



GREEN BUILDING
IN NORTH AMERICA

Paper 3a: Institutional Efforts for Green Building:

The Case of Mexico

Centro Mario Molina

TABLE OF CONTENTS

I. Introduction	3
II. Green Building in National Planning	3
II.1 National Development Plan, 2007–2012.....	5
II.2 National Urban Development and Land Use Planning Program, 2001–2006 (PNDU).....	7
II.3 National Environmental and Natural Resources Program, 2001–2006.....	11
II.4 National Energy Program, 2001–2006.....	13
II.5 National Housing Program, 2001–2006.....	14
II.6 Urban Development Plans or Programs.....	16
III. Elements of Sustainability in Building Codes	19
III.1 Building Codes and Local Zoning.....	22
IV. Laws and Standards Governing Product Environmental Performance	34
IV.1 Sustainable Energy Management Standards.....	35
IV.2 Sustainable Natural Resource Management Standards.....	37
V. Voluntary Green Building Promotion Programs	42
V.1 Profepa’s Voluntary Environmental Auditing Program.....	42
V.2 Mexican Institute of Intelligent Building.....	43
V.3 Mexican Green Building Council.....	43
VI. Financing for Green Building	47
VII. Green Building in the Mexican Educational System	50
VII.1 Undergraduate Level.....	50
VII.2 Graduate Level.....	51
VII.3 Certificate Programs.....	52
VIII. General Recommendations	55
IX. References	59

I. Introduction

This document analyzes the existing legal and institutional frameworks in Mexico in relation to construction activity with the purpose of identifying the obstacles to, and the potential for, green building in the country. Recommendations are included in each section with a view to smoothing the path towards achieving the sustainability objectives for building projects in Mexico posited in Paper One: Green Building Energy Scenarios for 2030.

II. Green Building in National Planning

The National Planning System (*Sistema de Planeación Nacional*—SNP) is the legal mechanism through which the federal government establishes its policies and programs for each six-year term of office. During the first six months of his administration, the President of the Republic must prepare The National Development Plan (*Plan Nacional de Desarrollo*—PND), which will serve as the basis for sector programs, and in turn, implementation activities. To promote green building in Mexico, this concept must first be introduced in the context of the SNP.

The first SNP came into force in Mexico 24 years ago, in January 1983, when *el Congreso de la Unión*, i.e., the Federal Congress (Mexico's government is comprised of three branches: the Executive, Legislative and Judicial) enacted the General Planning Act (*Ley General de Planeación*—LGP).¹ In so doing, it established the regulatory and legal foundations for planning in Mexico. Due to its general nature, application of this law falls under the jurisdiction of all three levels of government: federal, state and municipal. By national development planning is understood the organizing of the government's actions, in its different areas of jurisdiction, to regulate and foster national activity (see Diagram 1).

The LGP defines the responsibilities of the federal Executive (i.e., the President of the Republic) regarding its role in leading national development planning via the PND. The term of the latter is six years, as, in effect, each incoming presidential administration elaborates the PND, which is to govern the country's destinies for the duration of its mandate. The PND is elaborated and issued in the first six months of the presidential term. This is done with the participation of the different sectors of the population (i.e., social, political, business and academic organizations, as well as the general public) through an open democratic public consultation process. The Federal Congress then reviews the PND and adds its input prior to the PND's approval and publication.

Furthermore, the LGP establishes the various types of plans and programs comprising the SNP:

- a) The National Development Plan
- b) State development plans
- c) Municipal development plans
- d) The sector programs, which specify the actions of the National Plan in each sector under federal jurisdiction

¹ Ley de Planeación, *Diario Oficial de la Federación*, reform of 13 June 2003, Mexico.

- e) The institutional programs elaborated by the decentralized agencies of the federal government
- f) The regional programs are formulated to attend to priority or strategic areas of the country, which exceed any specific state's jurisdiction.
- g) Special programs designed to attend to the overall development priorities stipulated in the PND or to activities whose execution entails two or more public agencies.



Diagram 1. The National Planning System

National Planning System

In the pyramid:

Federation

State

Municipality

Top row:

National Development Plan – Environment – Urban Development – Housing – Energy
(under boxes: establishes national policy)

Middle row:

State Urban Development Plan of Baja California – Environment – Urban Development – Housing

(under boxes: establishes state policy)

Bottom row:

Municipal Development Plan 2002–2005 – Population Center Urban Development Plan – Environmental Land Use
(under boxes: regulates land use and building projects)

Among the PND’s 30 plus sector programs (also known as medium-term programs or PMPs) are the Housing, Energy, Human Settlements, and Environment and Natural Resources programs, all of which are relevant to green building.

For their part, the state and municipal governments engage in local planning, based on the provisions of the LGP, the SNP and the PND. State development plans have a term of six years, municipal development plans, three years. In all cases, these plans occasion government programs that remain in effect for the duration of the governments in question.

The actions contained in these stated plans and programs—which represent government commitments—are executed through the annual operating programs (AOPs) and the programming and budgeting processes that govern governments’ year-by-year expenditures. In the particular case of the President of the Republic, the Executive must present its yearly report, in the month of March, to the Congressional Standing Commission (*Comisión Permanente del Congreso de la Unión*) on the actions and results generated by the PND and PMPs.

At the time of this report’s writing, the PND of the incoming presidential administration was in the public consultation phase. Consequently, in lieu of the Plan per se, this report will include a brief summary of its highlights, as well as a review of the 2001–2006 PMPs (i.e., those of the previous administration), which pertain to the issue of green building.

II.1 National Development Plan, 2007–2012

As mentioned, the PND elaborated by the President of the Republic is the result of a broad public consultation process with a cross-section of society, including the indigenous communities, the three levels of government and the general public. As a means of gathering demands and proposals, this process represents, in effect, a commitment to society on the part of the federal government. The PND sets the objectives, policies and strategies that shall orient the government during its six-year mandate. The 2007–2012 PND sets a long-term objective for the Mexico of 2030: to become a country engaged in sustainable development, where the culture of respect for the environment and conservation is paramount.²

The 2007–2012 PND does not directly allude to “green building” or to “green buildings.” Nevertheless, the issue of sustainable development is incorporated as a fundamental aspect of the national strategy and of the objectives corresponding to the energy, environment and construction sectors (in particular, housing). Consequently, among the objectives mentioned is

² Presidencia de la República, Decreto por el que se aprueba el Plan Nacional de Desarrollo 2007-2012, *Diario Oficial de la Federación*, 31 May 2007, Mexico.

the need to: “Ensure environmental sustainability via Mexicans’ responsible participation in the stewardship, protection, preservation and rational exploitation of the country’s natural wealth, and, in so doing, consolidate economic and social development without compromising the natural heritage and quality of life of future generations.”

The PND articulates its objectives and strategies around five priorities, one of which is environmental sustainability: “If Mexico is to achieve true environmental sustainability it’s necessary to reconcile the environment with two other important facets of sustainable human development, namely productivity and the competitiveness of the economy as a whole.”

Thus, with the PND the federal government undertakes to join the international community’s vast campaign to avoid irreversible damage to the planet by phenomena such as global warming.

To reduce greenhouse gas emissions, the Government of Mexico will encourage the efficient use and management of energy along with the adoption of clean technologies. In the domestic sector, it proposes to promote the use of energy saving lamps and thermal isolation in housing. Similarly, it is proposed that new housing designs integrate efficient energy use criteria.

Furthermore, the federal government recognizes that understanding the constituent elements of the environment requires a holistic perspective. Hence, its acceptance of the strategic role that other stakeholders play in working towards the country’s sustainable development. The PND undertakes to convert environmental sustainability into a crosscutting public policy priority to ensure that all projects, particularly infrastructure and economic projects, are compatible with environmental protection.

Interinstitutional and intergovernmental coordination is also necessary to achieve this objective. Consequently, the PND recognizes the need for close coordination and integration of efforts between federal agencies, the three levels of government, and the three branches of the federal government, in the elaboration and implementation of environmental sustainability related policies.

Research into sustainable technological development is another federal government priority mentioned in the PND. This priority could take the form of support for applied research projects, for example. A specific case would be the development of energy recovery technologies to enable exploitation of the energy potential in waste matter generated by various activities.

Also, the PND recognizes that the country’s regional diversity imposes legal jurisdictional issues and restrictions on sustainable development. Consequently, the PND undertakes to orient land use, planning and management strategies in a manner that takes into account the characteristics of Mexico’s different regional or subregional jurisdictions. This latter task requires the participation and input of a broad range of stakeholders.

Concerning urban development, the PND takes responsibility for achieving a national land use pattern that will slow the chaotic growth of urban areas, provide land apt for urban development and facilitate access to services and facilities in both urban and rural communities. To this end, it

will undertake construction projects in accordance with the orderly, rational and sustainable development of human settlements.

Furthermore, the PND undertakes to increase the joint participation of the federation, states and municipalities with a view to creating the incentives needed to update and harmonize regulations, standards and building codes for different geographical areas and/or climate zones. In this area, the PND recognizes the need for proper coordination, interinstitutionally and between the three orders of government.

As for housing, the PND does not allude to the development of sustainable housing. That said, it does undertake to promote the creation of a National Information and Indicators System designed to record the variables needed to enable diagnostic and prospective analysis of the needs and growth trends in the country's housing sector. As such, it would serve as a tool for effective planning of public strategies and actions.

Recommendations

- To obtain quantifiable results by 2012 on this issue, it is, in principle, necessary to firmly establish the concept of *green building* and to develop concise guidelines that foster the use and adoption of clean and environmentally sustainable technologies in the construction industry. This is particularly so regarding certain PND 2007–2012 sector programs: i.e., Urban Development and Land Use Planning, Environment and Natural Resources, Energy, Housing and Education.
- Promote the inclusion of green building policies, strategies, guidelines and criteria in local planning. This is a task in which the local authorities responsible for approving or rejecting building projects will be called on to play a strategic role as leading actors in favor of green building.

II.2 National Urban Development and Land Use Planning Program, 2001–2006 (PNDU)

Urban planning in Mexico is one of the oldest types of planning in the federal government. Its origins date back to the 1930 General Planning Act of the Republic (*Ley sobre la Planeación General de la República*).³ That legislation sought to coordinate and orient the activities of the government's various agencies to achieve the material construction and development of the country in an orderly and harmonious fashion, in accordance with its topography, climate, population, history and traditions, its functional, social and economic life, national defense, public sanitation, and present and future necessities.

To achieve this objective, the federal government took up the challenge of elaborating “the National Plan of Mexico” (*Plano Nacional de México*), which included issues such as: the division of the national territory into zones, classified in accordance with their characteristics,

³ Secretaría de Desarrollo Social, *Programa Nacional de Desarrollo Urbano y Ordenación del Territorio 2001–2006*, Mexico, 2001.

functions, uses or intended uses; urban and regional planning and zoning; and the elaboration of regulatory plans for the Federal District and territories, among other issues.⁴

It was the Secretariat of Social Development (*Secretaría de Desarrollo Social—Sedesol*), the federal government agency now in charge of attending to the questions inherent to urban development, which formulated the 2001–2006 National Urban Development and Land Use Planning Program (*Programa Nacional de Desarrollo Urbano y Ordenación del Territorio—PNDU*). The PNDU establishes the principles, objectives, strategies and guidelines determining the organization of the federal government’s action in this area.

The PNDU established, within the framework of sustainability issues, a land use planning policy that integrates every territorial jurisdiction and settlement, from small and dispersed rural localities to major metropolises, into a planning and action schema that proposes to combat the structural causes of poverty and marginalization, maximize economic efficiency and strengthen the country’s political, social and cultural cohesion.

With this in mind, the PNDU set itself three strategic objectives for the year 2006 and, looking forward, the year 2025: 1) maximize economic efficiency in the country while guaranteeing social and cultural cohesion; 2) create synergies by sustainably integrating the National Urban Development System with regional development; and 3) integrate urban lands apt for development in support of urban growth. As for the environment, the program aims to achieve social and human development in harmony with nature and to create the necessary conditions for sustainable development.

To achieve these three objectives, three complementary strategies were defined to promote: a) a governmental policy on land use planning and regional urban activities; b) a national urban and regional development policy to favor strategic projects with a comprehensive vision of regions, metropolitan areas and cities; and c) a national policy on land and land banks.

The next level in urban planning takes the form of State land use planning programs (*programas estatales de ordenación del territorio—PEOT*). This function of state governments has could potentially play an important role in fostering green building, as PEOTs constitute the principal regulatory framework for inducing local governments (i.e., municipalities) to modernize their urban development programs.

The following are among the most important elements included in PEOTs:

- ✓ Precise definitions of the opportunities and limitations on land use imposed by natural conditions
- ✓ Land use vocations
- ✓ Urban development risk restrictions
- ✓ Areas with natural characteristics suitable for inclusion in a protection program
- ✓ Spatial and functional integration of human settlements
- ✓ Scenarios on land use and development of state territory

In these land use planning programs it is also possible to promote the incorporation of planning criteria to encourage the adoption, in the public, private and social sectors, of instruments that foster the construction of green buildings, promote sustainability approaches in the real estate

⁴ Semarnat, *La ordenación del territorio*, document consulted online: <www.reliot.ine.gob.mx/otsedesol.html>.

market and establish the foundations for the gradual incorporation of sustainability standards by businesses specializing in housing construction.

The PNDU also acknowledges the country's urban deficits which are prevalent and an impediment to achieving favorable comfort levels in living conditions: "If we just consider the 124 cities with over 50,000 inhabitants in the year 2000, 35 had high or very high levels of basic infrastructure coverage. That is to say over 75 percent of the dwellings in these cities had drinking water and electricity and were connected to a public sewer system. Ten of these cities are state capitals in the central and northern areas of the country. In contrast, the cities where tourism is important have low levels of municipal coverage, ranging from medium to low and very low, i.e., less than 50 percent of dwellings enjoy these three basic amenities. The contrast is particularly striking with the cities on the northern border where, for the most part, levels of coverage range from medium to very high."⁵

To these lags in the provision of municipal public services must be added the slowness of cities to support the clean technologies that green building requires, such as separating rainwater sewer systems and sanitary sewer systems, and putting in place the infrastructure necessary to recycle wastewaters.

Another section of the program underlines that "in 84 percent of the 124 cities with over 50,000 inhabitants less than 50 percent of the road network is paved. Furthermore, in Mexico there is an unequal distribution of health care, higher education and research facilities, as these are mostly concentrated in the Mexico City Metropolitan Area, the surrounding cities and state capitals."⁶

The quality of housing is another basic indicator of the physical conditions in a city and of the quality of life of its inhabitants. In the year 2000, 55 percent of the 124 urban localities with over 50,000 inhabitants were characterized by housing quality levels from medium to low and very low, i.e., at least a third of the housing units in these cities had dirt floors and walls and roofs made of non-permanent materials. Moreover, as with urban infrastructure, in addition to the existing deficiencies in terms of housing quality the expected increases in urban populations will bring new challenges. In effect, the total housing stock will rise from 21.9 million houses to 45.2 million houses in the next 30 years—houses that need to be built with techniques and procedures that ensure less environmental impact and real possibilities for increasing the quality of life of their inhabitants. With these lags in the quality of public services and housing, greater efforts are required on the part of all stakeholders if poverty is to be reduced and progress made towards sustainability in the long run.

