Sustainable Construction in Mexican Housing Markets

by

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Abstract

This thesis examines recent developments in Mexico's housing markets as an example of how sustainable construction is being adapted and applied in developing countries.

The recognition that the construction, operation, and demolition of buildings greatly impact the environment has spurred industry and government alike to examine ways to foster sustainability in the construction and property development industry. Mexico has made progress in addressing sustainability in low-cost housing through public sector-sponsored pilot programs, at a time when the developer-produced low-cost housing market is experiencing dramatic growth.

I examine the state of the art of sustainable construction in Mexico and ask: What are the barriers to the wide-spread adoption of sustainable construction in housing? How have programs for energy and environmental sustainability engaged these challenges? What conditions suggest additional approaches to promote sustainable low-cost housing?

Over four months in Mexico, I conducted semi-structured interviews of about thirty professionals in the development industry. The interviews suggest that consumers don't value environmental performance, but rather size and amenities; sustainable construction costs more to build, and this cost premium must be passed on to the consumer; and an inconsistent regulatory environment impedes efforts to provide a level playing field through building codes. The barriers on the side of the practitioners are that information sharing difficult both within firms and across firms, and the lack of training and experience in working with sustainable construction.

Mexico's first efforts in sustainable construction show that consumer preferences can and do change as information and options become available. These early programs also pioneered a novel cost-recovery program tailored to the financial abilities of customers while mitigating default risk for the funder, which later programs were able to adapt to shift the burden of additional developer first-costs to the buyers. Finally, an institutional actor has emerged in the key role as promoter of sustainable construction in low-cost housing.

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This thesis is dedicated to my parents Hae-Oak and Charlie, and to my dad Usung, an unconventional character with a keen sense both of individualism and public service. Though a non-smoker for 15 years, he was diagnosed with lung cancer in February 2005 and, never once having returned home, died on October 19, 2005, aged 57.

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Chapter 1

Introduction

1.1 Research Scope and Objective

The recognition that the design, construction, operation, and demolition of buildings play a key role in sustainability has spurred global interest in how the real estate development and construction industries can improve their environmental performance. In the 15 years that sustainable construction has been a subject of study, however, little has been written about the public policy and economic contexts of its application in developing countries. This thesis examines Mexico's national public policy initiatives to encourage private low-cost housing developers to adopt sustainable construction practices. To the extent that housing development industries in Mexico and other developing countries share characteristics foreign to those of Western developed countries, this study contributes to expanding the base of knowledge about the ways that sustainable construction can be advanced in the Global South.

In the most holistic sense, sustainable construction includes the social and environmental impacts of all economic activity related to real estate and construction: the extraction, manufacture, transport and disposal of construction materials; the generation and delivery of energy required to build, operate and dispose of built property; and the secondary impacts of real estate development on land use and transportation. In this thesis, I use the term "sustainable construction" to refer to the the subset of this broad domain that

relates directly to site- and building-specific decisions.[1] While recognizing the importance of the many facets of sustainable construction left outside this limited scope, I chose focus on the building/site level aspects addressed by existing sustainable construction policies: energy-efficiency, water conservation, sourcing and disposal of materials, and occupant comfort.[2]

Mexico's initiatives are interesting because they are among the first attempts to adopt a national policy of sustainable construction a Latin America, and because they have put sustainability on the low-cost housing agenda during a boom in housing construction. I examine the state of sustainable construction in Mexico and ask: What are the barriers to wide-spread adoption of sustainable construction by low-cost housing developers in Mexico? How have sustainable construction policies engaged them? What other opportunities to improve sustainable housing policies are suggested by the local context and institutions of housing development?

Mexican sustainable housing initiatives target new low-cost housing produced by for-profit private developers. As described in Chapter 2, this segment represents a small fraction of the total stock of housing. Retrofits of existing stock and new production through self-building are not examined in this thesis except to provide the broader context in which to understand the efforts in the developer-built low-cost housing segment. To what extent and under what conditions finished housing is substituted for self-built housing was also not considered in this research.

