsible person (PM / PIC) shall prepare and submit detailed program for pest control and surveillance program to the Office of Environmental Health, NEA before commencement of work.
The responsible person (PM / PIC) shall assign specific personnel for executing routine check for proper housekeeping and detect and remove breeding or harbouring of vectors.
The responsible person (PM / PIC) shall engage NEA registered pest control operator, and maintain a copy of the license, list of pesticides applied, and MSDS.
The responsible person (engineer / supervisor) shall ensure the following while storing construction materials. Materials must be stored or stacked in a safe, stable and orderly manner. Materials shall not obstruct any passageway or place of work. Materials must not create an environment conducive for vector growth. Materials must not exceed the safe design load of the floor of the platform where they are placed. Materials must not be placed closed to the edge of any floor or platform.
The responsible person (engineer / supervisor) shall ensure that the peripheral drain does not have stagnant or accumulated water.
The responsible person (SCO, SS, or HS and ECO, or WSHO) shall inspect the site at least once a week.

6.5.2 Control of Air Pollution

Control of Dark Smoke
The responsible person (PM / PIC) shall identify sources of dark smoke at different phased of the construction work based on the nature of work, analysis of hazards, environmental aspects, impact evaluation and initial site review.
6.5.2.2 Plant and Fuel Burning Equipment

The responsible person (WSHO, ECO, or WSHC) shall identify and report the defective fuel burning equipment causing excessive emission of black smoke to the PM / PIC.

Burning of debris or wastes on site or in public is an offence, and the PM / PIC shall be informed of such incidents. The responsible person (PM / PIC) shall enforce corrective action against the responsible parties.

6.5.3 Control of Dust

The responsible person (WSHO / ECO) shall ensure that vehicles carrying sand, debris or other materials likely to generate dust are completely covered by canvas before leaving the site.
The responsible person (WSHO / ECO) shall ensure that workmen use wet work method for cleaning higher units, or floors to reduce dust.
The responsible person (PM / PIC) shall ensure that storage areas for sand, cement, aggregates, etc. are located as far as possible from sensitive receptors such as public housing, school, hospital, etc.
The responsible person (site engineers) shall ensure that stockpile of sand and aggregates at concrete batching plant are sheltered whenever possible for prevention of dust pollution.

6.5.4 Monitoring and Measurement
I
gCC Section 603 requires buildings to be constructed in such a way that their energy use, production, and reclamation is measured, monitored, and reported.

This section also requires that a data acquisition and management system be provided capable of storing not less than 36 months worth of data collected by all meters, and capable of calculating the annual CO2 emissions associated with the operation of the building based upon the annual energy use measurements.

Electrical outlets that measure energy use in real time, or sub-metering system for plug loads

Water metering and automatic controls

Submetering is used to determine the proportion of energy use within a building attributable to specific end uses or subsystems (e.g., the heating subsystem of an HVAC system). End uses sub-metered separately from one another, such as space heating, cooling, area lighting, and ventilation fans

Building Automation Systems & Metering
Utility meter total energy consumption by energy type

At minimum, BAS monitors the status of sensors and controlled devices, schedules equipment off when not in use, schedules set points and setbacks, trends equipment status, and schedules lights to turn off during unoccupied times

6.5.5 Waste Management

Provides regulations regarding the construction phase of a project and is intended to reduce construction waste disposal. It requires that a construction material and waste management plan be developed and implemented to recycle or salvage construction materials and waste.

requires that not less than 50 percent of nonhazardous construction waste shall be diverted from disposal. This is to be achieved by developing and implementing a construction material and waste management plan that describes how, where, and what materials will be recycled or salvaged

6.5.6 Control of Noise and Vibration

The responsible person shall:

Define standards for noise and vibration for monitoring and analysis, and development of control measures *(see attachment on Allowable Noise and Vibration Levels).*

ensure that operational procedures such as planning and location of noise sources, maintenance of plant and machinery, and training of workers for material handling to mitigate noise and vibrations are appropriate.

6.5.7 Scheduling Of Noisy Activities

The responsible person shall ensure that piling sub-contractors submit method statements before commencement of piling works.

E[412]nsure that all machinery undergo regular maintenance schedule.

The responsible person (engineer / supervisor) shall forward a notification of intention to commence noisy activities to the PM / PIC. The responsible person (WSHO / ECO) shall consult with the working committee, neighbouring owners, schools, etc. and revise or prepare a schedule of work after consideration of exam periods, special functions, festivities, etc. to minimise inconvenience caused.

6.5.8 Operational Procedure

The responsible person (engineer / supervisor) shall ensure that site facilities during planning stage are located away from noise sensitive areas.

6.6 Site Location and Accessibility [413]

Regulations regarding building site development, land use, and natural resources

[412] http://qcode.us/codes/santamonica/view.php?topic=8-8_106&showAll=1&frames=on
[413] Sustainable Building Technical Manual was provided to Public Technology, Inc., by the U.S. Department of Energy (DOE)

Evaluate project site selection, based on green criteria. In many projects, the site is selected prior to commencement of the design phase. Ideally, the design team should be involved in site selection and should assess the appropriateness of the site relative to green design criteria. A team may decide if the site takes maximum advantage of solar access, existing vegetation, and natural geological features, as well as analyze the site's accessibility from existing transportation corridors and its ability to meet other needs of the building owner, tenants, and visitors. (See Part III for additional site information and selection criteria.)

Data Collection
Technical Site Data Perform a site analysis to determine site characteristics that influence building design.

– *Geographical latitude (solar altitude) and microclimate factors,such as wind loads—*
– *Topography and adjacent land forms—*
– *Groundwater and surface runoff characteristics—*
– *Solar access—*
– *Ai r-movement pa tt e rns , both annual and diurnal—*
– *Soil texture and its load-bearing capacity—*
– *Parcel shape and access—*
– *Neighboring developments and proposed future developments—*

Analyze specific characteristics of climate zones.Climate zones (hot-humid, hot-arid, temperate,and cold)
Analyze the site's existing air quality
Perform soil and groundwater testing.
Test soil suitability for backfills, slope structures, infiltration.
Evaluate site ecosystem for existence of wetlands and endangered species.

6.6.1 Transportation

6.7 Public Safety

This approach is an effort for to create its own standards that permit the highest degree of design freedom, while also protecting health, safety and well-being of its multiple constituencies: current residents and neighbors, to be sure, but also future generations of people and non-humans that share local ecosystems with us (PPN 2011) safeguarding the public health, safety and general welfare," and preserving a safe and healthy natural environment. Incorporating sustainability through energy efficiency, water conservation and resource reuse and reduction translates into a stronger economy and area growth.

The responsible person shall ensure that:
that comprehensive assessment and monitoring of surrounding buildings are carried out prior to commencement of work.
passageways that are heavily used by the general public are provided with covered walkways. site hoardings and walkways are appropriately designed, in good condition, and well maintained

ensure that full height safety netting have been provided at gondola, scaffold and work platform to mitigate the risk from falling debris during work.
The alternate footpath must be 1.2 m wide for ensuring barrier free access. Footpaths for pedestrians must be free from obstructions.

The Design-Builder will send shop or temporary construction drawings that may adversely affect the public health or safety to WSDOT and the local agency for review and approval at the same time the design team is reviewing the drawings. The Design-Builder, vendors, or subcontractors may prepare drawings for work such as shoring , crib walls, cofferdams, falsework, overhead signs, temporary support systems, formwork and other temporary work that may affect public safety.

6.8 Communication

Communication, for sustainability or any other field, must be approached strategically to ensure it is effective in conveying the creator's message. According to Day & Monroe (2000) this is done through four steps: (1) set a clear goal, (2) select the audience, (3) learn the audience's "media diet", and (4) write the message accordingly. This framework will be as a reference the creation of the communication methods in this study.[414]

6.8.1 Planning for Communication

The responsible person shall ensure that there is a communication plan for residents, tenants, town councils around the construction site.

6.8.2 Notices and Letters

The responsible person shall ensure that notices or letters are issued within five calendar days in advance for certain types of work that are considered to cause inconvenience *(see attachment on Work/Activities Requiring Issuance of Notice)*

6.8.3 Distribution and Display of Notices

The responsible person shall ensure that copies of notices or letters are also distributed to the Town Council, HDB Branch Office, etc. as applicable.

6.8.4 Handling Complaints and Feedback

The responsible person shall designate a trained person to receive calls on the hotline. Feedback details and complaints shall be recorded on a feedback or complaint form, and forwarded to the for follow up. The records shall be filed on closure of the case.

6.8.5 Site Security

The responsible person shall ensure that a guard post is available at the site entrance to prevent illegal entry to the site for an enclosed worksite. The responsible personnel (security guards) shall conduct regular checks on the site.

6.10 Procurement

The purpose of this SOP is to minimize the negative environmental impacts of the County's activities by ensuring the procurement of services and products that:

- reduce toxicity
- conserve natural resources, materials, and energy
- maximize recyclability and recycled content
- maximize energy efficiency in procurement of new computer equipment

[414] https://www.colgate.edu/docs/default-source/default-document-library/trudy-leed-certification.pdf?sfvrsn=0

- reward manufacturers and vendors that reduce environmental impacts in their production and distribution systems
- create a model for successfully purchasing environmentally preferable products that
- encourages other purchasers within our local communities to adopt similar goals

Purchase of new energy-efficient equipment and/or to finance energy efficiency retrofitting projects, additional energy saving management projects, related capital improvements, initiatives, and training, invest in renewable energy systems, and purchase electricity from renewable energy sources.

Purchasing decisions are guided by total cost of ownership and total life cycle cost. Any purchase by NC State will improve the environmental performance of its supply chain with consideration given to toxicity, recycled content, energy and water efficiency, rapidly renewable resources, and local production and manufacturing. Purchase decisions will improve the social responsibility of the supply chain, production working conditions and the use of historically underutilized businesses.

2.5.1 Environmentally and socially responsible attributes

- Include environmentally and socially responsible attributes whenever this does not infringe on the statute-driven purchasing processes defined by the State of North Carolina.
- Consider all phases of a product or service to determine its environmental impacts including: raw materials acquisition, production, manufacturing, packaging, distribution, operation, maintenance, disposal, potential for reuse and ability to be recycled.
- Include environmentally and socially responsible attributes in specifications, statements of work, and procurement of goods and services.