The PNDU notes that to confront the demands stemming from accelerated urban growth increasing responsibilities have been transferred to local authorities in terms of providing services and building urban infrastructure and public facilities. Today, municipal responsibilities include: administering the zoning by-laws in municipal urban development plans; participating in the creation and administration of land banks; controlling and monitoring land use in their jurisdictions; regularizing land tenancy on urban lands; granting construction licenses and permits; and participating in the creation and administration of ecological reserves.

Consequently, the municipality is the level of government closest to the community in terms of attending to and resolving its most immediate problems and necessities. It is, therefore, at the

⁵ Ibid.

⁶ Comisión Nacional de Fomento a Vivienda, 2006, Mexico.

local level where the greatest efforts must be deployed to ensure that sustainability concerns be incorporated into new building projects, via standards, regulations, and urban development plans and programs.

For reasons already mentioned, urban development plans or programs (PDUs) are the instruments that regulate land use and establish rules on the types and intensities of land use, as well as specific spatial planning. This is a function constitutionally reserved for municipalities, to be exercised by municipal governments. However, certain exceptions exist, such as when the territory covered in a plan exceeds the boundaries of a single municipality (in which case the state government has jurisdiction) or those of a single state (in which case jurisdiction is federal). All construction projects executed in any part of the national territory must comply with the specifications and regulations stipulated in the PDUs; similarly, the PDUs must comply with the regulations defined by higher level planning authorities (state urban development programs and the PNDU).

Of the three levels of urban planning—federal, state and municipal—it is the Executive that is charged with elaborating the respective plan or program, consulting citizens, and submitting it to the Legislature for its consideration and approval, prior to its final publication. Concerning the environment, the 2001–2006 version of the PNDU made vague commitments that were difficult to measure and, consequently, hard to assess in terms of compliance. Sedesol's role in the updating of the 2007–2012 program is crucial in terms of incorporating clearer strategies with quantifiable and measurable targets, which establish short and medium term commitments aligned with the present government's mandate—as well as being framed in terms of a long-term perspective, with the year 2030 as its horizon.

Sedesol, as the federal agency responsible for setting national urban development policy, and in light of its leading role in the formulation of the 2007–2012 PNDU, should join the efforts to foster a new sustainable urban culture. With Sedesol's participation and the incorporation of sustainable urban development strategies in the PMP, synergies would be unleashed at the local level, which would in turn generate innovative initiatives and proposals to be incorporated into the local urban planning process.

Recommendations

- Include in the 2007–2012 PNDU a strategic orientation on green building that considers, among other issues, the commitment to adopt sustainability criteria and standards in building projects, as well as the strengthening of said criteria and standards via clear urban zoning policies and the promotion of state and municipal urban development programs.
- That Sedesol, in light of its leading role in the implementation of the PMP, foster the new urban environmental conscience in a crosscutting fashion among federal government agencies and organizations, local governments, the social and private sectors, and civil society organizations. Such major efforts should unleash synergies at the local level that will generate innovative initiatives and proposals to be incorporated into the local urban planning process.
- Direct the greatest possible effort to ensure that sustainability translates into actual standards, regulations, and urban development plans and programs.

- Eliminate the components of urban development programs that hinder or block sustainable development, and promote land use provisions that foster responsible development.
- Include awards programs and incentives to encourage local authorities to engage in sustainable and responsible planning.
- That the federal government develop, via Sedesol and Semarnat, a strategy to establish environmental regulations focused on national urban development.

II.3 National Environmental and Natural Resources Program, 2001–2006

The National Environmental and Natural Resources Program (*Programa Nacional de Medio Ambiente y Recursos Naturales—PMA*)⁷ begins with an assessment of the state of the environment at the time of its elaboration. Based on that assessment, the PMA establishes the policy, lines of action, projects, targets and environmental management activities to be executed during the program's six-year term. It also encompasses sector programs on water, forestry resources and Protected Areas, as well as the Federal Attorney on Environmental Protection. All of these programs are 1) mutually compatible and 2) aligned with the provisions of the PMA.

The PMA's ecological policy is based on six pillars: comprehensiveness, commitment on the part of federal government sectors, new management, valuing natural resources, compliance with the law and fighting environmental impunity, social participation and accountability.

The PMA is therefore defined by four strategic programs:

1. Stopping and reversing the contamination of life-sustaining systems (water, air and soil)
2. Stopping and reversing the loss of natural capital
3. Conserving ecosystems and biodiversity
4. Promoting sustainable development

Due to the very newness of the green building concept, the PMA makes no mention of it. That said, the PMA establishes a general framework for action in which green building approaches are fully compatible with its vision. The PMA establishes, among other orientations, the need to foster an ecological culture that contributes to good stewardship of the environment, ensures that cities, beaches and rural areas are kept clean, and promotes environmentally rational waste management. The PMA also proposes a new model in favor of cities that are more human, less congested and less polluted. To this end, it recommends encouraging scientific research and technological innovation to stimulate experimentation and the development of clean production processes and technologies.

⁷ Secretaría de Medio Ambiente y Recursos Naturales, *Programa Nacional de Medio Ambiente y Recursos Naturales 2001– 2006, Síntesis ejecutiva*, 2001, Mexico.

The PMA includes targets on reducing the levels of air, water and soil pollution, as well as on reversing the loss of natural capital (water resources, forests, jungles and wildlife). Advocating adoption of green building would constitute a significant contribution to achieving these aims.

The environment sector's instrument for land use planning and action is known as the Program for Environmental Land Use Planning (*Programa de Ordenamiento Ecológico del Territorio*—POET). Compared with the PDUs described above, POET is a relatively new instrument, one that dates back to the first version of the General Law on Ecological Balance and Environmental Protection (*Ley General del Equilibrio Ecológico y la Protección al Ambiente*), enacted on 28 January 1988.

Like PDUs, POETs also encompass three jurisdictions: the national, which is a federal responsibility (exercised by Semarnat); the regional, which is under the purview of the state governments; and the local, which is the bailiwick of municipal governments. POETs establish land use and building regulations, as well as spatial planning. Both instruments, PDUs and POETs, regulate the same areas. However, their methodologies differ, as do their areas of focus:⁸ the former attends to social concerns while the latter deals with environmental issues.

In concluding this section, one issue stands out: the need to increase the presence of green building in national environmental policy. Progress could be made if this concern is indeed incorporated into the national strategy of the upcoming PMP, along with several of its ancillary programs (Environmental Land Use Planning, Environmental Impacts and Research), and in regulations as well.

Recommendations

- Include in the 2007–2012 PMA a section establishing, in detail, the commitments to be assumed by the environment sector in relation to green building. In addition to developing the standards and regulations establishing the basic mandatory environmental standards for future building projects in the country, signals must be given on the actions needed to promote the voluntary adoption of more efficient environmental standards in the construction sector. It would be advisable to offer innovative economic instruments to real estate developers that would make it economically viable to adopt lower environmental impact construction materials, equipment and systems. For example, exemptions could be granted regarding the requirement to produce an Environmental Impact Statement (*Manifestación de Impacto Ambiental*) for real estate developments that have already demonstrated compliance with established quality standards, i.e., which have been certified as green building projects.
- That the environmental land use planning done in priority urban development zones (i.e., mainly tourist areas) incorporate criteria, such as certification of environmental quality, of benefit to the market for green real estate development projects.

⁸ This situation has given rise to conflicts between federal and municipal authorities in both sectors, i.e., urban development and environment. A major example of this type of conflict was the one opposing the municipal authorities of Isla Mujeres, in the state of Quintana Roo, and Semarnat, due to the differences between their respective regulations in a fragile coastal zone populated by fauna not covered by any category of protection. A ruling by the Supreme Court was required to resolve this conflict.

- Encourage organizations such as the National Ecology Institute (*Instituto Nacional de Ecología*) in the elaboration of the studies required to quantify the reductions in carbon emissions induced by green building, such that it may be possible to assign prices to these reductions in the carbon credits market.

II.4 National Energy Program, 2001–2006

This program⁹ is considered strategic for national development. First, because in Mexico energy generation is reserved for the public sector, and second, because the energy sector is an important part of the economy *per se* in that it provides society with an indispensable service and incorporates strategic value into all other sectors of the economy. This sector encompasses a broad spectrum of economic activities, from natural resources extraction to final uses in industry, services, the residential sector and transport. The energy program has two priorities: 1) ensure the efficient use of energy from conventional systems to make them environmentally acceptable and 2) encourage the development of renewable energies and emerging technologies.

Regarding the use of renewable energies for electricity generation—such as wind, solar or biomass—the program also proposes to introduce new energy storage and transportation systems, such as hydrogen, an energy vector applicable to both transportation and stationary uses, and to enhance the possibilities offered by innovative systems, such as fuel cells. The program’s section on renewable energies stresses that intensifying technological development requires research, in all its forms, and concrete demonstrations to facilitate adoption of new technologies in industry and, more generally, in the market as a whole. On this point, it’s also important to promote technology transfer to facilitate the incorporation of new and better processes and products that orient the construction industry towards adoption of sustainability standards.

Another strategic issue that could not fail to be included in the energy program are the Kyoto Protocol commitments assumed by Mexico on the reduction of greenhouse gas emissions. This requires reducing the consumption of fossil fuels through the development of the fuels that generate the least emissions, increasing energy efficiency throughout the entire production and consumption cycle of conventional energies, and encouraging alternative technologies, renewable energies and nuclear energy, whether fission or fusion. Engaged in this commitment are pioneering groups such as those that have joined the movement to steer the construction sector towards green building.

Regarding technological development, the federal government’s Energy Secretariat has undertaken to continue with the progressive reduction of emissions of conventional combustion contaminants (sulfur dioxide, nitrogen oxides, volatile hydrocarbons, solid particulates, etc.), through the development of technologies that improve the equipment used in energy transformation and utilization. These emissions particularly affect air quality in urban areas with high concentrations of industrial activity. Similar considerations obtain as regards water and soil contamination arising from energy production and transformation processes.

⁹ Secretaría de Energía, *Programa Sectorial de Energía 2001–2006*, Mexico, 2001.

As for the future, the program posits the use of conventional energies, with gradual adjustments, to the extent possible, towards criteria compatible with sustainable development. Apparently, the priorities are to optimize the conventional forms and uses of energy to render them cleaner and more efficient, and also to encourage the use of renewable energies and emerging technologies.

The conclusion that emerges from this program review is the full compatibility between its objectives and those of the green building movement. In effect, achieving the latter's objectives would contribute to achieving the program's objectives, in that both posit the urgency of 1) making more efficient use of conventional energy sources and 2) fostering the development of alternative and renewable sources.

Be that as it may, research and technological development must continue at every level of the energy cycle. Likewise, it's vital to reduce individual consumption via the incorporation of new codes and standards on energy use and efficient energy management in green buildings.

Recommendations

- Continue research and technological development into sustainable energy at every stage of the production/consumption cycle to encourage the generation and use of alternative energies in buildings, principally those using renewable resources. Other goals include ensuring more efficient energy use and achieving residual carbon-neutral emissions, thus averting the environmental and ecological impacts of traditional production systems, such as thermal electric power plants.
- Promote cooperation agreements and technological exchanges with the other countries in the region on the challenges to be met regarding efficient energy management in buildings.
- Promote differential rates and fiscal and credit incentives that benefit consumers who can show that they've adopted energy generating or saving systems. The greater the savings, the greater the support and the greater the environmental and economic benefits.

II.5 National Housing Program, 2001–2006

Housing is one of the main priorities of social policy, as it constitutes a fundamental element in the well being of families due to the security and sense of belonging and identity that it provides. That said, in 1999 the National Housing Program (*Programa Sectorial de Vivienda—PSV*)¹⁰ noted an accumulated deficit of six million dwellings—along with the need to build 700 thousand new housing units per year to reduce the backlog and satisfy new demand. By the year 2010, the total housing stock must increase from 22 million housing units (in 1999) to 30.2 million units.

The plan's housing policy has two main components: 1) in conjunction with national and local housing organizations, strengthen coordination between the three levels of government and 2)

¹⁰ Comisión Nacional de Fomento a Vivienda, *Programa Sectorial de Vivienda 2001–2006, Resumen Ejecutivo*, Mexico, 2001.

widen coverage, mainly in social housing, through the participation of the public, social and private sectors.

The plan's strategic orientations are: institution building; improving and broadening financing services; deregulation and streamlining of bureaucratic processes; ensuring an accessible and sufficient supply of urban land; renovation and self-help housing; and encouraging technological development. Due to the vital importance of the latter element for the housing sector, it will surely be reincorporated into the new 2007–2012 version of the plan. Consequently, it will be feasible to have enhanced technology transfer recognized as a necessity of the different stakeholders involved in developing the green building sector.

Furthermore, the housing plan mentions, as an action for the short run, promoting the modernization of construction and development regulations, including those on the use of local construction materials and processes. In this regard, organizing forums, courses and seminars on green building has been important, which suggests that it is equally important to continue in the same vein so that in the medium term such efforts shall translate into regulations that are technically, socially and environmentally efficient.

The National Housing Development Commission (*Comisión Nacional de Fomento a Vivienda—Conafovi*)¹¹ has taken a first step in this direction with its Housing Construction Code (*Código para la Edificación de Vivienda*), a compendium of the regulatory instruments, with defined standards, in force in the country's different states and municipalities. The aim of this initiative is to initiate analysis and discussion of these standards in the interests of harmonizing the regulations in the different states and municipalities—while respecting these jurisdictions' autonomy and taking into account their particular characteristics (i.e., location specific bioclimatic, physical, technological, social, economic and cultural conditions).

Given the housing sector's present growth trends (and their expected continuation in the coming years), if the object is to obtain more and better results in terms of green building, one must propose that Conafovi establish medium-term targets—while maintaining a long-term perspective.

This strategy must also consider incorporating all stakeholders. The financial sector in particular is very important. It must be persuaded to participate via innovative market-based instruments. Hence the importance of learning about and disseminating the pertinent experiences in countries like Canada and the United States, as well as those in other parts of the world.

It would also be advisable to support Conafovi in the elaboration of its Guides, in particular, its Housing Construction Code. Moreover, this effort may be complemented by drawing lessons from domestic and foreign experiences, and by extending and promoting collaboration with academics, researchers, construction entrepreneurs, politicians and others. The purpose of such efforts: to generate, in the short-term, building regulations that are socially useful, technically solid and environmentally sustainable. In this regard, it recommended that a special section be proposed for inclusion in building regulations.

¹¹ Comisión Nacional de Fomento a Vivienda, *Hacia un Código de Edificación de Vivienda*, Mexico, May 2005.

Recommendations

- That the 2007–2012 PSV incorporate strategies with specific medium-term targets to induce quantifiable results in sustainable housing actions by 2030.
- Establish strategies to disseminate information among the different stakeholders in the housing construction process on the experiences in the planning and development of sustainable building projects in other cities, both in Mexico and abroad.
- Integrate an open information system, shared with the other countries of the region, on the state of sustainable housing in Mexico, which shall include performance indices and indicators.
- Establish exchange and cooperation agreements with Canada and the United States on scientific research and technological development in relation to green building.