[1] In the US, the term "green building" describes the subset of sustainable construction that I address in this thesis. In Mexican Spanish, "edificación sustentable" is often the term used to refer to building-scale sustainable construction. I chose to use the phrase "sustainable construction" rather than "green building", despite the more specific connotation of the latter, to preserve a clear relationship between the English and Spanish terms.

[2] A 2001 comparative study of European sustainable construction policy focused on "four generally recognized themes of sustainable building: energy saving, materials and waste management, and water conservation", noting that these themes were emphasized in building regulations (Sunikka 2001). LEED, the primary sustainable building certification system in the US, incorporates "sustainable sites, water efficiency, energy & atmosphere, materials & resources, indoor environmental quality, and innovation & design process (USGBC 2005).

1.2 Methodology

Over the course of four months in Mexico, I spoke with about thirty professionals in the development industry and related fields. Most of these conversations were 60-90 minute, semi-structured interviews conducted in person. Appendix A lists the interviewees grouped by the segment of the industry represented. A sample of the questions that were used as starting points are listed in Appendix B. Some conversations took place under circumstances that did not lend themselves to an interview format, but, none the less, informed my understanding of housing and green development in Mexico. Where I felt it would be appropriate, I included these "interviewees" in Appendix A. Additional data about the sustainable construction programs were taken from internal documents (reports, memos, presentations, and contracts) supplied by interviewees.

By interviewing those who design, build, and regulate low-cost housing, I hoped to learn how and why decisions about low-cost housing development are made, and to understand to what extent these decisions may be influenced by environmental considerations. I tried to balance representation of four groups: developers, public-sector administrators, architects and energy/green building NGOs and consultants.

1.2.1 Housing Developers

Among the developers, I contacted the companies that participated in the energy efficiency and sustainable housing pilot projects. Three of the interviewees (of Urbi, ICA and Bracsa) were directly involved in pilot projects. The fourth, of Casas Geo, was charged with coordinating energy issues for the largest housing builder in Mexico. All of the developers interviewed build low-cost housing, except BCBA, which builds middle-income to luxury projects.

1.2.2 Government and Quasi-governmental Agencies

I also interviewed representatives of the agencies that were involved in the efficiency and sustainable housing pilot projects: FIDE, Conavi, and INE[3]. Conae was included because of its role as a promoter of energy efficiency. I included representatives of the governments of Mexico City and the State of Mexico to get a sense of the local actors' perspectives. One omission of note in these interviews is the absence of interviewees representing the national housing institutes.

1.2.3 NGOs and Sustainability Advocates

Among the NGOs, the Mexico Green Building Council (CMES), Urban Land Institute, and Holcim Foundation for Sustainable Construction are organizations that have strong ties to international green development groups. AEAEE is a membership organization of companies that sell insulation, windows, HVAC systems, and other energy-efficiency products and services. Sustainability advocates Odón de Buen, Jorge Kanahuati, and researcher David Morillón were recommended by several other interviewees.

1.2.4 Architects

Of the architects, José Picciotto was named by several other interviewees as a leader in bioclimatic architecture. Jaime Varon was recommended as an architect with ties to a large low-cost housing developer. Dalibor Vokac was contacted because of his role in designing Torre Mayor, the only building at the time of the interviews that had been certified as meeting the Mexican building envelope standard for non-residential buildings (NOM-008). Jorge López was working on a residential project that was considering a green certification. Victor Marquez had given a presentation on green design at the architecture school of *Universidad Nacional Autónoma de México* (UNAM).

[3]Pls. see Appendix C for a complete list of abbreviations.

1.2.5 Housing Policy Literature

This thesis also draws on a review of literature in Latin American housing policy. Background information on self-help and informal housing in Latin America was drawn from the work of Alan Gilbert, Gareth Jones, William Siembieda, Ann Varley, and Peter Ward. Much of this scholarship addresses self-built housing, a significant economic activity in Mexico. This scholarship provided the background on questions of access to land, especially as they relate to the 1992 reforms to the Mexican constitution that enabled legal acquisition of communal farm lands by housing developers.