2.5.2 Expansion of environmentally and socially responsible purchasing

- Seek environmentally and socially responsible purchasing for products and services by selecting those that comply with the following current and credible environmental and social standards:
    - Green Seal certified for cleaning supplies, paints (no VOC), windows, doors, flooring and adhesives
    - Forest Stewardship Council certified for office paper, toilet paper, every type/use of paper
    - Green Guard standards for indoor environments such as paints, furniture and bedding
    - Cradle to Cradle production standards
    - Purchasing from sources that feature adequate safeguards for endangered forests and indigenous people

IgCC Section 505 provides regulations regarding selection of building materials and is intended to lessen the impacts of material extraction, processing, and transport.

IgCC Subsection 505.2 requires that not less than 55 percent of the total building materials used in the project − based on mass, volume, or cost − must be used (i.e. salvaged), recycled, recyclable, bio-based, or indigenous (within 500 miles).

6.11 Innovation [415]

The responsible person shall ensure that the construction activities make use of procedures or innovative technology to address environmental concerns, site challenges, or minimise public concerns

If innovative design solutions are proposed, the consultant must do so in conjunction with the Facilities and Construction Management staff and with consideration of benefits and risks, costing and life cycle analysis.

Suggested innovations include: exceptional performance (e.g., zero energy,
carbon neutral); innovative design strategies; or emerging technologies, materials, or construction practices.
The applicant MUST prepare a written submittal that includes:

- The intent of the innovation measure(s)
- The proposed requirement for compliance
- The proposed documentation to demonstrate compliance
- A description and an estimate of the benefit/impact provided by the proposed measure

Verification: Applicant must provide the above documentation in writing and any other supporting documentation, such as an evaluation report or specifications to quantify performance.

Green Innovation Strategy
Identify opportunities to incorporate climate protection, sustainability and environmental goods and service industries into economic development plans. Encourage workforce development training and school curricula that support the emerging green collar job sector, including renewable energy and energy efficiency, as well as climate smart solid waste management practices. Procure climate smart goods and services for local government operations and support modernizing of local and national electricity grids.[416]

6.12 Commissioning & Decommissioning
Commissioning is commonly performed when building systems are constructed or installed and, preferably, once again 12 months after occupants have been using the building and all systems have been operating for a while. However, a good commissioning process actually begins during the design phase with agreement on how the design criteria will be verified and documented during the post-construction and post-occupancy assessments. Recommissioning on an annual basis is also advantageous as a means of ensuring the proper functioning and upkeep of building systems throughout their useful lives. Given its importance and many potential benefits, commissioning is becoming part of good standard practice for the industry.

The building-commissioning process provides for testing and verification of building systems to ensure that they perform as designed and meet expectations for energy consumption and costs.

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[415] http://www.oakville.ca/assets/general%20-%20environment/SustainableDesignGuidelines.pdf
[416] Ulster County Government Sustainability Initiatives: Environmental Executive Orders, Laws, Resolutions & Procedures, January 2013 Michael P. Hein, County Executive

The contractor commissioning activities and documentation ensure that systems are installed as designed, thereby reducing the occurrence of problems at the project's completion and over the life of the building.
The building-commissioning process is used to discover deficiencies in the building and its systems before occupancy. It is more cost-effective to correct any deficiencies (both in design and construction) at that time.
Construction-phase and post-occupancy building commissioning improve the building systems' performance under real, live conditions, reducing the potential for user complaints.
The building-commissioning process helps ensure the proper functioning of buildings with good indoor air quality.2 (See Chapter 13, "Indoor Air Quality," for additional information.)
Using the HVAC system design documentation as a checklist ensures that the HVAC system capacity meets the projected peak and actual thermal loads for population and equipment.3 This review reduces the need for potentially costly construction change orders, which in turn reduces construction costs and the architect's potential liability.
The building-commissioning process provides the design team with a better understanding of the building's systems, resulting in improved design and better coordination of the construction documents.
Recommissioning a building throughout its life on a regular, annual, or biannual, schedule ensures the proper functioning of systems on a continuing basis. By maintaining indoor air quality, building recommissioning may also reduce worker complaints and improve worker productivity.4 This in turn may reduce the building owner's potential liability.

Some utility companies are exploring the possibility of providing rebates or reduced utility rates to building owners whose buildings are commissioned or recommissioned, which may provide additional savings to cover the commissioning costs.
Professional liability insurance companies are exploring the possibility of reducing annual premiums for architects and engineers who perform building commissioning on their projects.

Develop a strategy to implement the building-commissioning process. The ASHRAE guidelines provide a good overall model. *Figure 2* illustrates a three-step commissioning process showing the suggested activities and responsibilities of team members during each step. Ensure that the commissioning strategy encompasses all of the necessary activities in each stage of the process.

Prepare the design documentation and design criteria for the HVAC system,including the following information:

- The HVAC system building-commissioning design documentation form, similar to the example shown in *;*
- The HVAC system design criteria; and
- The HVAC system description.

Construction Phase
Involve the design team in monitoring the construction commissioning process. During the construction phase, the contractor plays the major role in performing the building commissioning. However, the design team should also be involved in monitoring the building-commissioning process. Since this is a relatively new process, "partnering" or team building may be required to ensure success. The benefit of partnering is that it establishes a forum for alternative dispute resolution so that building-equipment and system problems can be resolved quickly in "real time."

Conduct pre-commissioning workshops and commissioning progress meetings.Workshops and progress meetings are useful in ensuring that all building-commissioning issues are properly addressed. Attendees should include members of the commissioning team.

Observe that construction is in accordance with the contract documents.

- Perform systems and equipment startup.
- Demonstrate operations and conduct training.
- Recommend acceptance of the work and payment of the facility startup amount.
- Prepare the commissioning report.
- When the commissioning process is complete, the commissioning agent should issue a commissioning report to the owner, including the following information:
- Building description, including size, location, and use;
- Team members and responsibilities;
- The final project design documents and the commissioning plan and specification;
- A written and/or schematic description of each project system including architectural, mechanical, and electrical systems included in the project;
- A summary of system performances relative to the design intent;
- Completed pre-functional checklists;
- Completed functional checklists;
- All approval, non-compliance, and cost-tracking forms; and
- The manuals for each system, which should include the following information:

    i. System design intent;
    ii. System description;
    iii. As-built drawing;
    iv. Specifications and approved submittals;
    v. Emergency shutdown and operational procedures;
    vi. Test-and-balance and other testing reports;
    vii. Startup and verification checklists and reports;
    viii. Operations and maintenance manuals;
    ix. Material safety data sheets (MSDSs), and chemical disposal requirements; and
    x. Training documents and programs.

Post Occupancy Phase

Conduct fine-tuning of building systems and equipment after one year. Recommission buildings throughout their life on a regular schedule, possibly every one to two years.

Strategic decommissioning is about integrating the process of decommissioning former arrangements with the commissioning of new ones - not simply closing services or facilities but in parallel:[417]

- developing new approaches to meeting customer needs;
- conducting a controlled shutdown of existing ways of working;
- appropriately signposting alternatives;
- ensuring that at the end of the process customer and organisational needs have been met.

[417] https://www.croydon.gov.uk/sites/default/files/articles/downloads/decommissioning.pdf

Demolition[418]

How will the spread of dust be minimized during demolition and removal?

Monitor speed of wind
Prior start of the demolition neighbors most be notified

Secured to prevent unauthorized access?
If there are sidewalks, alleys or other walkways near the project, pedestrians paths must be protected
If there are adjacent or neighboring structures, it´ll be necessary to protect them from damage
Public stormwater system and right-of-way be protected from any sediment-laden runoff, track out from construction vehicles, or other materials leaving the site

Best Practices to Prevent Dust
WATER APPLICATION
Apply adequate amounts of water throughout the process to reduce the spread of dust during demolition and debris removal.
CAREFUL DEMOLITION
Use “Picker method” rather than wrecking ball.
Demolish building in approximately reverse order of construction.
Don’t drop! Lower debris from upper floors to the ground in receptacles, by elevator or hoists, or in tightly enclosed chutes.
Remove and safely dispose of components with high amounts of lead prior to demolition of the structure.

FENCING, SCREENING OR SHEILDING
Use high fencing or barriers around the site to contain wind-blown debris.
COVERED AND DRIP FREE LOADS
Cover loads on trucks to ensure that debris and dust are contained during removal from the site.
Ensure trucks with wet loads “tip up” to allow excess water to drain off before leaving the site.

Things to Consider
SITE
The site must be restored to a safe condition.
If the building to be demolished has a basement or foundation that will result in replacement fill of 12” or greater, a design for the fill by a qualified licensed design professional will be required. Special inspection will be required for placement and compaction of fill.
PLUMBING
A sewer cap is required if the building to be demolished is connected to a city sewer. If the sanitary system was a septic tank, the tank must be properly decommissioned.
Contact Lane County Public Works, Land Management Division for more information regarding decommissioning existing septic tanks.
EROSION PREVENTION

[418] A PRACTICAL GUIDE FOR DEMOLITION SITES IN THE CITY OF EUGENE DEMOLITION BEST PRACTICES https://www.eugene-or.gov/DocumentCenter/View/19567

If the site is located within a sensitive area as defined by Administrative Rule R-6.645, or the area of disturbance is greater than 1 (one) acre, an erosion prevention permit maybe required before any ground disturbing activities begin.

TREE REMOVAL

In certain situations, City regulations require a separate Tree Removal Permit. Whether a permit is required depends on the number and size of trees to be removed, and the site where the trees are located.

RECYCLING DEMOLITION MATERIALS

Reducing and recycling construction and demolition materials conserves landfill space, reduces the environmental impact of producing new materials, creates jobs, and can reduce overall building project expenses through avoided purchase/disposal costs. The City of Eugene actively supports and encourages the identification of demolition materials as commodities that can be reused or recycled and utilized in new building projects.

6.13 QA&QC[419]

The Design-Builder's quality policy is based on the fundamental concept that the control of quality is a team obligation that recognizes that quality is built into every aspect of the project. Our team will provide quality products and services that meet or exceed client´s requirements, delivered safely, on time, and within budget. Quality work will be the responsibility of every individual performing the work. Quality will be obtained through appropriate planning and control of work operations and by specific quality control activities such as reviewing, checking, inspecting, testing, and quality surveillance/audit.[420]

Monitoring specific project result to determine if they comply with relevant quality standards and identifying ways to eliminate cause of unsatisfied performance Contract documents comprise a clear, complete, and accurate description of the facility to be constructed, correctly conveying the intent of the owner regarding the characteristics of the facility needed to serve his or her purposes. The contract documents define a constructed facility considered acceptable under the applicable regulatory codes and standards of professional practice, in terms of its reliability, the ease with which maintenance and repairs can be performed, the durability of its materials and operating systems, and the life safety provided to its users. The facility is constructed in accordance with those documents.