II.6 Urban Development Plans or Programs

In Mexico, under the General Planning Act, municipal governments have the authority to plan land use in their own territories. Local governments have two planning instruments at their disposal: 1) the municipal development plans (*planes municipales de desarrollo*—PMD), which are part of the National Planning System and structured much like national and state development plans, and 2) the urban development plans (*planes de desarrollo urbano*—PDU), applicable to large population centers. The PMD sets the objectives, strategies and targets that a municipal administration undertakes to achieve, and, consequently serves as the basis for programming municipal public spending. The PDU is an instrument for regulating the growth of cities and the development of urban activities and building projects. Consequently, the application of a PDU affects society in its entirety, including the administrative functions of all three levels of government.

As for the elaboration and execution of plans or programs exceeding the boundaries of a given municipality—as happens in the case of conurbations—participants shall include the municipal governments concerned, in coordination with the relevant state government, and, should the national interest be at issue, the federal government may also intervene.

For such local planning to acquire legitimacy, The General Planning Act stipulates that civil society must be informed and that it must grant its approval. This is accomplished through open public consultation meetings. Following the consultation process—and integration of the resulting improvements, plans and programs are submitted for approval to the local legislature or town council. Once approved they are published in *diarios oficiales* (the Official Gazette) as well as in the local newspaper with the largest circulation. This planning instrument exists in practically all municipalities considered urban areas (i.e. with populations above 10,000).

Urban plans are generally composed of two parts: a main document and a cartographic appendix. The main document is usually divided into three sections: 1) “Diagnosis and Prognosis,” 2) “Strategy” and 3) a list of the instruments required to execute the plan.

The “Diagnosis and Prognosis” includes a characterization of the territory covered by the plan and the foreseeable trends in the short, medium and long runs, regarding: a) the physical environment (geography, geology, topography, pedology, hydrology and climate); b) the biotic environment (flora and fauna, and significant natural areas, including those under environmental protection); c) social and economic issues, including demographic trends; and d) urban issues (housing, roads, infrastructure, transportation, services and land uses). A major part of this section is concerned with urban assessments, including a summary of the city’s priority issues and challenges (including risk factors) in relation to the areas where it is lagging (e.g., attention to public services).

Based on the information contained in the diagnosis and prognosis, and in the various foreseeable scenarios, the plan’s “Strategy” section establishes an objective portrait. This in turn is the starting point for the comprehensive elaboration of a land use planning proposal that designates areas for different urban land uses, environmental conservation, growth in population centers, regional road networks, primary infrastructure networks and regional installations.

In addition, a master plan is elaborated, on a cartographic scale with greater detail, to indicate permitted, prohibited and mixed land uses, densities, urban centers and subcenters, neighborhoods, the primary and secondary road system, urban installations and public services. An indispensable element of the land use strategy are the urban development standards and criteria applicable to the urban strategies posited. Such standards and criteria include: maximum permitted heights, beams, building façades (e.g., permitted coverings on fronts, backs and sides of buildings), land use restrictions, building densities, land uses adjacent to urban corridors, criteria on urban centers, subcenters and heritage areas, permitted and prohibited installations, nomenclature, commercial signage, urban image, public uses, greenspaces, public and private parking lots, transportation, etc. Thus, this section may deal with urban zones or corridors as well as urban criteria and standards to encourage green building. In conclusion, it presents the works, services and actions required to attend to both the problems and issues identified in the diagnosis and to satisfy the expected demand driven by demographic growth.

The third and final part of any Urban Development Plan concerns the instruments that will be used to carry out the proposed urban strategy, including the different stakeholders, from the public, private and social sectors, who must contribute if the plan’s targets are to be achieved. The list of instruments includes actions carried out with public funds, actions requiring the municipal government to act in coordination with the other levels of government, and actions whose realization requires roundtable collaboration with the business community, civil society organizations, academia, the financial sector, and even political groups or parties. The proper elaboration of this section of the plan is of vital importance to the successful (middling or failed) execution of the plan’s posited strategy. This section may set policy on issues such as: the procedure for transferring development rights from one urban zone to another, urban renewal practices and policies, urban areas designated for the development of green building projects or rooftop gardens, etc.

Given that the implementation of green building projects depends in the end on the municipalities, as the jurisdictions with the authority to approve building projects, it is suggested

that they be informed and their participation fostered by way of conferences, workshops, symposia, forums, roundtables, etc. The goal being to encourage interest in green building and foster the sharing of experiences.

Such would facilitate proposing urban land use planning instruments to encourage the adoption of pro-green building strategies, such as systems for transferring development rights, and special development zones with specific land use standards favoring the application of green building quality standards. Likewise, the issuance of construction permits could be used as an instrument to ensure oversight of compliance with the applicable regulations—for example, the standard on energy efficiency in building shells.

Recommendations

- Continue research and technological development into sustainable energy at every stage of the production/consumption cycle to encourage the generation and use of alternative energies in buildings, principally those using renewable resources. Other goals include ensuring more efficient energy use and achieving residual carbon-neutral emissions, thus averting the environmental and ecological impacts of traditional production systems, such as thermal electric power plants.
- Promote cooperation agreements and technological exchanges with the other countries in the region on the challenges to be met regarding efficient energy management in buildings.
- Promote differential rates and fiscal and credit incentives that benefit consumers who can show that they've adopted energy generating or saving systems. The greater the savings, the greater the support and the greater the environmental and economic benefits.

III. Elements of Sustainability in Building Codes

The Constitution of the United States of Mexico (Section 115, paragraph II) grants municipalities the power to plan and regulate land use and building projects, manage land banks, intervene in the regularization of land tenancy, grant construction licenses and permits, and issue regulations and other provisions on public utilities as well as provide these latter services to the community. Moreover, to a large extent, these activities are carried out in accordance with the regulations stemming from municipal urban development plans and programs, municipal environmental land use planning and building codes, etc.

Building codes codify the requirements applicable to the actions of building, making an addition to, modifying or changing the use of a property or of its ownership status, or renovating or demolishing a building. However, building codes do not consider urban planning issues.

Until two decades ago, the elaboration of building codes was the responsibility of state governments. The role of municipalities was to see to their application, a situation that is changing, due to the amendment of Section 115. Presently, whereas every state government in Mexico has its own building code, the same may be said of just 72 of the country's 2,435 municipalities (plus 16 boroughs in the Federal District). In a word, less than 3 percent of the municipalities in the entire country have their own building codes, as distinct from those of their respective state governments.

A characteristic of the most recently updated building codes (those of the Federal District and the State of Mexico, for example) is the tendency to consign technical standards to appendices separate from the main body of the building code, such that only administrative type regulations and the general rules remain in the main text.¹²

Present Status of Municipal Building Codes in Mexico¹³

State	Num.	State	Num.	State	Num.	State	Num.
Aguascalientes	-	Federal District	-	Morelos	7	Sinaloa	2
Baja California	1	Durango	1	Nayarit	2	Sonora	2
Baja California Sur	-	Guanajuato	5	Nuevo León	6	Tabasco	11
Campeche	-	Guerrero	-	Oaxaca	-	Tamaulipas	-
Coahuila	1	Hidalgo	1	Puebla	-	Tlaxcala	-
Colima	4	Jalisco	5	Querétaro	-	Veracruz	2
Chiapas	8	México	-	Quintana Roo	5	Yucatán	3
Chihuahua	4	Michoacán	2	San Luis Potosí	-	Zacatecas	-

Moreover, great similarity is apparent between the administrative and technical requirements contained in building codes. For example, whereas the former generally deal with permits and licenses for private building projects or for the utilization of public thoroughfares, the latter specify characteristics in relation to habitability, structural security and functional aspects. In some municipalities, the technical issues are appended to the building code as complementary technical standards. Building codes typically contain the following provisions:

¹² In the Building Code of the Federal District, the specific regulations are contained in nine books, composed of 19 volumes.

¹³ Interpretation of information obtained from Conafovi. See bibliography.

- Administrative provisions in relation to proprietors
- Procedures for registering the names of the project manager and the other professionals in charge of project execution
- Required information on project scope and content when submitting a building project (e.g., habitability and functioning)
- Technical criteria for structural design calculations (e.g., seismic activity, wind).
- Mandatory fire prevention measures and measures for bringing fires under control
- Requirements to be satisfied during project execution

As may be seen, the issues covered vary widely. Moreover, some, which haven't been amended for many years, either are no longer in force or do not take into consideration the provisions in other statutes—for example, urban development, human settlement and environmental land use planning laws—or those in Mexican Official Standards.

In addition to building codes, building projects are also subject to a vast tangle of regulations, contained in diverse laws and regulations on: urban development, environmental protection, rights of disabled persons, subdivisions, civil protection, housing, the protection and conservation of monuments, potable water and sewer systems, zoning, environmental impact, urban impact, etc. Moreover, builders must respect other statutes such as: zoning by-laws and the rules in urban development programs, environmental land use planning (where it exists) and Mexican Official Standards. It is through the latter that the Mexican government establishes the rules on building design and construction, on energy efficiency, electricity, gas installations, the use and consumption of natural resources (such as water), liquid and solid waste management, etc.

Given this diversity, it's necessary to systematize the regulatory information generated by the three levels of government. Moreover, it is recommended that a section be incorporated into building codes which shall refer to this regulatory information system so as to enable builders to stay up to date. Moreover, more must be done to disseminate the NOMs applicable to building projects, both in the administrative agencies of state and local governments responsible for granting construction permits, as well as in the universities and professional colleges that train project managers and other project management professionals.

As for the general public, its lack of familiarity with the existing range of regulations is quite apparent—to which must be added the lack of sufficient information available to the individuals promoting the execution of any given construction project. It is common for such individuals to think that to go ahead with a building project one need only comply with the provisions of the building code. In fact, even some professionals entrusted with elaborating or coordinating a construction project hold the same belief. However, this is not the case. As mentioned, building codes only cover some of the issues to be complied with, notably habitability and structural security. In other words they are in fact complemented by other provisions.

To ensure compliance with this panoply of laws, regulations, standards and technical criteria, the provisions of building codes require that project managers and other project management

officials oversee compliance with all regulations. Hence the need to constantly update such professionals.

Given their key role in building projects, said professionals must assume their responsibilities in the face of the grave environmental crisis afflicting our planet. They must change their practices and adopt emerging measures to avoid the continued use of environmentally harmful construction systems, procedures and materials. It is no longer tenable to defer the adoption of clean practices such as the ones the CEC is promoting with green building. To this end, courses, seminars, workshops and other formal and informal educational activities should be encouraged to foster a new culture in the construction sector, one which will, in the short run, translate into the training of new professionals committed to sustainable development.

During a construction project, building codes require the maintaining of a project log to record observations, corrections, approvals and instructions from the Project Manager (PM) to the building contractor; an original numbered copy of this project log must, without fail, accompany the Project Completion Certificate, which is signed by the proprietor or his legal representative and the PM so that the competent local authority may grant the occupancy permit. Upon the project's conclusion, the PM delivers to the proprietor the original copies of the official final drawings of the completed project, the project log and the daily calculations log, while keeping a complete set of copies of these documents. Failure to comply shall result in fines for the proprietor and the PM. Observation of these rules contributes to ensuring quality services and works. It is proposed that an assessment be made of the advisability of 1) incorporating the monitoring and certification of the environmental quality of green buildings in the overall project monitoring procedure¹⁴ and 2) giving PMs the authority to act in this area, a step which would simplify progress in this regard.

In Mexico as a whole, the situation remains very diverse; according to Conafovi,¹⁵ in 2005, there were 104 building codes in the country: 72 municipal codes and 32 state codes. These 104 codes differ substantially in content and in their date of elaboration. Other sources consulted in 2007 refer to 120 building codes in force, which remains a very small number.

Along with its other activities, Conafovi is attempting to address this problem by elaborating technical guides¹⁶ intended for use by the different actors in the construction sector and by local governments as they formulate their building codes.

Finally, in addition to building regulations, some Mexican states also have Public Works Regulations designed to regulate spending and activities in relation to the planning, programming, budgeting, execution and/or preservation of municipal public works.

This type of regulation identifies the agencies that must be a party to the execution of public works projects and the conditions that shall govern this participation. These regulations stipulate

¹⁴ Such as the ones presently carried out by the Federal Attorney for Environmental Protection.

¹⁵ See the table entitled "Present situation of municipal building codes in Mexico", page 20 of the present document.

¹⁶ The National Housing Commission has published guides with sustainability criteria to be applied in housing construction on issues such as efficient water and energy use, and design of greenspaces. See bibliography. This section was written using this documentation.

that all works shall be subject to the provisions of the municipal budget or to the agreements that the municipality concludes with the state government.

Under the law, in complying with such Public Works Regulations, the builder must also comply with the legal provisions stipulated in urban development and environmental programs.

In conclusion, two major issues emerge in this section: 1) the near total absence of building codes with regulations corresponding to the particular conditions in each municipality and 2) the lack of an up-to-date and comprehensive vision that takes account of the vast range of existing regulations and responds to the vital issues of the day for the community. Among such issues are the ones stemming from the complex environmental problems affecting the planet's sustainability, including the importance of progressively reducing the environmental impact of buildings and building projects.

For these reasons, it is suggested that a federal program be established to strengthen the environmental performance of medium-size and priority cities with mandated resources to support municipal authorities as they elaborate or update their building regulations to incorporate a specific section on the technical specifications of sustainability standards for construction projects.

Another suggestion would be to explore, together with the professional associations and colleges of architects, engineers and other professionals involved in the construction sector, as well as the competent authorities, the possibility of instituting a new specialization among project management professionals, namely the responsibility for guaranteeing full compliance with environmental regulations and for developing and maintaining green buildings. Furthermore, another important and urgent task is to disseminate and share experiences among sector specialists on promoting the qualitative and quantitative changes required in construction practices.

III.1 Building Codes and Local Zoning

In Mexico, there still exists no organization or entity capable of integrating, systemizing and standardizing the enormous number of construction and zoning by-laws and criteria in force in the country's different localities and municipalities. Conafovi made an initial attempt to identify the criteria and bases needed to systemize this corpus of information with the publication of *Hacia un código de edificación de vivienda* ("Towards a Housing Building Code").¹⁷

This section presents a summary of the existing standards in Mexico. A careful and systematic review of same may contribute to the systemizing of the measures to be used in the certification of green building projects.

¹⁷ Comisión Nacional de Fomento a Vivienda, *Hacia un código de edificación de vivienda*, Mexico, 2005.