International approaches to the problem of sheltering the urban poor was drawn from the work of Schlomo Angel on housing market indicators and the history of World Bank's shelter lending by Robert Buckley and Jerry Kalarickal. This work provided a useful overview of the international interventions that have contributed to shaping the current Mexican housing policy.

Mexican housing data, such as volume of production and market trends, were taken from "The State of Mexico's Housing" reports produced by the Harvard University Joint Center for Housing Studies and the *Centro de Información y Documentación de la Casa, S. C.*, the publicly-available databases of the National Housing Commission (Conavi), and corporate reports of publicly-listed developers.

1.3 Thesis Outline

Chapter 2 profiles the housing markets in Mexico. It introduces the institutions and actors involved and describes its recent growth. Chapters 3 summarize the barriers to adopting sustainable construction in housing in Mexico, as identified by developers, architects, and public sector actors. . In Chapter 4, I examine four pilot programs: two early energy-efficiency programs and two new programs that target new housing construction. Finally, I review how the sustainable construction pilot projects have responded to the challenges in Mexico and suggest several interventions for further exploration.

Chapter 2

Overview of Low-cost Housing Construction in Mexico

The public policy initiatives for sustainable housing construction examined in this thesis respond to the conditions of low-cost housing development particular to Mexico[1]. The overview of the low-cost housing markets presented in this chapter serves as a backdrop for the subsequent discussion of the barriers to sustainable construction (Chapter 3) and the current policy responses (Chapter 4).

Article 4 of the Mexican Constitution recognizes "worthy and decent" housing as a right of all Mexican families and charges the state with providing access to it[2]. A decade of political and economic stability combined with aggressive reforms of housing institutions have underpinned a dramatic increase in publicly-managed housing delivery[3]; however,

[1]Many sources offer cogent and informative summaries of the state of housing markets (Schuetz et al. 2004, CIDOC 2005 and 2006), housing finance system (Fitch 2005, World Bank 2005, Fitch 2006), and the evolution of Mexican housing policy (SAM 1960, Gilbert 1989, Siembieda and López 1998 and 1999, del Rio and Gurría 2000).

[2]The Mexican Constitution is divided into two parts. The first part, containing the housing clause, lists rights of individuals. The second part describes the organization and powers of the state. Paragraph 5 of Article 4 reads: "Toda familia tiene derecho a disfrutar de vivienda digna y decorosa. La Ley establecerá los instrumentos y apoyos necesarios a fin de alcanzar tal objetivo."

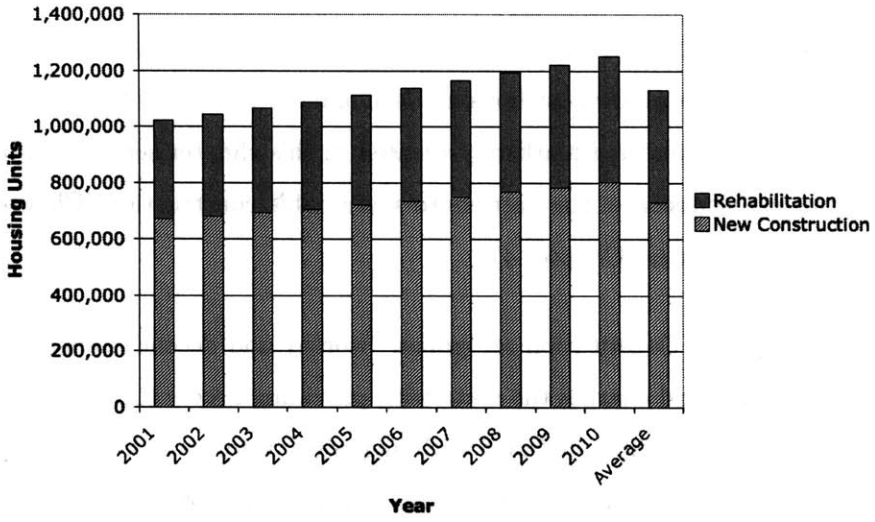
[3]As outlined in this chapter, the national housing funds are the most active and influential; however, several State housing agencies are also an important contributor of low-cost housing. Whereas the public sector at the national level provides exclusively financial support to the private sector, some State housing agencies are themselves developers of low-cost housing.