INPUTS Work results, quality management plan, Operational definitions, checklists

1.-TOOLS AND TECH. Inspection, Control charts, Pareto diagrams, Statistical sampling, flowcharting, Trend analysis

2.-OUTPUTS Quality improvement,

Acceptance decisions, rework, Completed checklist Process adjustment

1.2.3 QUALITY ASSURANCE Evaluating overall project perform on a regular basis to provide confidence that the project will satisfy the relevant quality standards

1. INPUTS Quality management plan, Result of quality control measurements, Operational definitions 2. TOOLS AND TECH. Quality planning tools and techniques, Quality audits

3. OUTPUTS Quality improvement

[419] http://www.internationaljournalssrg.org/IJCE/2015/Special-Issue/NCRACCESS-2015/Part-2/IJCE-NCRACCESS-P104.pdf

[420] http://www.wsdot.wa.gov/NR/rdonlyres/27A54B86-9825-4E81-9DEE-138823B4ED86/56842/QMPOutline0504091.pdf

Non-Conformance Remediation The NCR has several avenues for remediation depending on the severity of the problem. Among them are:

Prepare an RFI with proposed remedy to Design-Related NCR Issue—The DQAM or CQAM will issue the NCR and request design review, -the work will evaluate and determine whether a non-conformant, the non-conformance on performance, safety, durability, long-term maintain life of the item. Remedial actions will be documented and stamped by a Professional Engineer licensed in Washington. The DQAM must also sign the NCR, stating that remedial actions to be used have undergone the same level of checking, inspection, and testing as required for the original design. Price Reduction—for the work element outlined in the contract specifications, the CQAM will perform the calculations in accordance with the contract, obtain written approval from the DM of structural adequacy if applicable, and forward this information to WSDOT and the Project Manager for administrative closure of the NCR. Remove and Replace—The CQAM may reconforming work.

6.14 Users engagement & Community Outreach

Communicating the attributes of a green building is an important element of the green building process. According to the USGBC, “Greening a campus requires effective occupant education that includes clear and concise information about the attributes of the green campus and the occupants’ role in ensuring that energy and conservation goals are met” (Humblet et al., 2010, p. 89).
Provision of staff, faculty and administration energy efficiency training and/or technical assistance; operation and maintenance training for building operators and maintenance staff which can have tremendous impact on energy and water use; and promote employee involvement to enhance facility comfort and/or make operations more efficient, typically resulting in reduced maintenance costs.

7. Register (Depends on totally quality system)

Conclusions

The conclusion section is divided in four parts as follows

A. Sustainability Items Review
B. Green building forecast for Mexico and Canada
C. Comparison between Mexico and Canada
D. List of considerations for sustainability

A. Sustainability Items Review

The future is now, neither population growth nor urban development paths are going to change in the upcoming years. It is estimated that one-half of all non-renewable resources humankind consumes are used in construction. For this reasons, the construction sector is obligated to implement all achievable green building techniques even without intend to reach any certification.

In the same manner, It´s compulsory to bridge the gap between urban planning, building design and community development. The building dialogue between the buildings and the city, create tools, as the Swedish Eco-cycle would provide the best opportunities to yield synergies to benefit both society and environment.

Tackling the threats generated by anthropogenic actions that are already impacting the environment in the nine planetary boundaries described by Johan Rockström in 2009. Nowadays, It´s important that Green Building become a common goal in the construction sector. Integrate methodologies to implement plans that address all these issues in a holistic and inclusive process is the best way to achieve Sustainability. We cannot longer intent to solve each problem in an isolate way, and put aside transboundary issues like the construction sector impacts like cement, steel, and other industries that take part in the supply network.

The rating tools are just a part of the solution. Nobody can deny the benefits derived from Green Building certification such as LEED, BREEAM, Green Globes. However, in the same way all these tools has its limitations and weakness mainly in the operation phase, and the link community development. The competition among green building rating systems will provide a better fit for each country and even region, at his regard I would like to mention the Toronto Green Standard and UNAM´s environmental award as success cases.

The minimal formula to achieve sustainability in the design must involve Passive Design elements to reduce energy consumption, LCA to determine the efficiency of design until the decommissioning process, and privilege the implementation of Renewable Energies. Without underestimate, other elements by applying these techniques in the design process we can estimate the real benefits of Green Building, and have a more accurate baseline to compare with non-green-buildings that help us to present these features to clients, users and authorities.

It is also important to boost open source software and simulators, the use of these tools enables the design sector to improve energy efficiency, water conservation, outside and outdoor wellbeing and evidently save money. Authorities need to explore the possibility to create their own software, simulators and calculators or provide financial support for it. In this aspect, the use of "The Cloud" and "Big Data" is a key factor to involve with the operation management to reduce cost.

Third party assessment is compulsory to add credibility and crosschecking verification to the design process and give customer confidence about their performance. Certification gives you confidence that products and services will perform as expected, through a combination of regular company audits and a schedule of ongoing auditing. It benefits both suppliers and purchasers:[421]

- **Suppliers** can demonstrate to customers that their products and services meet the appropriate standards. This can enable companies to access and sell into new markets.
- **Purchasers** can trust third-party certified products and services to meet set standards, and therefore avoid costly mistakes and reduce risk.

"Buildings have extensive direct and indirect impacts on the environment. During their construction, occupancy, renovation, repurposing, and demolition, buildings use energy, water, and raw materials, generate waste, and emit potentially harmful atmospheric emissions. These facts have prompted the creation of green building standards, certifications, and rating systems aimed at mitigating the impact of buildings on the natural environment through sustainable design."[422]

Implement Standards such as ANSI/ASHRAE/USGBC/IES Standard 189.and NMX-AA-164-SCFI-2013 to construction codes is essential to provide minimum requirements for site, design, construction and operations in mandatory, code-enforceable language. At this point, I would like to quote the ICC Chief Executive Officer Richard P. Weiland. ***"We are now at a place in the evolution of the sustainability movement that requires the specificity, the reliability and enforceability that only a code can bring."***[423]

It´s necessary to enable Community outreach, and use green building as a medium for environmental education. From the outside, it may appear that building users are more likely to contribute to problems rather than solutions. Green-Building Literacy, like Ecological Literacy, is more than factual knowledge: it involves awareness, attitudes, skills, and participation. A supportive environment is one that attempts to educate and involve people, helping building users gain green-building literacy through engagement with the building (Cole, 2013)

B. Green building forecast for Mexico and Canada

Green building in Canada

The Canada green building market is vigorous and growing, according to the findings of this study, conducted by McGraw Hill Construction in partnership with the Canada Green Building Council.

In Canada, increased green building activity is widely predicted by many firms in this study, which suggests that the share of green in the overall market is likely to grow at a strong pace.

[421] https://www.bre.co.uk/page.jsp?id=1762
[422] https://www.wbdg.org/resources/gbs.php
[423] http://www.astm.org/SNEWS/ND_2009/sims_nd09.html

Education is typically a strong sector for green, as the findings in the U.S. in McGraw-Hill Construction's 2013 *New and Retrofit Green Schools SmartMarket Report* demonstrate. It is likely that there is also significant green investment in new construction in the Canadian school market. In addition, the growth in hospitals should also make that sector of interest to firms seeking green opportunities.

In Canada, a much higher percentage of firms expect to do residential green projects in the next three years (25% low-rise and 31% mid-/high-rise) than the U.S.

According to Thomas Mueller. President CEO Canadian Green Building Council "Regeneration at the building district, neighborhood and city scale is fast emerging as the next paradigm" he added that "building performance benchmarking and management will be critical success factors in the continued advancement of green building[424]

Green building in Mexico

"Mexico is leading globally in terms of expected green activity in the commercial sector. Therfore, it is not surprising that financial benefits are the key drivers for green in Mexico. However, like many developing countries, the need for greater public awareness and political support are key obstacles to green"[425]

The World Green Building Trends Report 2016 elaborated by Dodge Data & Analytics survey´s highlights:
Percentage of respondents whose firms have done more than 60 % Green Projects

2015 21 %
2018 44 % (Expected)

Note: Sectors with expected growth commercial projects, retrofits of existing buildings and commercial interiors.

In my opinion, it was not a No-brainer that the report underlines that the most important trigger is the business – financial factor and Clients demand, lower operating cost and higher ROI. Mexican construction market has been always focused in economic benefits rather than social benefits. Other finding is the lack of public awareness and lack of political support or incentives.

For me was a surprise that the report didn´t mention the social housing sector as the main potential area for green building. Since It´s expected to build at least 800 000 dwellings a year the next 10 years, nor is mentioned any government program such as NAMA´s and "Tu Casa".

I would like to point that green construction need to strengthen the presence in School, Hospitals, and Hotels. As showed in table 5.1. the three levels of government in Mexico hadn´t show interest to lead by example implementing green standards in their building and retrofitting projects.

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[424] World Green Building Trends SmartMarket Report 2013, MCGraw Hill Construction
[425] The World Green Building Trends Report 2016 elaborated by Dodge Data & Analytics

As mentioned in Chapter three The National Hosing Policy is coordinated by SEDATU and aims to build quality homes and promote central city model (Urban Containment Polygons). Since 2012, Mexico has meagre outcomes from this programs (13 000 dwellings ECOCASA, 75 pilots new home, August 2015). It´s more likely than not that authorities are been

Last April 14th, the U.S. Green Building Council released the certifications report of the first quarter of 2016 in respect to Latin America , Brazil stands in the first place and Mexico in second place (8 and 7 certified projects respectively) followed by Colombia, Argentina, Costa Rica and Perú.[426]

C. Comparison between Mexico and Canada

<table>
<tr><td></td><td colspan="4">Mexico</td><td colspan="4">Canada</td></tr>
<tr><td>Population</td><td colspan="4">120 Millions/374.25 MTCO_2e/1.54% global emissions contribution</td><td colspan="4">35 Millions/553.29 MTCO_2e/ 2.284 global emissions contribution</td></tr>
<tr><td></td><td colspan="2">Number of projects</td><td colspan="2">Gross square meters</td><td colspan="2">Number of projects</td><td colspan="2">Gross square meters</td></tr>
<tr><td>Certified LEED projects</td><td colspan="2">182</td><td colspan="2">2732327</td><td colspan="2">2282</td><td colspan="2">33534269</td></tr>
<tr><td>Registered LEED projects</td><td colspan="2">574</td><td colspan="2">12795407</td><td colspan="2">2763</td><td colspan="2">43084150</td></tr>
<tr><td>Total LEED projects</td><td colspan="2">756
8 Government
1 k -12</td><td colspan="2">15527734
64 gold
55 Silver
45 Certified
18 Platinum</td><td colspan="2">5045
1135 Government
336 Higher Ed
263 K -12</td><td colspan="2">76618419
864 Gold
742 Silver
581 Certified
95 Platinum</td></tr>
<tr><td>O</td><td>AP = 110</td><td colspan="2">AP (SPECIALITY)= 161</td><td>GREEN ASSOCIATE= 308</td><td>AP = 9198</td><td colspan="2">AP (SPECIALITY)= 2161</td><td>GREEN ASSOCIATE= 1857</td></tr>
</table>

Table 5.1. Comparison between Mexico and Canada Source: Country Market Brief USGBC (Last update 13/04/2016)

[426] http://www.bioconstruccion.com.mx/ranking-2016-recuento-certificacion-leed-en-el-mundo/

The reason I included the table 5.1 is not to show the obvious economic disparities between Mexico and Canada, neither the penetration of LEED standards in both countries, but to demonstrate the lack of involvement of the Mexican government in the Green Building sector, and the opportunities in Higher Education and K-12 school sector.