Standards in Local Planning Instruments in Mexico

INSTRUMENT	TYPE OF STANDARD
Urban Development Plans and Environmental Land Use Programs	<p><u>Land use standards:</u></p> <p>Zoning and land use:</p> <ul style="list-style-type: none"> • Permitted uses • Prohibited uses • Restricted uses • Installations • Public thoroughfares • Restricted zones (rights of way, rivers, risk zones, natural areas, etc.) • Urban corridors <p>Construction regulations:</p> <ul style="list-style-type: none"> • Open area • Height • Building densities • Housing density <ul style="list-style-type: none"> • Façades • Landscaping • Installations <p>Regulations for buildings:</p> <ul style="list-style-type: none"> • Lot divisions, amalgamations, divisions and subdivisions • Open areas <p>Instruments for promoting development:</p> <ul style="list-style-type: none"> • Transfer of development rights • Increases in permitted densities • Fiscal incentives <ul style="list-style-type: none"> ▪ Acquired rights ▪ Special development zones

Building Codes	<p>Administrative provisions:</p> <ul style="list-style-type: none"> • General provisions • Public thoroughfares and common spaces • Alignment and official number • Project Managers and other project officials • Requirements for the granting of licenses: <ul style="list-style-type: none"> ➔ Construction ➔ Demolition ➔ Subdivision ➔ Amalgamation ➔ Housing complex ➔ Division • Requirements for considering a architectural project: <ul style="list-style-type: none"> ➔ Project requirements ➔ Habitability and building function requirements ➔ Sanitation, services and environmental conditioning ➔ Re communications and prevention of emergencies ➔ Re integration into the local context and urban image ➔ Re installations • Structural safety • Construction • Use, operation and maintenance of constructions • Additions • Demolitions • Site • Safety • Inspection and fines
Building Codes (appendices)	<p>Technical construction standards and specifications:</p> <ul style="list-style-type: none"> • Re design <ul style="list-style-type: none"> ➔ Dimensions ➔ Habitable space ➔ Structures and foundations ➔ Installations ➔ Lighting ➔ Ventilation ➔ Adjacent areas ➔ Parking lots ➔ Comfort ➔ Greenspaces ➔ Others • Re construction <ul style="list-style-type: none"> ➔ Plotting, leveling and excavations ➔ Bricklaying and finishing ➔ Structures ➔ Hydraulic installations ➔ Sanitary installations ➔ Air conditioning ➔ Special installations ➔ Ironwork ➔ Carpentry ➔ Architectural image ➔ Gardening ➔ Others

Minimum lot sizes. Among the aspects to be considered in establishing quality standards for building green housing are the minimum permissible sizes in lot divisions. The following table presents the minimum lot sizes allowed by building codes in Mexico.

**Minimum Dimensions of Lots in Mexico
per Type of Housing Unit¹⁸**

Type	Minimum dimensions
Social/low-income housing	
Frontage	Between 3 and 10 m (typical case: 7 m)
Area	Between 75 and 180 m ² (typical case: 90 m ²)
Intermediate housing	
Frontage	Between 8 and 10 m (typical case: 8 m)
Area	Between 120 and 250 m ² (typical case: 160 m ²)
Standard housing	
Frontage	Between 9 and 20 m (typical case: 12 m)
Area	Between 150 and 525 m ² (typical case: 300 m ²)

Another indicator of the degree of comfort in housing units in Mexico are the minimum dimensions permitted by regulations per type of lot:

**Minimum Dimensions of Lots in Mexico
per Type of Lot**

Type	Minimum dimensions
Single-family lot	
Frontage	Between 4 and 8 m (typical case: 6 m)
Back	Between 8.13 and 20 m ² (typical case: 15 m ²)
Area	Between 32.5 and 160 m ² (typical case: 90 m ²)
Duplex	
Frontage	Between 6 and 14 m (typical case: 9 m)
Back	Between 8.13 and 20 m ² (typical case: 15 m ²)
Area	Between 62.57 and 210 m ² (typical case: 135 m ²)

Heights. It should also be mentioned, that to some extent, differences exist in minimum height regulations in housing. Thus, in states with temperate climates, such as the Federal District, Tlaxcala, Nuevo León, Durango, etc., the minimum height is 2.30 meters. In contrast, in states with hot climates (Baja California Sur, Morelos, Chihuahua, Colima, Campeche) the minimum is at least 2.40 meters, and may be as high as 2.60 meters (Quintana Roo).

¹⁸ Ibid.

Minimum habitable space. As for regulations on habitable space, the minimum permissible floor space varies from 6 to 20 m², with 13.60 m² as the typical case (e.g., for living room/dining room), although the minimum for bedrooms is lower (6 m²). The smallest permitted floor space applies to bathrooms: i.e., 1.1 square meters.

Lighting and ventilation. The standard used in building codes to determine minimum areas in terms of natural lighting is the percentage of the total floor space. As for the minimum in terms of natural ventilation, the relevant indicator is the percentage of the illuminated surface (i.e., total surface area of windows). The results emerging from analysis of these minima are counter-intuitive: illuminated and ventilated areas do not correlate with climatic conditions. Thus, in localities with hot climates like Uruapan and Lázaro Cárdenas, Michoacán, the ventilation percentage (4.17 percent) is lower than in localities with temperate climates like Guanajuato (4.76 percent); certain states with temperate climates like Nuevo León have very high ventilation percentages (50 percent), the most extreme case being that of Coahuila, where the ventilated area equals the illuminated area: i.e., 20 percent of the total floor space.

Minimum Dimensions for Lighting and Natural Ventilation

Type	Minimum dimensions
Electric lighting	Between 1 and 2.5 m ² (typical case: 2.5 m ²)
Natural lighting	Between 5 and 25 percent of floor space (typical case: 20 percent)
Natural ventilation	Between 4.17 and 100 percent of surface area of windows (typical case: 50 percent)

Roadways. Regulations and regulatory specifications in respect of roadways tend to be similar. Clearly, environmental, natural resources or climatological issues are not considered in construction regulations with respect to roadway design and selection of construction materials. These criteria are found in local urban development programs, principally in environmental land use programs. Unfortunately, these latter are in force in very few localities, the main exceptions being coastal tourist areas. Less than comprehensive urban image programs and urban image regulations also exist, mainly in heritage rich areas (Guanajuato, Querétaro, Zacatecas, Morelia, the central part of Mexico City, Taxco, etc.).

Minimum Dimensions of Roadways

Type	Minimum sections	Sidewalks: minimum width
Avenues 60 KPH	Between 16 and 22 m (typically, 20 m)	Between 2.5 and 3 m (typically, 3 m)
Primary street 50 KPH	Between 13 and 21 m (typically, 16 m)	Between 2 and 3 m (typically, 2.5 m)
Secondary street	Between 12 and 18 m (typically,	Between 1.5 and 2.5 m

40 KPH	12 m)	(typically, 2.5 m)
Local street 30 KPH	12 meters	Between 1.5 and 2.5 m (typically, 1.5 m)
Closed street 20 KPH	9 meters (at the discretion of municipal governments)	Between 1.2 and 2 m (typically, 1.5 m)
Laneway	Between 4 and 8 m (typically, 6 m)	–

Parking spaces. Although differences do exist in minimum parking space sizes from one set of regulations to another, these are minimal, as may be seen below.

Dimensions of Parking Spaces

Type	Minimum dimensions
Perpendicular parking	
Light truck	5.50 x 2.50
Regular	5.00 x 2.40
Compact car	4.20 x 2.20
Disabled	5.00 x 3.80
Parallel parking	
Light truck	6.00 x 2.50
Regular	6.00 x 2.40
Compact car	4.80 x 2.00
Disabled	6.00 x 3.60

Water consumption. As a consequence of the growth in large population centers in the world over the last century, the available information informs us that, today, half of the planet's inhabitants live with water shortage problems—defined as less than 5,000 m³ of water available per capita/per annum—due to the low availability of this resource. Mexico has passed the threshold from moderate availability (between 5,000 and 10,000 m³ of water per capita/per annum) to low availability: i.e., an average of 4.9 m³.

Moreover, this situation is worsening as the volume of water available is diminishing, due, notoriously, to the intense contamination of receiving bodies by discharges of human, agricultural and industrial wastes. The National Water Commission (*Comisión Nacional del Agua—CNA*), the organization responsible for managing this resource in Mexico, estimates that in December 2003, the country's municipal sewer systems collected 203 m³ of wastewaters per second, of which only 29.7 percent was treated; as for industry, the reported volume was 171 m³ per second, of which just 15.3 percent was treated.

Concerning the distribution of this resource, two phenomena are apparent. First, water has traditionally been considered a common good, abundant and accessible to all at low prices or even free of charge. Consequently, it was perceived as an inexhaustible resource—and as a waste product once it had been used. This is a culture that needs to be changed. Second, this resource is unequally distributed. Thus, a low-income family consumes an average of 5 to 7 m³ per month.

In effect, such populations live on the outskirts of cities where municipal waterworks do not exist and water distribution is by means of water tankers and bottles. As a result, water may cost as much as 40 pesos per m³. In contrast, populations connected to the municipal water and drainage systems consume a daily average of 200 liters per capita and pay generally much lower charges: 78 *centavos* per m³. Thus, a family of five that consumes 30 m³ per month pays a monthly water bill of 23.47 pesos, an amount far less than the 1,200 pesos it would pay if the rate were 40 pesos per m³.

As for water delivered through municipal waterworks, costs vary in accordance with the particular characteristics of each urban area. In effect, a number of factors interact: distance and type of water catchment, piping, drinking water treatment, the urban fabric, topography and soil type. Consequently, the cost per cubic meter of water runs from a minimum of 2.02 pesos to a maximum of 8.20 pesos. A similar situation prevails regarding drainage systems: costs of these services run from 1.00 to 1.80 pesos per cubic meter. Finally, sanitation costs may vary from 1.00 to 2.40 pesos. Consequently, the total cost of services varies between 4.02 and 12.40 pesos per cubic meter.

Daily Consumption Per Capita (in liters), According to Socioeconomic Class

Climate	Standard	Intermediate	Popular
Hot (above 22° C)	400	230	185
Moderately hot (18-22° C)	300	205	130
Temperate (12-17.9° C)	250	195	100
Cold (under 12° C)	250	195	100

Average consumption in the country is 223 liters per day, per capita, a figure that drops to 190 liters in the Federal District. Water use in the metropolitan area is broken down as follows: 40 percent for lavatories, 30 percent for showers, 15 percent for washing machines, 6 percent for food preparation and 5 percent for human consumption.

Solid municipal wastes. It is estimated that 31.5 million tons of solid municipal wastes were produced in Mexico in the year 2001. The states in the central part of the country accounted for 50 percent, while the Federal District and the northern states (border cities excluded) produced 14 percent and 19 percent, respectively.

Garbage collection services in Mexico have improved significantly: 84.6 percent of all garbage generated is now collected.

The percentage of municipal solid wastes generated in the country apt for recycling is 28.7 percent. While exact figures on the amount recycled are unknown, it is known that only 8.2 percent of the possible total is actually recovered in sanitary landfills. The rest is recovered in containers and garbage trucks. It is estimated that the total recycling rate in the country fluctuates between 8 and 12 percent, which signifies significant lags in recycling, compost production, and biomass energy recovery and generation.

Municipal domestic energy consumption. In Mexico, energy consumption is growing in relation to higher levels of personal comfort. Needs have expanded progressively, as have the dimensions and the context of the locales where economic activities take place. The tertiary sector—retail outlets, offices, schools, hospitals, hotels, banks and restaurants—has become predominant. Moreover, new centers of economic activity have emerged in regions with hot climates, a development that brings more housing construction to these areas along with the attendant increases in the demand for energy. It is in these hot climates where the demand for energy is the strongest, exceeding that of areas with temperate climates by a 4:3 ratio.

As for electricity generation, 75 percent comes from fossil fuels, which have a major environmental impact. For each kWh generated, a fuel-oil plant produces 1-kg of CO₂ emissions and a combined-cycle plant, 0.6 kilograms.

Both the quantity and the type of energy consumed in the country's housing units have a significant environmental impact in terms of phenomena such as the greenhouse effect and climate change. Population growth and growing urbanization produce major environmental impacts due to the direct energy consumption in housing and to the resulting increase in demand for electricity and fossil fuels. Growth in the housing sector, which is higher than in other sectors, is responsible for the construction of new power plants, which entails investing billions of dollars and important environmental impacts. That said, the domestic consumption of natural gas and LP gas has not grown significantly in 15 years.

In 2004, total energy consumption in the country was 4,141,352 petajoules. The housing, retail and public utilities sectors together accounted for 23 percent of this amount (873.4 pj); 83 percent of this fraction corresponded to housing, 14 percent to the retail sector and 3 percent to public utilities. Electricity consumption in buildings in the services sector in Mexico is over 25,000 GWh; in the housing sector it totals 42,000 GWh; and in the retail sector, 13,000 GWh. Today, buildings account for 19.7 percent of the country's total energy consumption. Peak consumption hours are after nightfall due to lighting needs. The latter exceeds the demand for energy occasioned by air conditioning during the evening hours.

The breakdown of energy consumption in the housing sector is as follows: highest consumption is for cooking, next comes hot water and lighting, and in third place are appliances. It's worth noting that energy consumption for air conditioning is greater in the northern regions and on the coasts, which have hot and dry and hot and humid climates, respectively. As a consequence, these areas occupy second place in terms of energy consumption.

In rural areas, firewood accounts for nearly 70 percent of residential energy consumption and is the principal source of energy for approximately 19 million Mexicans.

Regarding the existing regulations in the country, the Government of Mexico has evinced some concern in respect of tackling the issues of bioclimatic conditions and energy efficiency in urban design and housing. However, this concern has not translated into official norms or standards. To date, it has only resulted in booklets, manuals, leaflets and books of an academic or public education bent. This situation proved apparent upon review of several building codes. For example, it was found that no consideration was accorded to the particular conditions prevailing

in the different bioclimatic regions that make up the national mosaic, nor were any parameters fixed to limit energy consumption or stimulate energy savings.

In a few of the country's tourist and/or heritage zones and cities urban image programs do exist to foster a given urban and architectural design. In such cases inhabitants are required to incorporate bioclimatic considerations into building projects. Such considerations may concern textures and colors in façade and floor finishings, roofing materials and styles, vegetation management, window types/dimensions and ventilation criteria, optimal orientation of buildings, open spaces, public areas, greenspaces, etc. The following Conafovi datum is worth stressing: the energy consumption of a rural dwelling is triple that of an urban one due to the use of firewood and plant and mineral carbon in cooking and water heating. This consumption could be reduced substantially if more efficient sources of energy were used, such as renewables.

In conclusion, one might mention that due to climate change and growth patterns, in the near future the demand for electricity will grow as the services sector becomes the most dynamic part of the economy. An increase in the energy consumption of buildings is foreseeable.

Consequently, measures are necessary to reduce consumption per unit—measures such as the ones recently adopted by the Mexican government in relation to building shell standards. The fostering of such measures in favor of green building is highly commendable.

Greenspaces and open spaces. In Mexico, the terms *espacio natural* (natural area or space), *espacio abierto* (open space) and *área verde* (greenspace) are generally used synonymously, but their meanings are not identical. Open space and greenspace begin as natural space, which is unbounded, infinite. Until the late nineteenth century it was held that it required no care or stewardship of any kind, since it was “the countryside” or nature itself.

The urbanization of contemporary society led to the overuse and exploitation of natural spaces. Cities sprawled out over the countryside, upsetting the physical and environmental balance of the natural environment.

In this context, contemporary society developed a new concept of open space, with different values determined by culture, geographical location, and historical epoch.