As mentioned in Chapter tree, The CEC reports suggested aligning standards between all NAFTA members. In the Case of Canada and U.S.A. they have worked to homologate standards, and have developed and share rating systems (LEED, BOMA, Green Globes), and their building codes include materials controls (ASTM).Mexico recently launched the NMX-AA-164-SCFI-2013 Standard, and several social housing programs both are voluntary programs in implementation phase that expect to be in full practice in 2020.

Mexico has benefited from Green building international collaboration with Germany, United Kingdom and Canada to implement **Nationally Appropriate Mitigation Action** programs.[427]I believe that implementing a program like Toronto Green Standard in Metropolitan areas could be a game changer in the Green Building. The fact to mix mandatory and voluntary actions in the construction codes would allow scaling the Sustainable Building Criteria And Minimal

Environmental Requirements.

The School scaling factor in green building (**Low Emissions Schools NAMA) I would like to quote the objective of this program *"Acknowledging the potential catalytic role which young people can play, the Low Emission Schools Programme established in 2013, engaged schoolchildren aged between 10 and 16 to learn about reducing greenhouse gases in their schools and to make more efficient use of resources. As a consequence the schools have begun to significantly reduce their emissions as well as cutting costs. At the same time, the children and young people also transfer this knowledge to their families, friends and communities facilitating wider awareness raising and behaviour change across the community".*** Canada has a long tradition to involve schools in volunteering activities related with environment and community. In the other hand, Mexico has developed Green School programs that are cancelled as soon as the municipal administration changes, every six years the focus of the programs change.[428]The only way to make succeed these programs is to give them continuity and perform under continuous improvement assessment. Thousands of schools can be used as scaling factors, every student and teacher can multiply the effect of transfer Sustainability literacy to their community.

[427] https://www.thepmr.org/country/mexico-0
[428] https://www.diariodemorelos.com/article/desciende-afiliaci%C3%B3n-%E2%80%98escuelas-verdes%E2%80%99

The higher education institution Challenge, given the fact that budgetary capacity can limit sustainability programs, and reduce potential offsetting. For this reason, It´s important to remark that in some cases is not mandatory to invest money and time for a certification like LEED. The environmental award assessment implemented by the UNAM in its Campy and other facilities works perfect as a mitigation action. I mentioned this program to Sustainability Team of Dawson College and they show some interest on it. Since, there are more focused in direct actions rather than achieve public recognition from a label.

Personal forecast of Green Building

Short and middle term

In order to mitigate GHG emissions it´s necessary to involve the urbanization process into the building design, buildings are not isolated from their neighborhood neither their surrounding habitat. Rating systems will bridge this gap in the assessment by adding community aspects like transport, water scarcity and conservation area protection.

Long term

International rating systems are going to integrate in a common effort to push towards sustainability. It is not "Sustainable" to have so many local standards, competing for the green market. The cost-benefit ratio decrease in a such way that the Green Building standards are incorporated in the construction codes of each city, they are adapted by the climate zone, demographic and sociocultural aspects of the region.

D. <u>To do List for sustainability</u>

1. Define and implement clear and achievable goals and objectives
2. Involve Standards and codes with indicators and objectives
3. Use every possible economic benefit/tax cut from government
4. In the pre-design phase determine the bigger opportunities for green technologies
5. Through the whole construction process involve either community and users
6. Implement a hierarchy pyramid in the decision process (Energy, Water, Site and Materials)
7. Third party assessment is the only way to provide transparency to the achievements
8. Share all the outcomes in order to establish a dialogue with authorities and professional´s bodies
9. Create a database of each project and recalibrate baseline for the following project
10. Outreach community in environmental and social aspects
11. Sustainable responsibility is not only a label, but also an ethic component of every person involved in the project.
12. Foster the purchase of Energy Star and water saving appliances

REFERENCES

(2014). *2014 Green Building Market Barometer.* Turner Construction Company.

2014 Green Building Market Barometer et al. (2014). *World Green Building Trends.* Bredford, MA: 2014 Green Building Market Barometer.

Adolfo Gómez Amador, Aníbal Figueroa Castrejón, José Manuel Ochoa de la Torre. (2013). ACCIONES DESDE LA ARQUITECTURA HACIA UNA NORMATIVIDAD AMBIENTAL. *RED Aquitectura Bioclimática (Proyecto PROMEP: Normatividad y reglamentación para arquitectura*.

Alborzfard, N. (10 de January de 2010). Life Cycle Cost Analysis Framework for Sustainable Buildings. Worcester Polytechnic Institute.

Ali and al Nsairat. (2009). *Developing a green building assesment tool for developing countries.*

An introduction for international use BREEAM Communities 2012. (2012). *World Architects*.

Appleby, P. (2011). *Integrated Sustaianle Design of buildings.* London: eartscan.

Artmann N., D. Gyalistras, H. Manz, and P. Heiselberg. (2008). Obtenido de http://www.sysecol2.ethz.ch/publications/pdfs/Ar80.pdf

Barney L. Capehart, Ph.D., CEM, Wayne C. Turner, Ph.D. PE, CEM, William J. Kennedy, Ph. D., PE;. (2012). *Guide to Energy Management 7th Edition.* Lilburn, Ga: The Fairmont press Inc. & CRC Press.

Baweja, V. (2008). *A Pre-history of Green Architecture: Otto Koenigsberger and Tropical.* Ann Arbor: The University of Michigan.

Berardi, U. (2011). Sustainability Assessment in the Construction Sector: Rating Systems and Rated Buildings. *Sustainable Development(20)*, pp. 411-424.

Berardi, U. (2013). Sustainability assessment of urban communities through rating systems. *Environment,Development and Sustainability*, Volume 15, Issue 6 , pp. 1573-1591.

Bruno Marques and Carlos Rafael Loureiro. (April 2013). Sustainable Architecture: Practices and Methods to Achieve Sustainability in Construction. *IACSIT International Journal of Engineering and Technology, 5*(2).

(2012). *CDP Cities 2012 Global Report.* Carbon Disclosure Project (CDP) / AECON.

Chow D. H., and G. J. Levermore. (2010). The effects of future climate change on heating and cooling demands in office buildings in the UK. Building Services. *Engineering Research and Technology 31*, 307 - 323 .

Cole, L. (FAll de 2013). The Green Building as a Medium for Environmental Education. *Michigan Journal of Sustainability, I*. doi:http://dx.doi.org/10.3998/mjs.12333712.0001.012

Day A. R., P. G. Jones, and G. G. Maidment. (2009). Forecasting future cooling demand in London. *Energy and Buildings 41*, 942 -948.

Ding, G.K.C. & Langston, C. (2002). *A methodology for assessing the sustainability of construction projects and facilities.* Melbourne : ICEC.

F. Li and T. Yan. (2014). “Research on social and humanistic needs in planning and construction of green buildings”. *Sustainable Cities and Society, XII*, pp. 102-109.

Feist, D. W. (2010). *Passipedia.* Obtenido de http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.460.6892&rep=rep1&type=pdf.

Feist, D. W. (2012). *Technical Annex for Mexican NAMA.* Darmstadt, Germany: Passive House Institute.

Fisk. (2002).

GEA. (2012).

Grumman, D.L. (2003). *ASHRAE green guide.* ATLANTA: ASHRAE.

(2014). *Guide to Green Building Products in North America.* Montreal: Commission for Environmental Cooperation.

Gwen Christini, Michael Fetsko and Chris Hendrickson. (2004). Environmental Management Systems and ISO 14001, Certification for Construction Firms. *Journal of Construction Engineering and Managent*, 330–336.

Harvey M Bernstain et al. (2014). *Managing Uncertainty and Expectations in Building.* Bedford: McGraw Hill Construction.

Hassan, S. (2000). *The Assessment and Planning Project, Sustainability and Urban Regions.* University of Waterloo.

Horvath, A. (2004). *CONSTRUCTIONMATERIALS AND THE ENVIRONMENT.* Berkeley, California: Department of Civil and Environmental Engineering, University of California.

Hunt A., and P. Watkiss. (2011). *Climate change impacts and adaptation in cities review of the literature.* Obtenido de http://opus.bath.ac.uk/22301/.

Hunt A., and P. Watkiss. (2011). Climate change impacts and adaptation in cities: a review of literature. *Climatic Change*, 1 -37.

Isaac M., and D. P. Van Vuuren . (2009). Modeling global residential sector energy. *Energy Policy 37*, (págs. 507 – 521).

Jason Sumner et al. (2010). *Latin American Green City Index.* Munich: Siemens AG.

Jason Sumner et al. (2011). *US and Canada Green City Index.* Munich: Siemens AG.

John J Batten et al. (2015). *SUSTAINABLE CITIES INDEX .* ARCADIS.

JONATHAN WESTEINDE et al. (2008). *Green Building in North America.* Montreal: Commission for Environmental Cooperation.

Jorge Wolpert,Tomasz Kotecki Golasinska. (2012). *NAMA for Sustainable Housing Retrofit.* CD. DE MÉXICO: CONAVI, SEMARNAT.

Kats et al. (2003).

L. D. D., H. (2009). *Reducing energy use in the buildings sector: measures,.*

Landman, M. (1999). *Breaking through the Barriers to Sustainable Building: Insights from Building Professionals on Government Initiatives.* Tufts: TUFTS UNIVERSITY.

Levine M., et al. (2007). *Residential and commercial buildings. In: Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, United Kingdom and New York, NY, USA: Cambridge University.

Liu, H. (2015). Evaluating Construction Cost of Green Building Based on Life-cycle Cost Analysis: An empirical analysis from Nanjing, China. *International Journal of Smart Home, Vol. 9*(No. 12,), pp. 299-306.

MCDONALD, R. C. (2005). *THE ECONOMICS OF GREEN BUILDING IN CANADA: HIGHLIGHTING SEVEN KEYS TO COST EFFECTIVE GREEN BUILDING*. Manitoba, Canada: ROYAL ROADS UNIVERSITY.

(2006). *Mexico National GHG emissions Inventory.*

Miller et al . (2009).

O. Tatari and M. Kucukvar. (2011). "Cost premium prediction of certified green buildings: A neural network approach". *Building and Environment, 46*(5), pp.1081-1086.

Odón de Buen R., M.Sc. et al. (2009). *Greenhouse Gas Emission Baselines and Reduction Potentials from Buildings in Mexico.* Mexico: United Nations Environment Programme.

Philipp Rode et al. (2011). *Buildings Investing in energy and resource efficiency, Towars a Green Economy.* United Nations Environment Programme.

Reeder, L. (2010). *Guide to green building rating systems (Understanding LEED, Green Globes, Energy Star, the Ntional Green Building Standard.* Hoboken, New Jersey: John Wiley & Sons, Inc.

Robert Kaineg,Georg Kraft, Rolf Seifried, Werner Neuhauss, Heiko Störkel,Witta Ebel, Susanne Theumer, Maria del Carmen Rivero,Angelika Stöcklein, Salvador Rodriguez,Matthias Krey, Stefan Wehner. (2012). *Supported NAMA for Sustainable Housing in Mexico - Mitigation Actions and Financing.* Cd. México: CONAVI, SEMARNAT.

Rockström, J. et al. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity . *Ecology and Society*, , 472-475.

Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer,. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecology and Society, 14(2): 32*. Recuperado el 3 de March de 2016, de http://www.ecologyandsociety.org/vol14/iss2/art32/

Ruegg, R.T., and H.E. Marshall . (1990). *Building Economics: Theory and Practice.* New York: Van Nostrand Co.

S. Binnemars,J.I.M. Halman, E. Durmisevic. (September, 2012). Development of a decision support model for determining life-cycle strategies in the Netherlands.

(2012). *The Green City Index.* MUNICH: Siemens AG.

Ürge-Vorsatz , Danila et al. (2012). *Best Practice Policies for Low Energy and Carbon.* Cambridge, UK: Cambridge University Press.

Ürge-Vorsatz D., et al. (2012). *Energy End-Use: Buildings. In: Global Energy Assessment-Towards a Sustainable Future.* Cambridge, UK: Cambridge University Press.

Urge-Vorsatz et al. (2012).

Venou, A. (2014). Investigation of the “BREEAM Communities” tool with respect to urban design. Stockholm, Master of Science Thesis, Sweden: KUNGLIGA TEKNISKA HÖGSKOLAN.

William Kennedy et al. (2008). *Green Building in North America (Opportunities and challenges).* Commission for Environmental Cooperation (CEC).

(2014). *World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).* United Nations, Department of Economic and Social Affairs, Population Division.

Websites retrieved

1. http://www.cbc.ca/news/canada/hamilton/news/game-changer-randle-reef-cleanup-plan-moving-ahead-1.2956258
2. http://www.randlereef.ca/
3. http://ec.gc.ca/default.asp?lang=En&n=976258C6-1&news=491B73F8-2719-4B56-B632-5C1327F9350F
4. http://m.insidehalton.com/news-story/5739007-hamilton-firm-wins-randle-reef-contract
5. http://centreforaviation.com/profiles/newairports/new-mexico-city-international-airport
6. http://www.airport-world.com/features/airport-design/4944-project-watch-new-mexico-city-international-airport.html
7. http://diversidadambiental.org/medios/nota476.html
8. http://www.hamiltonharbour.ca/index.php?page=index&p=about_the_rap
9. http://www.marinedelivers.com/hamilton-harbour-remedial-action-plan
10. http://www.cbc.ca/news/canada/hamilton/news/u-s-steel-closes-hamilton-blast-furnace-and-steel-making-1.2287483
    http://www.bambapolitica.com.mx/nuevo/index.php?option=com_content&view=article&id=14395:pide-corte-internacional-de-arbitraje-ambiental-no-privilegiar-intereses-comerciales-en-nuevo-aicm&catid=34:noticias-del-dia&Itemid=58
11. http://cuencavalledemexico.com/consejo-de-cuenca-del-valle-de-mexico/historia/
12. http://ideas.time.com/2013/07/31/the-end-of-the-suburbs/
13. http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html
14. http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html
15. http://www.eoearth.org/view/article/157161/
16. www.uncsd2012.org/rio20/
17. https://www.habitat3.org/
18. www.un.org/.../development/.../groupb_unhabitat_s...
19. http://www.bre.co.uk/filelibrary/pdf/Brochures/BREEAM_Communities.pdf
20. https://www.habitat3.org/the-new-urban-agendaunhabitat.org/?wpdmact=process&did=MjczLmhvdGxpbms=
21. http://www.un.org/esa/agenda21/natlinfo/countr/canada/eco.htm
22. http://www.un.org/esa/agenda21/natlinfo/countr/mexico/inst.htm
23. http://sustainabilityworkshop.autodesk.com/buildings/environmental-issues-building-design
24. http://thinkprogress.org/climate/2015/03/28/3640220/mexico-emissions-cuts/
25. http://www.energy.gov.on.ca/en/saving-energy-for-home/
26. http://sustainability.niagaracollege.ca/content/Projects/CampusProjects/Energy/DemandResponseProgram.aspx
27. http://www.energy.gov.on.ca/en/smart-meters-and-tou-prices/
28. http://www.danvers.govoffice.com/index.asp?Type=B_BASIC&SEC={847324FF-5997-45CB-BA9E-4FF3EB24E61B}&DE={E2F01AE5-762D-4468-9DFF-EB0E3C9165C1}
29. http://www.unccd.int/en/programmes/Event-and campaigns/WDCD/WDCD2013/Pages/default.aspx
30. http://www.climateadaptation.eu/spain/desertification/
31. http://www.un.org/waterforlifedecade/scarcity.shtml

32. http://www.greenfacts.org/en/desertification/index.htm
33. http://unhabitat.org/urban-themes/water-and-sanitation-2/
34. http://www.unep.org/geo/geo5.asp
35. http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=00EEE0E6-1
36. https://ec.gc.ca/eau-water/default.asp?lang=En&n=2DC058F1-1
37. http://www.conagua.gob.mx/english07/publications/statics2010.jpg
38. http://www.statista.com/statistics/183388/per-capita-consumption-of-bottled-water-worldwide-in-2009/
39. http://www.theconstructioncentre.co.uk/sustainable-homes/sustainable-drainage-systems.html
40. http://www.branz.co.nz/cms_show_download.php?id=5f70c27162a425bf44d9a614fa247c3f53581b5a
41. http://www.oldcastlematerials.com/docs/crh-social-responsibility-annual-reports/2009.pdf?sfvrsn=4
42. http://www.emergysystems.org/folios.php [accessed 02.06.09.
43. http://environment.nationalgeographic.com/environment/greendex/.
44. http://www2.inecc.gob.mx/publicaciones/libros/495/residuos.html
45. http://garbage.speakupwinnipeg.com/2010/11/17-diversion-%E2%80%93-what-does-this-mean/
46. https://www.wbdg.org/design/env_preferable_products.php
47. https://wbdg.org/tools/athena_ec.php?a=1
48. https://wbdg.org/tools/bees.php?a=1
49. http://www3.epa.gov/epawaste/conserve/imr/cdm/index.htm
50. http://blog.mountee.eu/2014/04/02/waste-management-in-sustainable-renovation-projects-by-cecile-copigny/
51. http://mitigation2014.org/report/publication/
52. http://www.worldcat.org/title/evaluating-the-diffusion-of-green-buildingpractices/oclc/86705809)
53. http://www.mdpi.com/2071-1050/7/8/10324/htm
54. http://onlinelibrary.wiley.com/doi/10.1002/sd.532/epdf
55. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f85552cc66061410VgnVCM10000071d60f89RCRD
56. http://www3.epa.gov/region9/greenbuilding/codes/contents.html
57. http://www.etsi.org/standards/what-are-standards
58. https://www.wbdg.org/resources/gbs.php
59. http://www.knaufinsulation.com/en/sustainable-buildings-and-green-building-rating-systems
60. https://www.ntnu.no/wiki/download/attachments/39650028/GetFileVeg.pdf?version=1&modificationDate=1324451439000
61. http://www.usgbc.org/articles/rating-system-selection-guidance
62. http://issuu.com/usgbc/docs/leed_in_canada
63. http://www.usgbc.org/cert-guide/fees
64. http://ecobrooklyn.com/review-critique-leed/
65. http://www.pbs.org/wnet/need-to-know/culture/architect-frank-gehry-talks-leed-and-the-future-of-green-building/1458/
66. http://www.passipedia.org/examples/residential_buildings/single_-_family_houses/central_europe/the_world_s_first_passive_house_darmstadt-kranichstein_germany

67. www.cepheus.de/eng
68. http://www.treehugger.com/green-architecture/passivhaus-precedents-zero-energy-house-1970s-recognized-award.html
69. www.passivehouse.com
70. http://www.gotad.ca/leed-vs-passive-house/
71. http://home.howstuffworks.com/home-improvement/construction/green/10-benefits-of-a-passive-house9.htm
72. http://www.passiv.de/en/05_service/03_literature/0302_cost-effectiveness/030202_energy-efficiency_sustainable-housing_Mexico.htm
73. https://www.google.com.mx/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&ved=0ahUKEwjc7a7Vi4DKAhWEaD4KHSmkDW8QFgg0MAM&url=http%3A%2F%2Fdx.doi.org%2F10.4236%2Fce.2012.37b001&usg=AFQjCNGpjrAoyAqVZ6f7pB_sFCfTyncmYQ&bvm=bv.110151844,d.cWw
74. www.bre.co.uk
75. http://www.breeam.com/technical-standards
76. http://www.freshworkspace.com/blog/2015/09/weighing-up-the-pros-and-cons-of-the-breeam-environmental-standard/
77. http://www.energystar.gov/about
78. http://www.energystar.gov/index.cfm?c=new_homes.nh_proven_value
79. https://www.energystar.gov/ia/home_improvement/HPwES_Program_Plan_Template.pdf
80. WWW.energystar.gov/homes
81. http://www.csrwire.com/blog/posts/1524-three-jevons-paradoxes-for-the-future-of-sustainable-supply-chain-management-and-one-way-to-resolve-them-all
82. http://www.thestar.com/business/2012/08/10/way_more_pros_than_cons_to_energy_efficiency.html
83. http://www.nlcpr.com/greenglobe.php
84. http://www.thegbi.org/green-globes-certification/how-to-certify/new-construction/
85. http://www.sballiance.org/our-work/libraries/haute-qualite-environnementale/
86. http://www.chba.ca/envirohome.aspx
87. http://www.chba.ca/r-2000.aspx
88. http://www.builtgreencanada.ca/homeowner-benefits
89. https://energycode.pnl.gov/EnergyCodeReqs/
90. https://stars.aashe.org/pages/participate/register-stars.html
91. http://www.bomacanada.ca/
92. http://www.bomacanada.ca/resources/standards.html
93. http://www.boma.org/sustainability/Pages/default.aspx
94. http://www.ide.titech.ac.jp/~nabe/wp/casbee-vs-leed-how-is-each-embraced-by-its-building-community/
95. http://www.ibec.or.jp/CASBEE/english/overviewE.htm
96. http://www.ibec.or.jp/CASBEE/english/statistics.htm
97. http://www.greencitytimes.com/Sustainability-News/geothermal-district-heating-in-iceland.html
98. http://hammarbysjostad.se/?lang=en
99. http://www.ecologyandsociety.org/vol14/iss2/art32/
100. http://www.treehugger.com/corporate-responsibility/green-mortgage-to-promote-sustainable-building-in-mexico.html
101. http://hubpages.com/technology/Sustainability-and-Green-Construction-Standards