By definition, open space is any outdoor, typically public space. This may be broken down into the major categories of inert open space (e.g., streets, squares, patios, benches, bicycle paths, parking) and greenspace (e.g., parks, gardens, flower beds, median dividers, ecological reserve areas). A third category is that of residual spaces carved out by intersecting roads, or lying under viaducts, high-tension lines, or along rights of way. Due to their relative inaccessibility, these spaces are infrequently used and therefore have no tangible value to the community. In many cases they suffer from lack of care, attention, and maintenance. The point to note is that open space is not synonymous with abandoned, residual, waste, or disused space; on the contrary, it is highly valuable due to its indispensable social and environmental role in harmonious urban development.

Urban greenspace plays an important environmental role as an “urban lung,” in that the vegetation found there purifies the air, allows for aquifer recharge, and serves as a link between human beings, the city and nature. Peri-urban or metropolitan forests are large spaces of this

kind, while smaller ones include parks and large or household gardens, and greenery along roads, roundabouts, and parkways.

Though these areas provide vital environmental services to cities, they are increasingly scarce in our modern-day urban context. For example, the average area of parks, gardens, flower beds or median dividers, and landscaped roundabouts or intersections in the national capital is 2.3 m² per inhabitant,¹⁹ whereas the UN recommends 16 m² per inhabitant and other international standards call for 9 m². The scarcity of these spaces leads to their overuse and an alarming degradation in their quality.

The sum total of greenspaces and inert spaces make up the open space within the urban fabric, and even vacant lots, landfills, and residual spaces form a part of a whole whose use must be planned and made an object of study. An example of the management of these spaces in our country is the redesign of the lands once occupied by a sanitary landfill in Santa Fe, within the Mexico City urban zone, into greenspace, thus fulfilling environmental and landscaping functions simultaneously.

The automobile contends with humans for dominion over urban open spaces. Cities are modified to facilitate car travel and parking, resulting in an enormous loss of greenspace. The redensification of urbanized areas that already possess infrastructure and services also accelerates the loss of open space; the shortage of lots on which to develop various kinds of buildings causes continual change in the urban fabric. Real-estate market pressures are major drivers of these changes and urban open spaces are always quick to disappear, despite the technical specifications set out in building codes and urban plans, which have not failed to protect them.

Society must recognize the aggregate value of open spaces, such that they truly form a part of the cultural baggage of the city; as long as open space remains divorced from its specific qualities of form, function, and meaning, its use and conservation will always be truncated. If cities have a minimum of open space, it should at the very least be of a quality sufficient to uphold these values.

The high real-estate value of urban lots is an obstacle to efforts to expand greenspace in the city. Consequently, city residents experience a gradual loss of such spaces. The environmental implications of this pattern include abrupt changes in urban microclimates, higher temperatures, and severe harm to human health, among many others conducive to global climate change. In reaction to the gradual loss of urban greenspace, the concept of *green roofs* has been making some headway in Mexico. One of the few notable examples is Technical Secondary School 28 in Xochimilco, Mexico City, which inculcates a culture of environmental awareness in its students and whose building boasts a green roof.

In view of the diverse, vast, and complex range of issues related to Mexico's building regulations, as well as the lack of an instrument that could be used to give them conceptual coherence, it is proposed to create a national databank or information system providing a comprehensive view of the standards applied in the different regions of the country. The databank would be for the use of the authorities, building contractors, competent professionals,

¹⁹ Government of the Federal District, General Urban Development Program of the Federal District - 2003, Mexico, 2003.

and other interested persons. It would offer viable technical solutions for the future development of buildings, with codes that take into account the particular geographic, social, economic, and environmental conditions and opportunities of each location.

In this connection, the importance of the work done by Conafovi must be stressed. It is recommended that Conafovi promote efforts to develop the necessary electronic and computer resources without delay. These efforts should be accompanied by horizontal coordination with local authorities and other interested parties with a view to helping them draft or modernize their building codes, as discussed in the previous section.

Recommendations

- Create an electronic databank or information system, to be shared among the countries of the region, that provides a comprehensive view of the sustainability standards applied in the different regions of the country. The databank would be for the use of the authorities, building contractors, competent professionals, and other interested persons. It would offer viable technical solutions for the future development of buildings, with codes that take into account the particular geographic, social, economic, and environmental conditions and opportunities of each location.
- Encourage the municipal authorities to include in their building codes a section referring to a modernized information system containing environmental quality standards that is easily accessible to builders for purposes of continuing education and professional development.
- Step up the dissemination of the building-related NOMs to the administrative units of the state and local governments responsible for construction permitting as well as the universities and professional associations that train project managers and construction site managers.
- Support and promote the offering of courses, seminars, workshops, and similar formal and informal educational activities with the goal of fostering a new culture among construction industry personnel that gives rise, in the short term, to a cohort of new professionals who harbor a commitment to sustainable development.
- Create a federal environmental capacity building program for priority and/or medium-sized cities with mandated funding to assist the municipal authorities in drafting or modernizing their building codes, such that these to include a specific section establishing technical specifications and sustainability standards for buildings.
- In conjunction with the professional associations of architects, engineers, and other building-related professions as well as with the competent authorities, explore the possibility of creating a new area of specialization—green building development and maintenance—for project managers and other professionals responsible for overseeing the environmental compliance of building projects, with the idea of streamlining and accelerating the adoption of green building practices by the building trades.

- Provide forums and other opportunities for discussion of green building by industry specialists in order to promote the necessary qualitative and quantitative changes in construction practices.
- Conafovi could act as a liaison between interested local authorities and the various construction-industry players — academics, businesspeople, professional associations, industry associations, NGOs, etc. — who possess the experience, know-how, and technological capacity to help municipalities with the drafting of their building codes.

IV. Laws and Standards Governing Product Environmental Performance

The Mexican standardization system has its foundation in the Federal Metrology and Standardization Act (*Ley Federal sobre Metrología y Normalización—LM*). Product and building system assessment is subject to the provisions of this act. An initial group of building standards, consisting of those that are classified as Mexican Official Standards (*Normas Oficiales Mexicanas—NOM*), covers the following areas:

- Electrical installations
- Gas installations
- Elevators
- Accessibility in health-care buildings
- Sewer systems
- Water supply and treatment
- Water sector products
- Energy efficiency
- Exterior lighting
- Thermal insulation
- Measurement instruments

Also falling under the purview of the LM is a second group of standards, called Mexican Standards (*Normas Mexicanas—NMX*), which, although not mandatory, are applied by means of other administrative instruments and procedures. The following are examples:

- Cement, concrete, asphalt, unpaved roads
- Weatherproofing materials, paints
- Blocks and partition walls
- Tiles
- Sanitary fixtures, water tanks
- Shower heads and faucets, flow meters, valves
- Panels, beams, and vaults
- Fire resistance
- Pipes, manholes, drains
- Doors, windows
- Electrical products

The LM establishes the methods and procedures to be followed in issuing standards. The process begins with the formation of expert working groups with a structure along the lines of a national standards advisory committee, and continues with the publication of a draft standard for public review. According to information from the National Energy Efficiency Commission (*Comisión Nacional para el Ahorro de Energía*),²⁰ the country currently has 18 energy efficiency-related NOMs in force and two more in the draft phase. These standards are mandatory and their application must be contemplated in building codes.

²⁰ Information for this section is taken from <www.conae.gob.mx>.

The LM establishes procedures for certification of compliance with the NOMs. Assessment of compliance with any standard is the responsibility of the competent body or of certification agencies, testing or calibration laboratories, or qualified auditing units that have been duly accredited by the responsible accreditation entity. The accreditation entity is authorized to make decisions regarding accreditation applications.

*Entidad Mexicana de Acreditación, A.C. (EMA)*²¹ was the first Mexican private entity whose mission is to accredit the organizations that assess compliance or conformity with standards (testing laboratories, calibration laboratories, certification bodies, and auditing units or inspection agencies). Accreditation of compliance assessment organizations began in Mexico in 1980 with the implementation of the National Testing Laboratory Accreditation System (*Sistema Nacional de Acreditamiento de Laboratorios de Pruebas—Sinalp*) and the National Calibration System (*Sistema Nacional de Calibración—SNC*). These two systems, the foundation for the current system, were initially regulated by the federal government.

Accreditation is the act whereby it is assured that calibration or testing laboratories, auditing units (inspection agencies), and certification bodies shall accurately execute the relevant regulations and standards with a view to testing, verifying, or certifying the products and services consumed by the public. Accreditation entities such as EMA are the bodies guaranteeing the reliability and technical competency of compliance assessment bodies.

Another private nonprofit organization, the Mexican Institute of Standardization and Certification (*Instituto Mexicano de Normalización y Certificación—IMNC*),²² contributes to the insertion of the Mexican economy into globalized markets and with the enhancement of the competitiveness and productivity of Mexican organizations. The IMNC works on certification and accreditation.

The LM also prescribes penalties for parties that fail to comply with the standards. Those standards which, due to their nature, can and should be included in the measurement system for green building certification are presented below.

IV.1 Sustainable Energy Management Standards

There are 3 NOMs in force, plus one under development, whose purpose is to improve urban energy efficiency. An additional 14 standards regulate the manufacture of building-related products. The standards in force are:

- ➔ **NOM-007-ENER-2004.** Energy efficiency in lighting systems for non-residential buildings.
- ➔ **NOM-008-ENER-2001.** Energy efficiency in buildings; non-residential building shells.
- ➔ **NOM-013-ENER-2004.** Energy efficiency for lighting systems on roads and in outdoor public areas.

²¹ See <www.ema.org.mx>.

²² See <www.imnc.org.mx>.

The second of these, relating to non-residential building shells, is considered the one most relevant to the issue of green building. It was drafted under the auspices of the National Standards Advisory Committee for the Preservation and Rational Use of Energy Resources (*Comité Consultivo Nacional de Normalización para la Preservación y Uso Racional de los Recursos Energéticos*), with the support of the Institute for Electrical Research (*Instituto de Investigaciones Eléctricas*) and the collaboration of some 20 organizations and businesses.

The purpose of this NOM is to limit the heat gain of buildings through their building shells, and thus to rationalize energy use in cooling systems. The term “building shell” refers to the roof, walls, spaces or gaps, floors, and ground surfaces that define the interior space of the building.

“Heat gain through the building shell” means the sum total of conductive heat gain (through the opaque and transparent parts of the building shell) plus heat gain due to solar radiation (through the transparent parts of the building shell). Here, all components of the building are considered.

Thus, heat gain through the projected building shell should be less than or equal to the heat gain through the envelope of a similar reference building that is certified as having met the minimum conditions set forth in this standard. This standard applies to all new buildings and additions with the exception of industrial or residential buildings.

New buildings and additions to existing buildings are required to post, in the main entryway or lobby of the building, a certificate informing users of the ratio of solar heat gain between the projected building and the reference building. Non-compliance with the standard is penalized and sanctioned as prescribed by the LM and the applicable building code.

In April 2007, a fourth energy efficiency standard, complementary to the one described above for non-residential buildings, was in preparation:

➔ **NOM-020-ENER.** Energy efficiency in buildings, shell of residential buildings.

The standards governing manufacturing processes for devices and equipment used in buildings are also relevant, since their use can and should be included in the measurement system for green building certification:

➔ **NOM-001-ENER-2000.** Energy efficiency of vertical turbine pumps with external vertical electric motor. Limits and testing method.

➔ **NOM-003-ENER-2000.** Thermal efficiency of domestic and commercial water heaters. Limits, testing method, and labeling.

➔ **NOM-004-ENER-1995.** Energy efficiency of 0.187–0.746 kW centrifugal water pumps for domestic use. Limits, testing method, and labeling.

➔ **NOM-005-ENER-2000.** Energy efficiency of domestic washing machines. Limits, testing method, and labeling.

- ➔ **NOM-009-ENER-1995.** Energy efficiency of industrial thermal insulation.
- ➔ **NOM-010-ENER-2004.** Energy efficiency of deep well submersible motor and pump assembly. Limits and testing methods.
- ➔ **NOM-011-ENER-2002.** Energy efficiency of central, package, and split air conditioners. Limits, testing methods, and labeling.
- ➔ **NOM-014-ENER-2002.** Energy efficiency of single-phase, squirrel-cage, air-cooled, alternate current induction motors with rated power of 0.180–1.500 kW. Limits, testing method, and marking.
- ➔ **NOM-015-ENER-2002.** Energy efficiency of domestic refrigerators and freezers. Limits, testing methods, and labeling.
- ➔ **NOM-016-ENER-2002.** Energy efficiency of three-phase, squirrel-cage, air-cooled, alternate current induction motors with rated power of 0.746–373 kW. Limits, testing method and marking.
- ➔ **NOM-017-ENER-1997.** Energy efficiency of compact fluorescent lights, limits and testing methods.
- ➔ **NOM-018-ENER-1997.** Thermal insulation materials for buildings. Characteristics, limits and testing methods.
- ➔ **NOM-021-ENER/SCFI/ECOL-2000.** Energy efficiency, user safety requirements, and elimination of chlorofluorocarbons (CFC) in room-type air conditioners. Limits, testing methods, and labeling.
- ➔ **NOM-022-ENER/SCFI/ECOL-2000.** Energy efficiency, user safety requirements, and elimination of chlorofluorocarbons (CFC) in self-contained commercial refrigeration appliances. Limits, testing methods, and labeling.

Also in existence are various mandatory standards enacted by local authorities for their purposes. An example is the Federal District’s environmental standard establishing the criteria for use of solar power for hot water heating, which applies to establishments that commence operating or totally renovate their facilities and require hot water for their operations.

IV.2 Sustainable Natural Resource Management Standards

To date, the environmental sector has issued four NOMs²³ applicable to real-estate developments and buildings with a view to preventing and controlling water pollution:

²³ See <www.semarnat.gob.mx> and <www.cna.gob.mx>.

- ➔ **NOM-001-SEMARNAT-1996**, Establishing maximum contaminant levels in wastewater discharges into national waters and property.
- ➔ **NOM-002-SEMARNAT-1996**, Establishing maximum contaminant levels in wastewater discharges into urban or municipal sewer systems.
- ➔ **NOM-003-SEMARNAT-1997**, Establishing maximum contaminant levels for treated wastewater reused in public utilities.
- ➔ **NOM-004-SEMARNAT-2002**, Environmental protection. Sludges and biosolids. Specifications and maximum contaminant levels for their use and final disposal.

For its part, the agency responsible for the use and protection of national water resources, the CNA, has issued 12 NOMs whose purpose is to guarantee that products and services offered to local drinking water, sewer, and treatment system operators meet quality standards and employ sound, efficient water management practices.