102. www.iso.org
103. http://easytobegreen.com/Preview/standardsP.shtm
104. https://www.iso.org/obp/ui/#iso:std:iso:14064:-1:ed-1:v1:en
105. https://www.iso.org/obp/ui/#iso:std:iso:21931:-1:ed-1:v1:en
106. http://easytobegreen.com/Preview/standardsP.shtm
107. http://www.techstreet.com/ashrae/products/1865968
108. http://www.sofame.com/index.php?module=CMS&id=92&newlang=eng
109. http://www.csemag.com/home/single-article/documenting-ashrae-901-compliance/275aae2f4c30bf85951a68913f0103a7.html
110. http://www.autodesk.com/products/green-building-studio/overview
111. https://wbdg.org/tools/athena_ec.php?a=1
112. https://wbdg.org/tools/bees.php?a=1
113. http://www.doe2.com/equest/
114. https://energyplus.net/
115. http://www.cop21paris.org/about/cop21
116. http://www.stcatharinesstandard.ca/2015/11/13/review-of-conservation-act-concerns-environmentalists
117. http://inmobiliare.com/chapultepec-ave-cultural-corridor-or-urban-scar/
118. https://www.ec.gc.ca/dd-sd/default.asp?lang=En&n=892FBDA6-1#s2
119. https://www.mcgill.ca/urbanplanning/planning
120. http://www.wbdg.org/design/sustainable.php
121. http://www.scientificamerican.com/article/greenwashing-green-energy-hoffman/
122. http://dictionary.reference.com/browse/greenwash
123. http://www.canadainternational.gc.ca/mexico-mexique/canmex.aspx?lang=eng
124. http://www.epa.gov/greenbuilding/pubs/whybuild.htm
125. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f85552cc66061410VgnVCM10000071d60f89RCRD.
126. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=8131fbfa98491410VgnVCM10000071d60f89RCRD
127. http://www.tdsb.on.ca/AboutUs/FacilityServices/SolarSchoolsProject.aspx
128. http://sbcanada.org/toronto2030district.html
129. http://www.cagbc.org/CAGBC/Resources/GreenBuildMarketRes2014/CAGBC/Resources/Green_Building_Marke.aspx?hkey=36b22df4-d4f7-4bc2-80da-fd8767ff42d6
130. http://www.international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/nafta-alena/index.aspx?lang=eng
131. http://www.canadainternational.gc.ca/mexico-mexique/canmex.aspx?lang=eng
132. http://www.edc.ca/EN/Country-Info/Pages/mexico.aspx
133. http://www.cec.org/about-us/NAAEC
134. http://www.c40.org/history
135. http://c40-production-images.s3.amazonaws.com/other_uploads/images/128_Advancing_Climate_Ambition.original.pdf?1411486101)
136. http://c40-productionimages.s3.amazonaws.com/researches/images/35_USGBC_C40_WGBC_City_Market_Brief_Compendium.original.pdf?1427985432
137. http://www.cagbc.org/News/EN/2016/20160203_News_Release.aspx
138. http://www.cagbc.org/News/EN/2015/20151005_News_Release.aspx

139. http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2010_national_building_code.html
140. http://www.buildforce.ca/en/system/files/products/green_sustainable_building_in_canada_0.pdf
141. https://www.ontario.ca/laws/regulation/r11397
142. http://www.nrcan.gc.ca/energy/efficiency/housing/leep/17338
143. http://www.greenbuildingcanada.ca/green-building-guide/green-building-certifications-rating-systems-canada/
144. http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/5085
145. http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/5051
146. http://www.greenbuildingcanada.ca/green-building-guide/green-building-certifications-rating-systems-canada/
147. http://www.enerquality.ca/program/greenhousetm/
148. http://www.efficaciteenergetique.gouv.qc.ca/en/my-home/novoclimat/#.Vrkr7FI1YZw
149. http://www.nowhouseproject.com/aboutWhatis.php
150. http://www.elfinanciero.com.mx/empresas/infonavit-fracasa-en-la-venta-de-vivienda-abandonada-en-mexico.html
151. https://www.bing.com/videos/search?q=NMX-AA-164-SCFI-2013&&view=detail&mid=36DDC1733E8350C9980936DDC1733E8350C99809&FORM=VRDGAR
152. https://www.iso.org/obp/ui/#iso:std:iso:15392:ed-1:v1:en
153. http://www.designingbuildings.co.uk/wiki/Building_user's_guide
154. Campos-Arriaga, L. (2015). *La NAMA de Vivienda. Política de vivienda sustentable del Gobierno de* http://www.conavi.gob.mx/images/documentos/sustentabilidad/Market_Readiness_Assessment.docx
155. http://www.nama-facility.org/projects/mexico.html
156. http://nama-database.org/index.php?title=Mexico
157. http://www.conavi.gob.mx/images/documentos/sustentabilidad/Urban_NAMA_ingl%C3%A9s.doc
158. http://www.conavi.gob.mx/images/documentos/sustentabilidad/Urban_NAMA_ingl%C3%A9s.doc
159. https://es-us.finanzas.yahoo.com/noticias/registrar%C3%A1-m%C3%A9xico-nama-urbano-mundo-192900253.html
160. http://www.nama-database.org/index.php/Mexico
161. http://www.fide.org.mx/index.php?option=com_content&view=article&id=121&Itemid=219
162. Sustainable Housing in Mexico and Latinoamerica : The Green Mortgage retrieved from: www.bshf.org/scripting/getpublication.cfm?...
163. http://www.passiv.de/en/03_certification/02_certification_buildings/04_enerphit/04_enerphit.htm
164. http://www.sustainablekingston.ca/our-community/sk-plan/four-pillars-of-sustainability/
165. http://www.aashe.org/
166. http://www.idrc.ca/EN/Themes/Environment/Pages/ResultDetails.Aspx?ResultID=223
167. http://talloiresnetwork.tufts.edu/blog/2016/03/15/civic-engagement-movement-mexico-in-2017/
168. http://www.centerforgreenschools.org/

169. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/consumption03/universities.cfm
170. http://www.ulsf.org/programs_talloires_history.html
171. http://www.ulsf.org/programs_talloires_td.html
172. http://www.iisd.org/educate/declarat/actionpl.htm
173. http://www.iisd.org/educate/declarat/swansea.htm
174. http://www.iisd.org/educate/declarat/coper.htm
175. http://www.ulsf.org/www.iau-aiu.net/content/rtf/sd_bkyoto.rtf
176. http://www.presidentsclimatecommitment.org/
177. https://stars.aashe.org/institutions/data-displays/dashboard/
178. http://www.aashe.org/
179. https://stars.aashe.org/pages/about/technical-manual.html
180. https://stars.aashe.org/pages/about/timeline.html
181. https://news.ontario.ca/tcu/en/2014/11/support-for-the-niagara-college-advanced-manufacturing-innovation-centre.html
182. http://sepn.ca/research_results/sustainability-canadian-post-secondary-institutions-leaders-laggards-live/
183. https://news.ontario.ca/tcu/en/2014/11/support-for-the-niagara-college-advanced-manufacturing-innovation-centre.html
184. http://www.mohawkcollege.ca/environmental-sustainability.html
185. https://www.dawsoncollege.qc.ca/sustainable/
186. https://www.dawsoncollege.qc.ca/sustainable/projects/carbon-neutral-project/
187. https://en.wikipedia.org/wiki/Dawson_College_shooting
188. https://www.dawsoncollege.qc.ca/sustainable/projects/peace-garden/
189. https://www.dawsoncollege.qc.ca/sustainable/projects/
190. http://ecopuma.unam.mx/movilidad.php
191. http://www.dforcesolar.com/energia-solar/la-alberca-olimpica-de-la-unam-caliente-gracias-a-la-energia-solar/
192. http://www.collegesinstitutes.ca/news-centre/perspective/perspectives-april-18/
193. http://www.nama-database.org/index.php/Low_Emission_Schools
194. https://issuu.com/dawsoncollegeqcca/docs/sc_final_report_online_version/1?e=2458721/32139909
195. https://www.dawsoncollege.qc.ca/sustainable/projects/mexico-project/
196. http://talloiresnetwork.tufts.edu/blog/2016/03/15/civic-engagement-movement-mexico-in-2017/
197. https://www.dawsoncollege.qc.ca/news/uncategorized/art-science-and-tradition-for-sustainability-a-forum-for-campus-sustainability/
198. http://www.wbdg.org/resources/greenprinciplesresdesign.php
199. http://dcra.dc.gov/page/green-construction-code
200. http://publicecodes.cyberregs.com/icod/igcc/2012/icod_igcc_2012_3_sec002.htm?bu=IC-P-2012-000023&bu2=IC-P-2012-000019
201. https://www.energycodes.gov/resource-center/ace/compliance/step2
202. Jones, 1998 Cited in UNEP, 2007, p. 7
203. https://www.pik-potsdam.de/news/press-releases/four-of-nine-planetary-boundaries-now-crossed
204. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3393065/
205. http://www.gsa.gov/portal/content/104462
206. http://www.usgbc.org/credits/mr21