- ➔ **NOM-001-CNA-1995**. Sanitary sewer system – hermeticity specifications.
- ➔ **NOM-02-CNA-1995**. Residential potable water uptake – specifications and testing methods.
- ➔ **NOM-003-CNA-1996**. Requirements during construction of water wells for prevention of aquifer contamination.
- ➔ **NOM-004-CNA-1996**. Requirements for aquifer protection during maintenance and rehabilitation of water wells and for closing of wells in general.
- ➔ **NOM-005-CNA-1996**. Flow meters. Specifications and testing methods.
- ➔ **NOM-006-CNA-1997**. Septic systems. Specifications and testing methods.
- ➔ **NOM-007-CNA-1997**. Safety requirements for construction and operation of water tanks.
- ➔ **NOM-008-CNA-1998**. Showerheads used in personal hygiene. Specifications and testing methods.
- ➔ **NOM-009-CNA-2001**. Toilets for sanitary use. Specifications and testing methods.
- ➔ **NOM-010-CNA-2000**. Intake valve and discharge valve for toilet tank. Specifications and testing methods.
- ➔ **NOM-011-CNA-2000**. Water conservation. Establishing specifications and method for determining mean annual availability of national waters.
- ➔ **NOM-013-CNA-2000**. Drinking water distribution systems. Hermeticity specifications and testing methods.

The Ministry of Health (*Secretaría de Salud*)²⁴ has published the following five NOMs, which establish permissible quality standards regarding water for human consumption and the means of

²⁴ See <www.ssa.gob.mx>.

water storage and distribution, as well as the monitoring and assessment mechanisms used to control water quality.

- **NOM-127-SSA1-1994**. Environmental health. Water for human use and consumption. Permissible quality standards and required potability processes.
- **NOM-179-SSA1-1998**. Monitoring and assessment of quality control of water for human consumption distributed through public water supply systems.
- **NOM-012-SSA1-1993**. Sanitary requirements for public and private water supply systems for human use and consumption.
- **NOM-013-SSA1-1993**. Sanitary requirements for tanks of vehicles transporting and distributing water for human use and consumption.
- **NOM-014-SSA1-1993**. Sanitary procedures for sampling of water for human use and consumption in public and private water supply systems.

Observance of this list of standards, which is updated and amended on an ongoing basis, is mandatory. Therefore, they must be disseminated not only through the *Official Gazette* but also among developers and other actors in the construction industry. It is suggested that this be done through the professional development courses given to consultants and project managers who are responsible for compliance with building codes.

Furthermore, in the process of updating and issuing building regulations and municipal urban development plans, it will be necessary to refer to a set of codes and standards, still to be drafted, that would take account of the entire life cycle of buildings, including their exterior aspects. The most important of these standards are:

- Federal energy efficiency code
- Bioclimatic building design
- Sustainable water use
- Use of recycled construction materials
- Use and sustainable management of waste
- Greenspaces
- Environmentally efficient use of public spaces, including roads
- Planning for use and final disposal of maintenance and construction materials during and after the useful life of buildings.

Finally, it is important to stress the fact that the Federal Congress, made up of the Senate and the Chamber of Representatives, can play a significant role in the promotion of green building in Mexico. The Congress, with its power to propose, amend, and enact legislation, is a critically important player in the creation of a regulatory framework that gives impetus to green building.

Recommendations

- In the green building standardization process, consider regulations for the entire life cycle of a building, including its recycling, as well as its impact on various components of the environment; that is, on both the building interior and on the ecosystem.
- Reach regional agreements to foster the scientific and technological cooperation necessary for the drafting of NOMs and NMXs.
- Provide support for local initiatives promoting the adoption of sustainability standards and codes that complement and strengthen federal regulations.
- In cooperation with the professional associations and the local governmental authorities, offer courses, meetings, seminars, and other forums for regional discussion on modernization of the national regulatory framework with a view to enriching the experience of the participants and disseminating the application of said regulatory framework.
- Establish a joint work program with the Federal Congress and the local congresses to incorporate the *green building* concept into the relevant legal provisions, in order thereby to develop a legal framework conducive to green building in Mexico (see Figure 2).

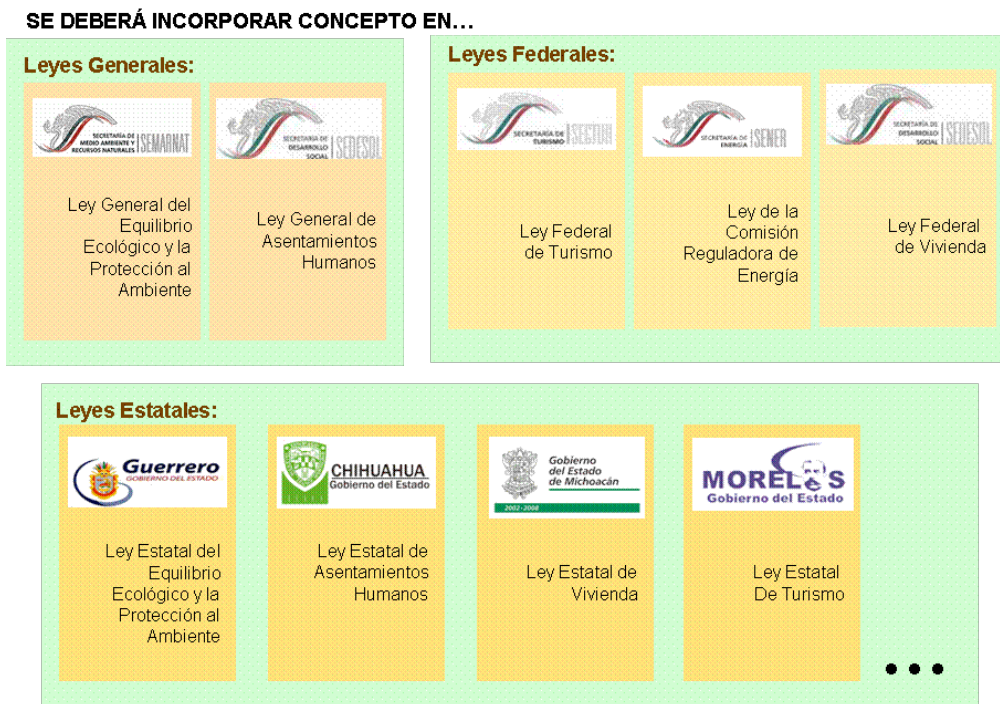


Figure 2. Legal framework to be amended to include green building criteria

General laws:

General Ecological Balance and Environmental Protection Act, General Human Settlements Act

Federal laws:

Federal Tourism Act, Energy Regulatory Commission Act, Federal Housing Act,

State laws:

State Ecological Balance and Environmental Protection Act, Human Settlements Act, Housing Act, and Tourism Act

V. Voluntary Green Building Promotion Programs

Voluntary initiatives in which green building is used as a new environmental strategy with which to confront the complex problem of global climate change have been few and of recent vintage in Mexico. The UN World Commission on Environment and Development links development and environment within a single concept: *sustainable development*. Since 1992, strategies have been geared toward modifying human activities with a view to minimizing environmental degradation and ensuring the sustainability of development processes. The principles of sustainability consist of:

- Limiting human impact on the biosphere
- Preserving biological patrimony
- Ensuring the rational use of non-renewable resources
- Fairly allocating the costs and benefits of resource use
- Promoting appropriate technologies
- Devising economic policies that contribute to the preservation of natural capital.

It is imperative to incorporate a range of activities into the national strategy that modify consumption habits and curtail the waste of natural resources. This is the motivation for the voluntary initiatives presented below, which emerge variously from the public or the private sector but all share the goal of improving and expanding building quality standards.

V.1 Profepa's Voluntary Environmental Auditing Program

The Office of the Federal Attorney for Environmental Protection (*Procuraduría Federal de Protección al Ambiente*—Profepa) has, for the last fifteen years, had responsibility for the National Environmental Auditing Program (*Programa Nacional de Auditorías Ambientales*—PNAA),²⁵ whose purpose is to certify business regulatory compliance with environmental, health, and environmental safety and risk standards. This program does not include energy efficiency, construction, or zoning standards. Based on these audits, a periodically renewable official “green seal” is awarded. This program has been highly successful, with more than 900 audits performed annually. It issues “Clean Industry” certificates for industrial facilities, “Environmental Compliance” certificates for non-industrial organizations, and “Environmental Excellence” certificates for persons and companies.

Profepa has expanded this program, which originally focused on industry, to encompass commercial buildings such as hospitals, hotels, airports, and schools as well as tourist developments and municipalities.

The PNAA is a system of support, promotion, and recognition for organizations (companies, public or private institutions, municipalities, industrial parks, etc.) that voluntarily submit to an audit and reach agreement with the authorities on the implementation of plans of action to correct deficiencies, improve environmental performance, and reduce impacts and risks for ecosystems. The role of the program then is preventive and in keeping with the provisions of

²⁵ See <www.profepa.gob.mx>.

law, in that the government, in addition to punishing those parties who harm the environment, recognizes and promotes voluntary private efforts to cooperate with the harmonious and sustainable development of the country.

The purpose of the PNAA is to promote the adoption and implementation of measures to prevent, reduce, and/or mitigate environmental risks and impacts caused by human activities that, by their very nature, modify the environment. A further goal is to use environmental performance labeling (“green labeling”) to encourage the public to support the environmental improvement of organizations by opting for their products and services in the marketplace.

Another relevant government initiative is the voluntary NMX on green buildings now being drafted by Semarnat, which will offer alternatives to developers who opt for sustainable practices in their buildings.

V.2 Mexican Institute of Intelligent Building

The Mexican Institute of Intelligent Building (*Instituto Mexicano del Edificio Inteligente*—IMEI), the country’s first building quality certification agency,²⁶ is a nonprofit association that was incorporated in Mexico City in late October 1991. Its members consist of businesses and professionals active in the area of *intelligent buildings*: “An intelligent building is a building offering its owner, user, and administrator a flexible, efficient, comfortable, and safe environment through the use of integrated communications, controls, and technological systems.”²⁷

IMEI also acts as a forum for sponsoring companies, giving them an opportunity to demonstrate their technologies at seminars, conferences, and exhibitions and through certificate programs. It disseminates ideas related to the planning, construction, equipping, and operation of intelligent buildings; promotes the appropriate use of technology, and strengthens the market through the promotion of enterprises yielding benefits to investors, goods and services providers, and end users alike.

IMEI works in four main areas. In education, it holds monthly conferences, gives a yearly certificate course on intelligent and green building technology, and offers more specialized courses. It publishes bulletins, books, and reports. In addition, for a decade now, it has been awarding an annual national intelligent building prize. Finally, it offers an ongoing certification program for individuals, organizations, and buildings.

Examples of certified intelligent buildings in Mexico City include the Gabriel Mancera Regional General Hospital No. 1 in the Del Valle district; the Cenit Plaza Arquímedes building, in Polanco, and the World Trade Center (WTC), in the Nápoles district.

V.3 Mexican Green Building Council

²⁶ See <www.imei.org.mx>.

²⁷ Pablo Mota, “CB Richard Ellis”, at <<http://www.imei.org.mx/descargas/template.pdf>>, 20 July 2005.

Noteworthy among Mexican experiences in green building promotion are the efforts of the Mexican Green building Council (*Consejo Mexicano de Edificación Sustentable*—CMES).²⁸ A civic association composed of construction industry leaders, CMES is a member of the World Green Building Council and an affiliate of the International Initiative for a Sustainable Built Environment (IISBE),

CMES's programs and activities are concentrated in two main areas: dissemination of knowledge, and development of the Green Building Qualification System (*Sistema de Calificación de Edificaciones Sustentables*—SICES). As for the first, CMES gives courses relevant to green building and publishes the periodical *Edificación Sustentable en México* (Green Building in Mexico). As for SICES, it will be a voluntary certification system based on a consensus among a broad grouping of construction industry representatives, and is intended as a tool for market transformation. The purpose of SICES is to promote and accelerate the widespread adoption of green building and development practices through the creation and implementation of standards, tools, and operating criteria that are universally understood and accepted. SICES will provide assessment tools for all phases of a building's life cycle and for various building types, budgets, and areas of environmental assessment.

Another activity of CMES is the Comprehensive Sustainable Housing Program (*Sustentabilidad de la Vivienda Popular*—SICESvive). The idea behind this program is to reach out to a broader sector of the construction industry, that of homebuilding, encouraging the shift toward sustainable high-, middle-, and low-income homes. In 2007 it plans to hold the Latin American Congress on Green Building in Mexico.

In concluding this section, let's note the need in the short term to build agreement between the federal authorities and various stakeholders (academics, technicians and tradesmen, businesspeople, politicians, community organizations) on development of a system of measures for green building certification that supports the structure, scope, and goals of the most viable system for Mexico.

It is proposed that this system of measures be implemented in the form of a code that serves to foster voluntary initiatives by developers that go beyond the standards established in regulations and other mandatory provisions. To this end, it is suggested that it be complemented with inducements such as certification-based recognition, fiscal and credit incentives, and national and international prizes. This system should preferably have governmental recognition and be equivalent to the one applied by LEED in the United States and Canada, to facilitate mutual recognition.

Since the companies participating in the Profepa environmental auditing program derive concrete benefits from certification, it is recommended that Profepa pilot a broad consultation process leading to the formation of a non-profit, non-governmental organization backed by the stakeholders from the private and academic sectors associated with the construction industry.

Part of this certification system should consist of a set of indicators that shall serve to measure the impact on the adoption of voluntary systems. Additionally, in the design and operation of this

²⁸ With information from <www.cmes.org.mx>.

certification, it will be important to secure the participation of Mexican organizations such as EMA and IMNC. EMA is the primary private entity in the country with a mission to accredit compliance assessment organizations (testing labs, calibration labs, certification agencies, and auditing units or inspection agencies). IMNC is an independent and impartial, private, multi-sector, third-party association that works in the areas of standardization and certification of management systems, products, and persons, as well as acting as the national standards body and the agency that audits compliance with the NOMs.

Emerging as a conclusion from this first phase of discussion among the three NAFTA countries is the need to further the exchange of experiences in green building. In this effort, it would be advisable to pursue joint efforts to develop green building practices: for example, a case study of a city in which various activities related to green building are being carried out would offer an opportunity to measure the extent and results of the measures adopted. In the case of Mexico, a new city being planned from the ground up in Nuevo León could serve as an example of a city planned and built with a focus on sustainability.

Recommendations

- Strive for an agreement in principle between the public sector, the private sector (represented by the construction-related segments of the real-estate, financial, and industrial sector), and other interest groups (professional associations and colleges, and academics in general) with a view to developing the system of measures for green building certification; the structure of the entity that will be responsible for this task, its principles, objectives, and roles, and the instruments that will, in principle, be implemented to promote the adoption of green building in the real-estate market, so as to help meet the Kyoto commitments.
- Propose the production, by 2010, of an initial progress report containing information on the degree of compliance with Mexico's various commitments. Said report should examine green building experiences and assess, in monetary terms, the response of the real-estate market and the construction industry to the various incentives, and other equally important aspects such as green building's inclusion in the National Planning System, in the federal and local regulatory frameworks, and in the initiatives of the different orders of government.
- Governments should act to ensure that the buildings they occupy (whether owned or rented) are renovated or built according to the principles of green building. This should be applied at all three levels of government, particularly in offices with high public visibility.
- Promote the development of a system of efficiency and effectiveness indicators that facilitates quantifying the performance of green buildings and strengthens the system of measures.
- Carry out a pilot project involving the planning and construction of a real estate development that serves as a flagship for the *green building* concept in Mexico. To this end, it is suggested that the three levels of government join forces so as to include a range of stakeholders and develop at least two green building pilot projects in cities such as Aguascalientes and Monterrey. In so doing, they would demonstrate the

advantages of this concept, in addition to creating an initial group of businesses and individuals possessing the training and tools necessary to advance the green building agenda in Mexico.

VI. Financing for Green Building

Financing experiences in Mexico in the green building market have been few and far between. The Institute of the National Fund for Workers' Housing (*Instituto del Fondo Nacional para la Vivienda de los Trabajadores*—Infonavit), a government agency that uses employee premiums to finance home ownership, has initiated a “green mortgage” program,²⁹ offering an enhanced line of credit with which to offset the additional cost of environmental services.

To qualify for a loan, a building must be certified by the National Energy Efficiency Commission as being equipped with energy saving appliances. With certification in hand, buyers can then apply to Infonavit for funding.

The “green mortgage” program is now working in conjunction with the National Institute of Ecology (*Instituto Nacional de Ecología*) to expand its initial offering in such a way that users derive maximum benefit at minimum additional cost.

On water conservation, an initial phase will consist of certifying buildings equipped with water-saving faucets, dual-flush devices for toilets, and proper installation of domestic hookups; later additions may include wastewater treatment in housing developments, and storm water collection and recycling. In terms of energy, the program will include the installation of thermal insulation and efficient heating and cooling systems. Greenspaces will be another important component. The units covered by the program run the gamut from social housing to the conventional housing market.

Currently, two new programs are being developed. The first involves the construction of a residential complex in the city of Tijuana, while the second concerns the construction of a new city in the state of Nuevo León. The specific characteristics of these projects and their financing sources and methods are as yet unknown; all that is known is that sustainability criteria will be included in their design.

It is proposed that a study be done of green building activities carried out in Mexico and other countries, to identify their impact on the real-estate market, and to use the lessons identified by this research to recommend the necessary instruments to financing agencies. Furthermore, we agree with Group Four's proposal as to the need to foster a comprehensive strategy that will transform the behavior of the market in such a way that green buildings become a natural part of supply and demand, thus orienting the market toward innovations for continuous improvement of performance.

In order to develop this strategy, it is recommended that the CEC pursue its leadership in the promotion of green building, which has already yielded significant results for the region. The CEC should continue to offer a forum where strategies may be discussed which, if applied across the entire region, will enhance their market impact (e.g., issuance of green guidelines).

²⁹ Francisco Rojas, “Llegan las hipotecas verdes” (Green mortgages are here), *El Universal*, 13 April 2007.

Another concurrent activity whose impact will be greatest if coordinated across the region is a cost-benefit analysis of all the financial incentives currently operating in the real-estate market, on both the supply and the demand side, so as to recommend the proper tax incentives. This analysis should review the charges to which development costs give rise so that they include green building characteristics.

Another measure that should be explored for its potential to influence the construction market is the development of a carbon market under the aegis of NAFTA. This would help to promote projects that reduce greenhouse gases and increase energy efficiency. In this connection, it is recommended that a proposal be submitted to the Interministerial Commission on Climate Change (*Comisión Intersecretarial de Cambio Climático*—CICC) on inclusion of the category of green building projects in the National Climate Action Strategy as potential sellers of carbon credits. The CICC coordinates the government's national policy formulation and implementation on greenhouse gas prevention and mitigation and adaptation to the effects of climate change; in general, it promotes the development of climate action programs and strategies related to Mexico's fulfillment of its commitments under the United Nations Framework Convention on Climate Change and the instruments ensuing from it, notably the Kyoto Protocol.

According to data provided by the National Climate Action Strategy, which was developed in 2006 by the Working Group of the Advisory Council on Climate Change (*Consejo Consultivo de Cambio Climático*):³⁰

- Mexico contributes around 1.5 percent of the world's greenhouse gas emissions. If patterns of energy consumption and production continue as they have to date, the country's future emissions will increase substantially.
- As shown by the National Greenhouse Gas Emissions Survey (*Inventario Nacional de Emisiones de Gases de Efecto Invernadero*—INEGEI), emissions in 2002 reached 389.5 million tons of CO₂, corresponding to 61 percent of the national total. These emissions are caused by the burning of fossil fuels (plus fugitive emissions), including in the manufacturing and construction industries (13 percent), as well as by consumption activities in the residential, commercial, and agricultural sectors (8 percent).
- According to emissions data provided in 2006 by the Mario Molina Center for Strategic Energy and Environmental Studies, the share accounted for by the residential and services sector from 1994 to 2004 held steady at 7 percent. It is expected that this will be reduced to 6 percent by 2014, since the energy consumption pattern in this sector has changed.
- Carbon markets have become the preferred mechanism for encouraging activities that reduce greenhouse gas emissions as efficiently and economically as possible. All indications are that European Union emission trading in 2006 will reach 874 million tons of CO₂ for a value of 17.8 billion euros.

³⁰ Interministerial Commission on Climate Change, National Climate Action Strategy, Mexico, May 2007.

- The Mexican Carbon Fund (*Fondo Mexicano de Carbono*—Fomecar) was created to take advantage of the Clean Development Mechanism (CDM) and other carbon markets. The fund's objectives are to identify and promote greenhouse gas reduction activities, offer financial support to project developers, and buy and sell Certified Emissions Reductions (CER) and carbon credits. This fund is administered and operated by *Banco Nacional de Comercio Exterior* (Bancomext), a state-run credit corporation that operates as Mexico's export development bank, coordinating the corresponding federal financial support and guarantees.

Recommendations

- Take advantage of existing programs to offer financial incentives to green building developers.
- Foster government-industry cooperation on capacity building to support research and development in this area.
- Give precedence in policymaking to market-based over tax-based strategies.
- Promote the adoption of tax reforms that shift the tax burden onto those goods and services that harm the environment while rewarding those that benefit it; for example, promote the adoption of graduated public utility rates for increasing volumes of consumption, reward conservation and punish excessive consumption, or tax inefficient technologies and transfer the benefits to consumers of efficient technologies.
- Offer subsidies and low-interest loans to purchasers of sustainable materials, components, systems, and buildings.
- With the energy sector, work towards a situation in which payment for consumption takes into account tax deductions at the levels of both generation and energy efficiency.
- Encourage local authorities to adopt market-based instruments that encourage green practices; for example, the incorporation of development right transfers in favor of green buildings in their urban development plans; special zoning (*polígonos de actuación*) for zones where green building is favored, as well as facilities for developers who incorporate green criteria or codes into their buildings.
- Continue the promotion of green building through the use of government-backed green mortgage credits and the like.
- In conjunction with the state governments and associations of real estate appraisers, promote the adoption of sustainability criteria in real estate appraisals.
- Propose to the CICC that green building projects be incorporated into the National Climate Action Strategy as potential sellers of carbon credits.
- Promote the development of a carbon market under the auspices of NAFTA so as to finance green building projects.

VII. Green Building in the Mexican Educational System

Education is the most important foundation of any society; on it depends the future of the nation. In Mexico, environmental issues are now a significant part of textbooks from primary school onward.

The subject is covered in the higher grades not only in disciplines connected to the natural sciences, but increasingly in disciplines relate to technology and the arts.

The academic disciplines most closely associated with green building are architecture and engineering. In Mexico, architecture is taught at some 80 institutions of higher education, according to information from the Mexican Association of Architecture Teaching Institutions (*Asociación de Instituciones de la Enseñanza de la Architecture de la República Mexicana*).³¹ The curriculum of each of these institutions includes at least one course related to the environment or sustainable development.

VII.1 Undergraduate Level

The largest public educational institution in Mexico is the *Universidad Nacional Autónoma de México* (UNAM), whose faculty of architecture offers various courses relevant to the topic at hand. Among the core courses are Architecture, Environment, and the City (I and II) and Urban Environmental Design. Electives include Sustainable Development in Architecture, Bioclimatic Design, Bioclimatic Architecture, Mexico: Towards the Sustainable City, Green Buildings, and Landscape Architecture.³²

Another example of an academic institution whose curriculum includes related material is the *Universidad Iberoamericana/León* Campus, a private university offering Analysis of the Natural Environment, Bioclimatic Architecture (I and II), Ecology and Society, and Laboratory in Urban Design and Landscape Architecture.³³

The private *Universidad Intercontinental* offers the following core courses at its three Mexico City campuses: Alternative Energy Sources, Ecological Architecture, Bioclimatic Architecture, and Ecology and Sustainable Development. It offers the following electives: Landscape Architecture, Urban Environment and Urban Image Revitalization, Topics in Ecological Architecture and Environmental Design.³⁴

The curriculum of the *Universidad Veracruzana*, a Veracruz state university, does not include any relevant core courses, but offers as electives Bioclimatic Architecture, Landscape Architecture, and Man and his Environment.³⁵

³¹ See <www.uaemex.mx/asinea>.

³² Universidad Nacional Autónoma de México, Faculty of Architecture, at <www.architecture.unam.org.mx>.

³³ Universidad Iberoamericana Campus León, at <www.leon.uia.mx>.

³⁴ Universidad Intercontinental, at <www.uic.edu.mx>.

³⁵ Universidad Veracruzana, at <www.uv.mx>.

The curriculum of the *Universidad Autónoma de Guadalajara*, a public university, includes the core courses Environmental Design and Habitat Development.³⁶

Tecnológico de Monterrey, a private institution offering a complete degree in architecture at nine campuses around the country and a partial degree at six others, includes in its curriculum one relevant core course: Environmental Sustainability.³⁷

An Internet search produced the following results:³⁸

- Bioclimatic architecture is a subject included in the curricula of 25 schools and institutes of higher education in 8 Mexican states.
- Sustainable architecture is covered to varying degrees in 130 courses given in 19 states.
- Environmental architecture is covered in 94 courses given by institutions in 23 states.

VII.2 Graduate Level

Graduate study in sustainable architecture-related fields is available at three academic institutions: the *Universidad Autónoma Metropolitana* (Azcapotzalco campus), which offers a master's program in bioclimatic design and architecture;³⁹ the *Universidad de Colima*, offering a master's in bioclimatic architecture,⁴⁰ and the *Universidad Cristóbal Colón*, Veracruz, which has a master's program in building design and bioclimatic studies.⁴¹ In addition, UNAM allows interested master's-level architecture students to specialize in this area,⁴² as does the *Universidad Autónoma de Ciudad Juárez*, in the state of Chihuahua, with its master's program in holistic design.⁴³

The Faculty of Architecture at the *Universidad de Colima* is a pioneer in the field of bioclimatics. The curriculum of the university's master's program in bioclimatic architecture has the following objectives:⁴⁴

- Equip students with the knowledge they require to identify and to solve design problems with reference to environmental conditions.
- Develop students' proficiency with basic bioclimatic design processes at three different scales: device design, building design, and urban design.
- Provide students with the auxiliary tools necessary for decision-making in the area of passive climate control systems.

³⁶ Universidad Autónoma de Guadalajara, at <www.uag.mx>.

³⁷ Tecnológico de Monterrey, at <www.itesm.mx>.

³⁸ See <www.emagister.com.mx>.

³⁹ Universidad Autónoma Metropolitana (UAM-Azcapotzalco), at <www.uam.mx>.

⁴⁰ Universidad de Colima, Faculty of Architecture, at <www.ucol.mx>.

⁴¹ Universidad Cristóbal Colón, at <www.ver.ucc.mx>.

⁴² Universidad Nacional Autónoma de México, Graduate Division, at <www.posgrado.unam.mx>.

⁴³ Universidad Autónoma de Ciudad Juárez, at <www.uacj.mx>.

⁴⁴ Universidad de Colima, *op. cit.*

- Create a system of values in which the architect is engaged with his/her social, natural, and cultural environment in the pursuit of sustainable habitat development and continuous quality-of-life improvement.

This master's program is directed at architects, civil engineers, mechanical engineers, urban planners, industrial designers, and other professionals in areas related to the design, construction, and control of artificial environments who have prior experience or demonstrated interest in the field of energy efficiency, passive heating and cooling systems, or the environment in general. The main research interest is the development of sustainable habitat in the subhumid tropics.

At the *Universidad Autónoma Metropolitana*, Azcapotzalco campus, the Division of Design Sciences and Arts offers certificate, master's, and doctoral programs in bioclimatic architecture and in landscape and garden planning and conservation.⁴⁵

The *Universidad Cristóbal Colón* offers a master's degree in building design and bioclimatics with a general research focus encompassing humanistics, design, technology, ecology, and environment. Its curriculum includes the following core courses: Ecology and Environmental Impact; Ergonomics; Thermal, Light, and Acoustic Factors; Laboratory in Applications of Biodesign and Biodesign Technology to Architecture; Environmental Resources for Comfort; Applications of Advanced Technology to Design.⁴⁶

Ecological-bioclimatic issues are an important research focus of the master's program in holistic design at the *Universidad Autónoma de Ciudad Juárez*, in the state of Chihuahua, which cover the application of alternative energy technologies to urban architecture, design, and methods. This program includes topics such as environmental management for design, solar power and passive systems, sustainable systems, ecological design in arid and semiarid areas, and sociology of sustainability-oriented development.⁴⁷

VII.3 Certificate Programs

Programs of this type are offered by the UNAM Faculty of Chemistry, the *Universidad Iberoamericana*/Federal District Campus, and the *Universidad de Sonora*.

A large number of people with different levels of specialization carry out various tasks in the building process in general, and their involvement is by the same token fundamental to the success of green building projects. In particular, it is necessary to train construction workers and technicians so as to create a pool of workers trained (and certified) in green building-related techniques. Mexico has a wide range of technical and trade schools that can contribute to this process.

In summary, it is the role of Mexican institutions of higher education to train and graduate the construction industry professionals who will plan, certify, and appraise in the area of green building; these professionals could be evaluated and, as applicable, accredited by a collegial

⁴⁵ Universidad Autónoma Metropolitana (UAM-Azcapotzalco), *op. cit.*

⁴⁶ Universidad Cristóbal Colón, *op. cit.*

⁴⁷ Universidad Autónoma de Ciudad Juárez, *op. cit.*

body linked to certification. An equally important task is training and certification of construction workers and technicians.

Similarly, considering the fundamental role of the local authorities in strengthening the green building promotion strategy, closer collaboration must be sought with the municipal authorities and officials responsible for urban planning and administration and with the professional associations linked with them. The objective: working towards inclusion of sustainability criteria in building codes and urban development plans. Despite the importance of their involvement if tangible results are to be achieved in this area, municipal authorities have been generally uninformed about green building issues and hence totally absent from the corresponding forums. For this reason, it is proposed that their involvement be fostered through the organizing of forums, meetings, seminars, conferences, and similar events specifically aimed at municipal officials.

Moreover, market demand for this type of building is crucial, as is the willingness to operate such buildings appropriately. Therefore, educating consumers and helping them make more intelligent, enlightened choices is a critical task that falls to the three level of government in conjunction with developers, universities, and NGOs.

In the area of trinational cooperation, what is needed is an automated database on housing information, provided by the three countries, on the status of green building. This will further our understanding of the behavior of the real estate market, helping us to discern the obstacles and the prospects for the penetration of green building practices and to effect a transformation of the real estate market.