207. https://www.researchgate.net/publication/257478981_An_overview_of_construction_and_demolition_waste_management_in_Canada_A_lifecycle_analysis_approach_to_sustainability
208. http://www.tpsgc-pwgsc.gc.ca/ecologisation-greening/achats-procurement/politique-policy-eng.html
209. http://internationaltransportforum.org/cpb/projects/urban-mobility.html
210. http://www.buildingecology.com/articles/calculating-greenhouse-gas-emissions-from-buildings/
211. http://www.wbdg.org/resources/greenhousegasemissions.php
212. https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=1357A041-1
213. http://www.igreenbuild.com/_coreModules/content/contentDisplay_print.aspx?contentID=3123
214. http://news.nationalgeographic.com/2015/11/151118-ten-countries-pledges-paris-climate-talks-warming-carbon/
215. http://bloomington.in.gov/green-building-benefits
216. http://www.wbdg.org/design/use_analysis.php
217. http://www.wbdg.org/design/utilize_management.php
218. http://www.c2es.org/technology/overview/buildings
219. http://www.awc.org/greenbuilding/factsheets
220. http://www.awc.org/greenbuilding/factsheets
221. www.mdpi.com/journal/sustainability
222. https://www.wbdg.org/design/sustainable.php
223. http://energy.gov/eere/femp/best-management-practices-water-efficiency
224. http://qcode.us/codes/santamonica/view.php?topic=8-8_106&showAll=1&frames=on
225. https://www.colgate.edu/docs/default-source/default-document-library/trudy-leed-certification.pdf?sfvrsn=0
226. http://www.oakville.ca/assets/general%20-%20environment/SustainableDesignGuidelines.pdf
227. https://www.eugene-or.gov/DocumentCenter/View/19567
228. https://www.bre.co.uk/page.jsp?id=1762
229. https://www.wbdg.org/resources/gbs.php
230. http://www.astm.org/SNEWS/ND_2009/sims_nd09.html
231. http://www.bioconstruccion.com.mx/ranking-2016-recuento-certificacion-leed-en-el-mundo/
232. https://www.thepmr.org/country/mexico-0
233. https://www.diariodemorelos.com/article/desciende-afiliaci%C3%B3n-%E2%80%98escuelas-verdes%E2%80%99
234. http://www.ulsf.org/programs_talloires_signatories.html#Canada

PDF documents retrieved

1. http://www.ceaa-acee.gc.ca/050/documents/p80001/84290E.pdf
2. http://sirepub.halton.ca/councildocs/pm/18/Jun%2010%202015%20Administration%20and%20Finance%20FN3415%20%20Randle%20Reef%20Update%20%202015%20%20FN3415%20%20Randle%20Reef%20Update%20%202015doc%20185695.pdf
3. http://www2.hamilton.ca/NR/rdonlyres/CB2B6D55-614D-414E-9665-93780CDD1185/0/Apr19EDRMS_n86769_v1_8_1__PW10042.pdf
4. http://www.biologicaldiversity.org/publications/papers/Silent_Spring_revisited.pdf
5. https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf
6. http://unhabitat.org/wp-content/uploads/2014/07/The-Habitat-Agenda-Istanbul-Declaration-on-Human-Settlements-20061.pdf
7. http://www.uncsd2012.org/content/documents/Supporting%20Local%20Action%20for%20Biodiversity.pdf
8. http://www.edu.gov.mb.ca/k12/cur/socstud/frame_found_sr2/tns/tn-43.pdf
9. www10.iadb.org/intal/intalcdi/PE/2013/11799.pdf
10. http://www.bre.co.uk/filelibrary/pdf/Brochures/BREEAM_Communities.pdf
11. www10.iadb.org/intal/intalcdi/PE/2013/11799.pdf
12. http://www.un.org/en/development/desa/policy/untaskteam_undf/groupb_unhabitat_suscities.pdf
13. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/5976/code_for_sustainable_homes_techguide.pdf
14. http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/WWDR4%20Volume%201-Managing%20Water%20under%20Uncertainty%20and%20Risk.pdf
15. http://www.usgbc.org/sites/default/files/Water%20Conservation%20in%20Californias%20Green%20Buildings_GBIG%20Insight.pdf
16. http://www10.iadb.org/intal/intalcdi/PE/2013/11799.pdf
17. http://www.repsa.unam.mx/documentos/Camarena_2010_Xerojardineria-imprenta.pdf
18. http://proyectos2.iingen.unam.mx/LACClimateChange/docs/boletin/Nota15.pdf
19. http://www.canadawood.cn/downloads/pdf/sustainability/sustainability_english.pdf
20. http://www.umich.edu/~nppcpub/resources/compendia/ARCHpdfs/ARCHsbmIntro.pdf
21. www.epa.gov/greenbuilding/pubs/gbstats.pdf
22. www3.gov.ab.ca/env/waste/aow/crd/publications/CRD_Report_All.pdf
23. http://www.guanajuato.gob.mx/iee/expo-pdf/soluciones.pdf
24. http://www.seas.columbia.edu/earth/wtert/sofos/GWMS_paper_Themelis_Oct2008.pdf
25. http://www.worldgbc.org/files/6314/1152/0821/WorldGBC__Health_Wellbeing__productivity_Full_Report.pdf
26. http://webarchive.nationalarchives.gov.uk/20110118095356/http:/www.cabe.org.uk/files/future-health.pdf
27. http://www.worldgbc.org/files/1513/6608/0674/Business_Case_For_Green_Building_Report_WEB_2013-04-11.pdf
28. http://www.worldgbc.org/files/8613/6295/6420/World_Green_Building_Trends_SmartMarket_Report_2013.pdf
29. http://www.prres.net/Proceedings/..%5CPapers%5CReed_International_Rating_Tools.pdf
30. http://www.cabrillo.edu/~msoik/3/LEED%20v4%20guide.pdf
31. https://www.nrdc.org/sites/default/files/citizens_guide_LEED-ND.pdf

32. http://www.zerocarbonhub.org/sites/default/files/resources/reports/Lessons_from_Germanys_Passivhaus_Experience(NF47).pdf
33. http://gse.cat.org.uk/downloads/passive_house.pdf
34. http://www.passiv.de/downloads/03_certification_criteria_residential_en.pdf
35. http://gse.cat.org.uk/downloads/passive_house.pdf
36. http://www.islington.gov.uk/publicrecords/library/Environmentalprotection/Information/Guidance/2011-2012/%282012-03-03%29Introduction_to_BREEAM_and_CSH.pdf
37. https://www.energystar.gov/ia/home_improvement/HPwES_Program_Plan_Template.pdf
38. http://www.edsf.com/fileadmin/user_upload/Dokumente/2013/Sustainability_Certification_Systems.pdf
39. http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/94372/ESL-IC-10-10-01.pdf
40. http://cal.abe.kth.se/uploads/Reports/Eco-cyclemodel2.0.pdf
41. https://www.sweco.se/Global/Sweden/Areas%20of%20operation/Architecture/Documents/SUCI_brochure_US_english_100dpi.pdf
42. http://siteresources.worldbank.org/INTEASTASIAPACIFIC/Resources/226262-1246459314652/Eco2Cities_PartThree_ConfEdition6-26-09.pdf
43. http://www.ewg.apec.org/documents/EWG34PledgeReview_Mexico.pdf
44. http://www.oecd.org/mexico/42876980.pdf
45. http://www.iso.org/iso/theiso14000family_2009.pdf
46. http://www.hkeia.org/iso50001/eguidebook/ISO50001%20guide_ENG%2019Aug(Final).pdf
47. https://www.unikassel.de/maschinenbau/fileadmin/datas/fb15/100725_EuroSun2010_Paper_headline.pdf
48. http://meteonorm.com/images/uploads/downloads/mn71_software.pdf
49. http://aceee.org/files/proceedings/2014/data/papers/11-203.pdf
50. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oee/files/pdf/publications/13-0431_CanQuest_e_Access.pdf
51. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/pdf/fichier/79060/EE4-English-2008-02-01.pdf
52. http://aceee.org/files/proceedings/2014/data/papers/11-203.pdf
53. statements/Environmental_Issues_and_Sustainable_Development_Policy_Statement_EN.pdf
54. http://www.sma.df.gob.mx/sma/links/download/archivos/paccm_summary.pdf.
55. http://www.conuee.gob.mx/work/sites/CONAE/resources/LocalContent/8711/1/PCESparaforodeCONUEE6mrzo.pdf
56. http://www3.cec.org/islandora/en/item/2335-green-building-in-north-america-opportunities-and-challenges-en.pdf
57. http://www.buildforce.ca/en/system/files/products/green_sustainable_building_in_canada_0.pdf
58. http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/oee/files/pdf/2012%20R2000%20Standard%20EN.pdf
59. http://biblioteca.semarnat.gob.mx/janium/Documentos/Ciga/agenda/DOFsr/DO3156.pdf
60. http://www.conavi.gob.mx/images/documentos/sustentabilidad/2_NAMA_for_Sustainable_New_Housing_with_Technical_Annex.pdf
61. http://www.conavi.gob.mx/images/documentos/sustentabilidad/3_NAMA_for_Sustainable_Housing_Retrofit.compressed.pdf

62. http://www.conavi.gob.mx/images/documentos/sustentabilidad/2_NAMA_for_Sustainable_New_Housing_with_Technical_Annex.pdf
63. http://www.conavi.gob.mx/images/documentos/sustentabilidad/3_NAMA_for_Sustainable_Housing_Retrofit.compressed.pdf
64. http://www.ecpamericas.org/data/files/Initiatives/energy_efficiency_working_group/eewg_mexico_workshop/infonavit.pdf
65. http://www.passiv.de/downloads/03_certification_criteria_enerphit_en.pdf
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67. http://www.creativecity.ca/database/files/library/Creative_City_News_E.pdf
68. *http://www.unep.org/greeneconomy/Portals/88/documents/ger/GER_9_Buildings.pdf*
69. https://www.aianei.org/uploads/CES/2008/080724%20LEED%20for%20Schools%20Workshop%20-%20July%202008.pdf
70. http://www.usgbc.org/Docs/Archive/General/Docs5020.pdf
71. https://www.dawsoncollege.qc.ca/sustainable/wp-content/uploads/sites/85/Dawson-College-Premises-GHG-Assessment-Report-v2.0.pdf
72. http://idl-bnc.idrc.ca/dspace/bitstream/10625/52672/1/IDL-52672.pdf
73. http://www.sustainable-procurement.org/fileadmin/files/Other_publications/ICLEI-SP-Services-leaflet-2014-FINAL-WWW.pdf
74. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/325012/Cost_Led_Procurement_Guidance.pdf
75. http://www.oakville.ca/assets/general%20-%20environment/SustainableDesignGuidelines.pdf
76. https://www.croydon.gov.uk/sites/default/files/articles/downloads/decommissioning.pdf
77. NCRACCESS-P104.pdf
78. http://www.wsdot.wa.gov/NR/rdonlyres/27A54B86-9825-4E819DEE138823B4ED86/56842/QMPOutline0504091.pdf

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TALLOIRES DECLARATION INSTITUTIONAL SIGNATORY LIST (as of January 14, 2016)
Total Signatory Institutions: 499

Mexico
El Colegio de Jalisco, A.C., Guadalajara
El Colegio de Mexico, Mexico City
El Colegio de Michoacan, A.C., Zamora
El Colegio de Sonora, Hermosillo
El Colegio Mexiquense, A.C., Toluca, Edo
Instituto Tecnológico y de Estudios Superiores de Monterrey, Monterrey

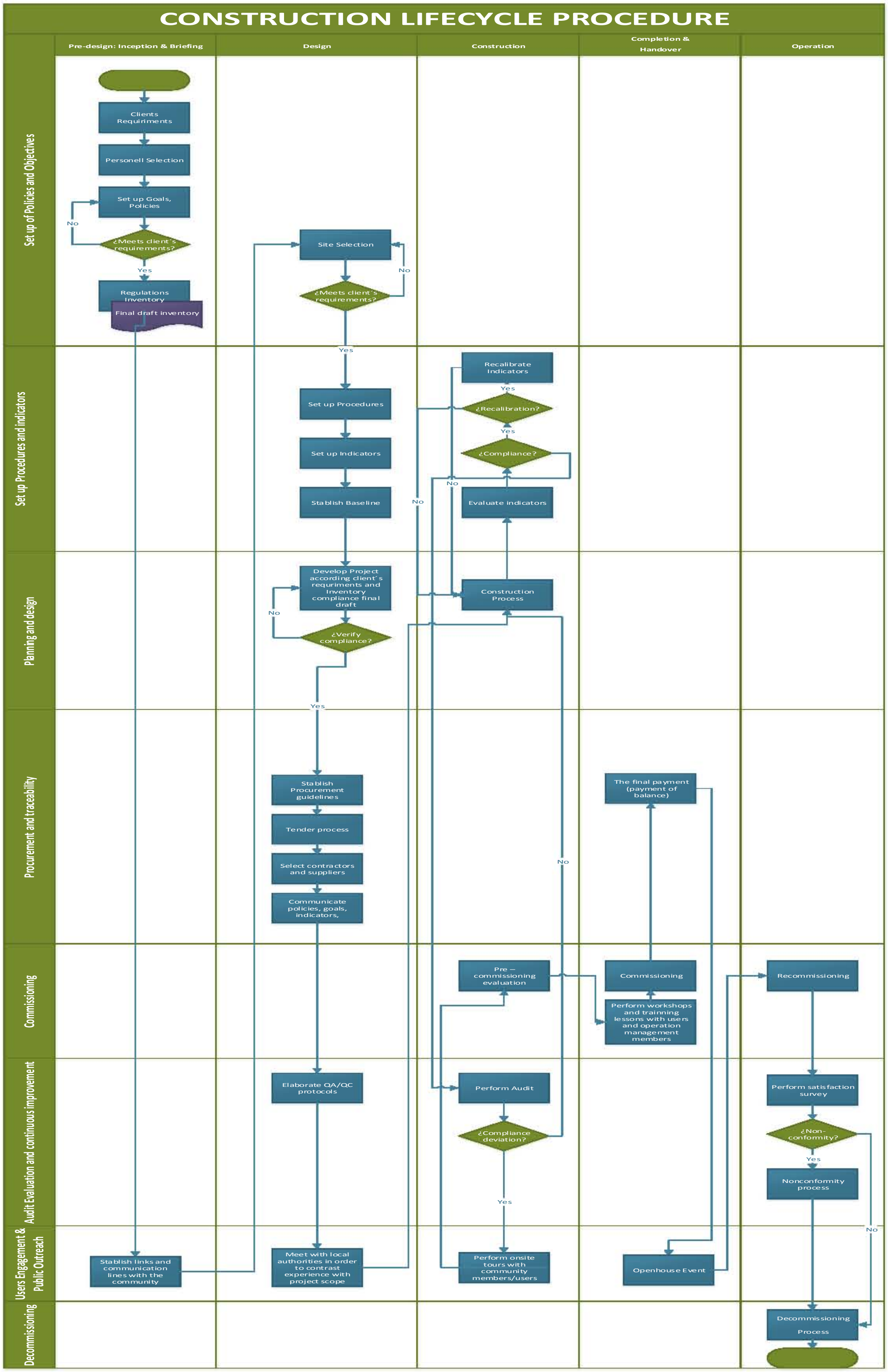
[429] http://www.ulsf.org/programs_talloires_signatories.html#Canada

Universidad Juarez del Estado de Durango, Durango
Universidad Nacional Autonoma de Mexico, Mexico City
Universidad Regiomontana, Monterrey

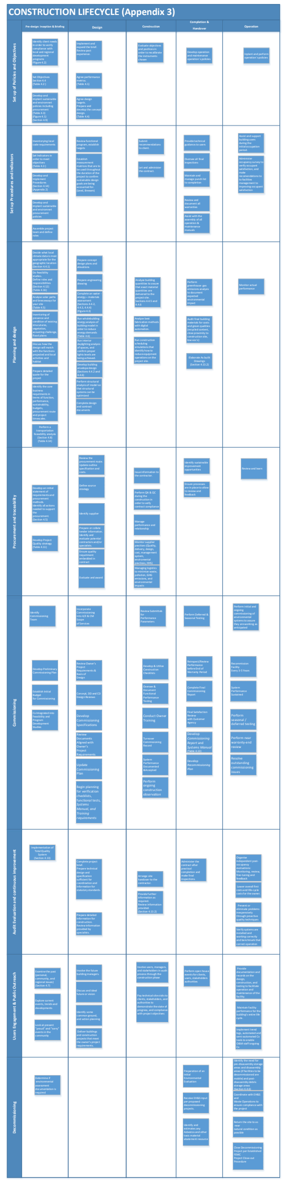
Canada
Acadia University, Wolfville, Nova Scotia
Algonquin College, Ottawa, Ontario
Atlantic School of Theology, Halifax, Nova Scofia; The Rev DrGordanMcDermid, President; 1991
Bishop's University, Sherbrooke, Quebec; Michael Goldbloom; Principal and Vice-Chancellor; 2010
Carleton University, Ottawa, Ontario
Concordia University, Montreal, Quebec
Dalhousie University, Halifax, Nova Scotia
Dawson College, Westmount, Quebec; Richard Filion, Derector General; 28 January 2009
Emily Carr Institute of Art and Design, British Columbia
Grant MacEwan College, Edmonton, Alberta; Dr Paul Byrne, President and CEO; 12 February 2009
Lakehead University, Thunder Bay, Ontario
Laurentian University, Thunder Bay, Ontario; Dominic Giroux, President and Vice Chancellor; 17 September 2014
McGill University, Monteal, Quebec
McMaster University, Hamilton, Ontario, Canada; Patrick Deane, President and Vice-Chancellor; 18 October 2010
Mount Saint Vincent University, Halifax, Nova Scotia
Okanagan College, Kelowna, British Columbia; Jim Hamilton, President; 14 January 2011
Red River College, Winnipeg, Manitoba, Stephanie Forsyth, President, 2 November 2012 (Can)
Royal Roads University, British Columbia; Allan Cahoon, President and Vice Chancellor; 28 February 2008
Ryerson Polytechnical Institute, Toronto, Ontario
Saint Francis Xavier University, Antigonish, Nova Scotia
Saint Mary's University, Halifax, Nova Scotia
Saint Thomas University, Fredericton, New Brunswick
Simon Fraser University, Burnaby, British Columbia, Dr William G. Saywell, President; 1991
Universite de Montreal; Guy Breton, Rector; 11 February 2001
University College of Cape Breton, Sydney, Nova Scotia; Dr Jacquelyn Thayer-Scott, President; 1991
University of British Columbia, Vancouver, British Columbia
University of Calgary, Alberta; John Peroration, Chair Board of Governors, Joanne Cuthbertson, Chancellor, Harvey Weingarten, President and Vice-Chancellor; 22 October 2007
University of Guelph, Guelph, Ontario
University of Lethbridge, Lethbridge, Alberta, Dr.Howard E. Tennant, President and Vice Chancellor; 1991
University of Manitoba, Winnipeg, Manitoba
University of Northern British Columbia; Dr. Charles J. Jago, President and Vice Chancellor; 24 August 2005
University of Ottawa, Ottawa, Ontario
University of Saskatchewan, Saskatoon; Dr. J. W. George Ivany, President; 1991
University of Victoria, British Columbia
University of Western Ontario, London, Ontario
University of Windsor, Windsor, Ontario

University of Winnipeg, Manitoba
Vancouver Island University, Nanaimo, BC; Ralph Nilson, President and Vice Chancellor; 6 March 2009
York University, Toronto, Ontario

Appendix 2


CONSTRUCTION LIFECYCLE PROCEDURE
Pre-design: Inception & Briefing
Design
Construction
Completion & Handover
Operation
Set up of Policies and Objectives
Set up Procedures and indicators
Planning and design
Procurement and traceability
Commissioning
Audit Evaluation and continuous improvement
Users Engagement & Public Outreach
Decommissioning
Clients Requirments
Personell Selection
Set up Goals, Policies
¿Meets client´s requirements?
No
Yes
Regulations Inventory
Final draft inventory
Site Selection
¿Meets client´s requirements?
No
Yes
Set up Procedures
Set up Indicators
Stablish Baseline
Develop Project according client´s requriments and Inventory compliance final draft
¿Verify compliance?
No
Yes
Stablish Procurement guidelines
Tender process
Select contractors and suppliers
Communicate policies, goals, indicators,
Elaborate QA/QC protocols
Stablish links and communication lines with the community
Meet with local authorities in order to contrast experience with project scope
Recalibrate Indicators
Yes
¿Recalibration?
Yes
¿Compliance?
No
No
Evaluate indicators
Construction Process
No
Pre – commissioning evaluation
Perform Audit
¿Compliance deviation?
Yes
Perform onsite tours with community members/users
The final payment (payment of balance)
Commissioning
Perform workshops and trainning lessons with users and operation management members
Openhouse Event
Recommissioning
Perform satisfaction survey
¿Non-conformity?
Yes
Nonconformity process
No
Decommissioning Process

Appendix 3



(See the print attached in the printing version)