Recommendations

- Incorporate into the Education Sector Plan a short-term action whereby Mexican institutions of higher education train the construction industry professionals whose task it will be to plan, certify, and appraise green building projects.
- Likewise, it will be necessary for technical and trade schools to train the construction workers and technicians who work in areas related to green building.
- Propose that Sedesol hold an initial national meeting on green building to be attended by local officials in charge of urban administration, members of construction-industry-related professional associations, and local authorities, with the goal of having sustainability criteria incorporated into building codes and urban development plans at the drafting stage.
- Convene regional meetings with representatives of local authorities, such as the Mexican Association of Municipalities (*Asociación de Municipios de México*) or the Municipal Urban Planning Institutes (*Institutos Municipales de Planeación Urbana*), to encourage their acceptance of the concept of sustainability.
- Create a dynamic and comprehensive regional system with information on sustainability indicators that allows governments to opt for the adoption of policies guided by the principles of effectiveness and efficiency.

- Encourage the signing of regional agreements to promote exchange of experiences and transfer of clean, cutting-edge technology while averting unfair external competition from high-impact or dirty technologies.
- Offer forums, courses, and seminars led by individuals highly qualified in green building practices to local personnel who can wield decisive influence over the incorporation of environmental criteria into standards, urban plans, and building codes. The result being to encourage medium-term adoption by municipalities of modern instruments that are both appropriate to local needs and consistent with national standards.
- Develop a communications and consumer education strategy that will help people make informed decisions based on sustainability criteria when purchasing or occupying a building.

VIII. General Recommendations

From the standpoint of institutions and standards, the promotion of green building in Mexico requires a comprehensive, participatory approach (see Figure 3).

With the collaboration of the various construction industry stakeholders, Mexico will be in a position to promote green building throughout the country. All the stakeholders, within their respective spheres of activity, must come to a consensus on their respective commitments so that the sustainability goals may be achieved according to an agreed timeline, e.g., by 2012. For this to happen it will be necessary for all stakeholders, especially the federal and local governments, to take their commitments seriously and act accordingly. **Error!**

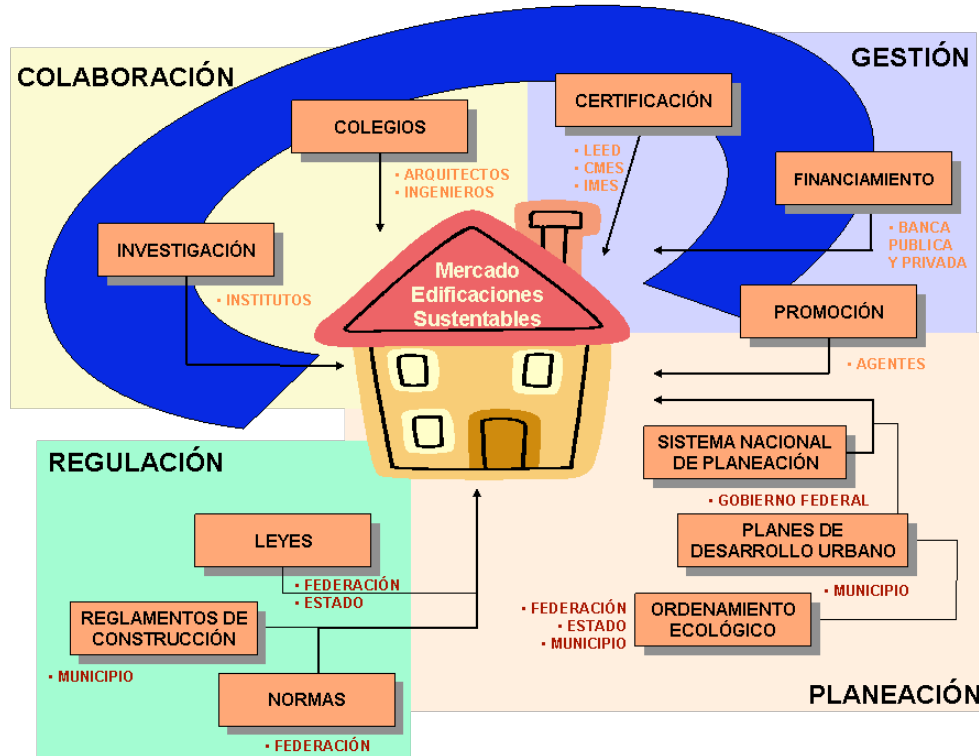


Figure 3. Policy instruments to promote green building

[Legend, gray boxes, clockwise from bottom left:]

Standards (federal government)

Building codes (municipality)

Laws (federal government, state governments)

Research (educational institutions)

Professional associations (architects, engineers)

Certification (LEED, CMES, IMES)

Financing (public and private)

Promotion (agents)

National Planning System (federal government)
Urban development plans (municipality)
Environmental land use planning (federal, state and municipal governments)

[Center:] Green building market

[Bold titles, clockwise from bottom left:] Regulation, Collaboration, Management, Planning

The principal recommendations of this report are presented below:

1. Incorporate the *green building* concept into the National Planning System

In order to obtain quantifiable results in green building by 2012, it is necessary to begin by incorporating this concept into the Urban Development and Land Use Planning (*Desarrollo Urbano y Ordenación del Territorio*—PDUOT), Environment and Natural Resources (*Medio Ambiente y Recursos Naturales*—PMARN), Energy (*Energía*—PE), Housing (*Vivienda*—PV), and Education sector plans, at a minimum. This must be done without neglecting the need for its inclusion in local planning, and with due consideration for the strategic role played by the local authorities in project approvals, i.e., as important potential leading actors in green building.

2. Foster the involvement of the local authorities in strengthening green building

It is proposed that an initial national meeting be held with local authorities before year-end 2007 to promote the development or modernization of their building codes to include green building criteria. Potential collaborators on this initiative would include established, legitimate representative groups such as the Mexican Association of Municipalities and the Municipal Urban Planning Institutes.

3. Promote the modernization of construction bylaws with the introduction of the green building concept

As a result of the foregoing consideration, it is also necessary to establish a federal program to support priority and/or medium-sized cities, with mandated funding to help the municipal authorities draft or modernize their building codes via the addition of a specific section setting out the technical specifications of sustainability standards for buildings.

4. Determine criteria for the promotion of green building in urban development plans

It will be necessary to include in the National Urban Development and Land Use Planning Program (*Programa Nacional de Desarrollo Urbano y Ordenación del Territorio*) for 2007–12 a strategic component on green building that contemplates,

among other things, a commitment to assist local authorities with the adoption of sustainability criteria and standards in their buildings and with their inclusion in the urban zoning of their respective state and municipal urban development plans.

5. Develop technical requirements (in the form of codes, NOMs, and NMXs) to provide for the regulation and administration of new buildings based on sustainability principles

In the process of modernizing and promulgating building codes and municipal urban development plans, it is necessary to refer to an as yet non-existent set of codes and standards that encompass the entire building life cycle. The most important of these codes and standards are:

- Federal energy efficiency code
- Bioclimatic building design
- Sustainable water use
- Use of recycled construction materials
- Sustainable use and management of waste
- Greenspaces
- Environmentally efficient use of public spaces, including roads
- Planning of use and final disposal of maintenance and construction materials during and after the useful life of buildings.

6. Promote and adopt a voluntary certification system that is recognized by the Mexican governmental and accepted in North America

Mexico should promote a voluntary green building certification system arising out of a broad consultation process with individuals and associations involved in construction. Preferably, this system should enjoy government recognition and, for purposes of mutual recognition, be equivalent to the one applied by LEED in the United States and Canada.

Since the companies participating in the Profepa environmental auditing program derive concrete benefits from certification, it is recommended that Profepa convene a broad consultation process leading to the formation of a non-profit, non-governmental organization backed by the segments of the private and academic sectors associated with the construction industry.

7. Create a national databank or information system providing a comprehensive view of the standards applied in the different regions of the country

In view of the diverse, vast, and complex range of issues related to Mexico's building regulations, as well as the lack of an instrument that could serve to give them conceptual coherence, it is proposed that a national databank or information system be created to provide a comprehensive view of the standards applied in the different regions of the country. The databank would be at the disposal of the authorities, building contractors, competent professionals, and other interested persons. It would offer viable technical solutions for the future development of buildings, with codes that take into account the

geographic, social, economic, and environmental conditions and opportunities specific to different regions.

8. Encourage the nation's institutions of higher education to create certificate programs in green building

It is recommended that the sector education plan include, as a short-term action, the objective that Mexican institutions of higher education train and graduate the construction industry professionals whose task it will be to plan, certify, and appraise in the area of green building; these professionals could be evaluated and, where applicable, accredited by a duly empowered professional association or college.

9. Propose a financial study

Such a study would ascertain the green building-related activities that have been carried out in Mexico and other countries, identify their impact on the real-estate market, and recommend the necessary instruments to financial institutions.

10. Propose a pilot study

This would be a trilateral study involving one city in each of the three countries (Canada, the United States, and Mexico), in which various green building-related activities are carried out and the scope and results of the measures adopted are evaluated. Monterrey could be chosen as the participating Mexican city.

11. Incorporate green building into the ENAC

Present to the CICC a proposal for green building to be incorporated into the ENAC with a view to defining targets and strategies for this sector.

12. Create a national framework for coordinated and inclusive action

It is important to develop and formalize a working arrangement allowing for interaction among the relevant federal departments and for coordination with the state and municipal governments, the legislative branch, and other stakeholders. This arrangement could take the form of an interministerial commission on green building or the like.

13. Pursue the trilateral coordination initiated by the CEC

Pursue the coordination among the members of the Publishers and Advisors Group with a view to holding a summit within two years, where the participants may discuss the relevant issues and take stock of progress on the implementation of the agreements.

IX. References

- Cámara de Diputados del H. Congreso de la Unión. *Ley de Planeación. Diario Oficial de la Federación*, amended 13 June 2003.
- Cámara de Diputados del H. Congreso de la Unión. *Ley Federal sobre Metrología y Normalización. Diario Oficial de la Federación*, amended 28 July 2006.
- Casar Marcos, Guillermo. “Temas y oportunidades de la edificación sustentable en México.” CEC workshop, “Sustainable Building in North America: the Mexican Perspective.” Mexico, 21 February 2007.
- Comisión Nacional de Fomento a la Vivienda. *Diseño de áreas verdes en desarrollos habitacionales*. Mexico, 2005.
- Comisión Nacional de Fomento a la Vivienda. *Hacia un código de edificación de vivienda*. Mexico, May 2005.
- Comisión Nacional de Fomento a la Vivienda. Programa Sectorial de Vivienda 2001-2006. Executive summary. Online at www.conafovi.gob.mx, Mexico, 2001.
- Comisión Nacional de Fomento a la Vivienda. *Uso eficiente de la energía en la vivienda*. Mexico, 2006.
- Comisión Nacional de Fomento a la Vivienda. *Uso eficiente del agua en desarrollos habitacionales*. Mexico, 2005.
- de Buen, Odón. “Edificios, energía y cambio climático en México: algunos datos importantes.” CEC workshop, “Sustainable Building in North America: the Mexican Perspective.” Mexico, 21 February 2007.
- Department of Energy. Office of Energy Efficiency and Renewable Energy. Energy Code for New Federal Commercial and Multi-Family High Rise Residential Buildings.” Final Rule, Part IV, 6 October 2000. CEC workshop, “Sustainable Building in North America: the Mexican Perspective.” Mexico, 21 February 2007.
- Gobierno del Distrito Federal. *Normas técnicas complementarias del reglamento de construcciones para el Distrito Federal 2004*. Online at www.arq.com.mx/documentos/Detalles/52874.html.
- Gobierno del Distrito Federal. Programa General de Desarrollo Urbano del Distrito Federal 2003. Mexico, 2003.
- Gobierno del Distrito Federal. *Reglamento de construcciones para el Distrito Federal*. Online at www.paot.org.mx/centro/reglamentos/df/pdf/regladecons.pdf.

- Gobierno del Estado de Veracruz-Llave. *Reglamento de construcción para el Estado de Veracruz-Llave*. Online at www.veracruz.puerto.gob.mx/general/pdf/reglamento_construcciones.pdf.
- Hirata Nagasaki, Evangelina. Comisión Nacional de Vivienda. “Hacia una vivienda asequible y sustentable.” CEC workshop, “Sustainable Building in North America: the Mexican Perspective.” Mexico, 21 February 2007.
- Lacy, Rodolfo (Centro Mario Molina). “Energía, cambio climático y el sector de la edificación.” CEC workshop, “Sustainable Building in North America: the Mexican Perspective.” Mexico, 21 February 2007.
- Mayagoitia Witron, Fernando (Lean House Consulting). “Hacia una vivienda asequible y sustentable.” CEC workshop, “Sustainable Building in North America: the Mexican Perspective.” Mexico, 21 February 2007.
- Morillón Gálvez, David (UNAM). “La importancia de la edificación sustentable.” CEC workshop, “Sustainable Building in North America: the Mexican Perspective.” Mexico, 21 February 2007.
- Municipio de Acapulco, Guerrero. *Reglamento de construcciones para el municipio de Acapulco de Juárez*. Online at www.acapulco.gob.mx/marco/construcciones.pdf.
- Municipio de Hermosillo, Sonora, *Reglamento de construcción para el municipio de Hermosillo*. Online at www.tododecasa.com/articulos/upload/reglamento_construccion.pdf.
- Presidencia de la República. Plan Nacional de Desarrollo 2007-2012. *Diario Oficial de la Federación*, 30 May 2007. Online at www.gobernacion.gob.mx/compilacion_juridica/webpub/prog02.pdf.
- Secretaría de Desarrollo Social. Programa Nacional de Desarrollo Urbano y Ordenación Territorial 2001-2006. Online at www.Sedesol.gob.mx/subsecretarias/desarrollourbano/subsecretarias/documentos.pdf. Mexico, 2001.
- Secretaría de Energía, Programa Sectorial de Energía 2001-2006. Online at www.energia.gob.mx/work/sites/SenerNva/resources/localcontent/3866/prosec. Mexico, 2001.
- Secretaría de Medio Ambiente y Recursos Naturales. Programa Nacional de Medio Ambiente y Recursos Naturales 2001-2006. Executive summary. Online at www.semarnat.gob.mx.pdf. Mexico, 2001.

Websites viewed

www.anuies.mx
www.arquitectura.unam.org.mx
www.ceu.unam.mx
www.cicese.mx
www.conacyt.mx
www.copaes.org.mx
www.df.gob.mx
www.dgae.unam.mx
www.emagister.com.mx
www.fcarn.org.mx
www.leon.uia.mx
www.planeacion.unam.mx
www.posgrado.unam.mx
www.profepa.gob.mx
www.sedesol.gob.mx
www.semarnat.gob.mx
www.sep.gob.mx
www.todoarquitectura.com
www.uaemex.mx
www.uam.mx
www.uacj.mx
www.uag.mx
www.ucol.mx
www.uic.edu.mx
www.uma.es
www.universidaddecolima.org.mx
www.universidades.org
www.universia.net
www.uv.mx
www.ver.ucc.mx