meeting this responsibility to provide housing affordable to the majority of Mexican households continues to pose a great challenge.

2.1 National Housing Needs

As Mexico's young population continues to form new families, the number of households in need of affordable independent housing will continue to increase. In its 2000 projection of housing needs for 2001-2010 (Fig. 2-1), Conafovi estimated that a yearly average of 730,000 new units and 400,000 significant renovations of existing houses would be needed to accommodate population growth and the deterioration of existing buildings.

Figure 2-1: Annual Housing Needs 2001-2010



Source: Conafovi

The need for new housing reflects demographic and social trends. The population aged 20-34 years drives new household[4] formation. In 2006, this age group numbered 25 million and made up almost a quarter of the total population (Table 2.1). According to estimates,

[4] "Group formed by one or more persons united or not by blood ties, who habitually live in the same home and are supported by a common income, mainly for food. Thus, there can be more than one household in the same home." (CIDOC 2005)

it will number 30 million by 2020. That more households were living as extended families in 2000 and 2005 than in 1990 may indicate additional latent demand. The increase in households also reflects a long-term trend toward smaller household size (CIDOC 2006), which was 4.2 people per household according to the 2005 Count of Population and Housing (INEGI).

Table 2.1: Population and Households (1990-2005)

	1990	2000	2005	Growth/Yr
Total Population*	81.2	97.5	103.3	1.8%
Population Aged 20-34*	19.9	24.4	25.0	
Total Households*	16.2	22.3	24.8	3.5%
Extended Family Households	19.5%	24.5%	23.6%	
Nuclear Family Households	74.5%	68.7%	68.3%	
Single Person Households	4.9%	6.3%	7.5%	
Unrelated Co-resident Households	0.52%	0.43%	0.46%	

*Millions. INEGI data.

The social and demographic trends that drive housing needs are not nationally uniform, with the result that the potential demand for housing is greater in large cities[5]. As housing developers seek economies of scale, finished housing is not available in rural areas with low demand (Schuetz et al. 2004). Rural families tend also to have lower incomes[6] and are less likely to have access to the system of subsidized loans available to salaried workers.

Of the 660,000 new households that formed in 2004, more than three-quarters were in urban areas and about 40% of these households had access to subsidized mortgages through the national housing institutes (CIDOC 2005).

2.2 Volume and Modes of Housing Production

There are two dominant modes of new housing production: self-built housing and developer-built finished housing (Table 2.2). Self-financed, professionally-built homes and

[5]Demand for finished housing is greatest in the 80 largest cities of 100,000 or more residents (Schuetz et al. 2004).

[6]In urban areas, 70% of households earn at least 3 minimum wages. In rural areas, the same percentage of households earn less than 3 minimum wages (CIDOC 2005).

debt-financed self-built homes make up a small fraction of annual production. The total housing stock in 2005 was estimated at 24 million private homes[7] and 2.9 million rental units[8]. Some two thirds of the standing stock is thought to have been originally self-built (Schuetz et al. 2004). In the 2000-2005 period, the stock of housing grew by 2% per year[9]. Table 2.2 shows the estimated addition to the stock in 2004, including the portion contributed by self-building.

Table 2.2: Estimated Housing Production, 2004

	Units*	% of Total
Cash-financed		
Finished housing	19.7	2%
Self-built housing	242.4	30%
Total	262.1	33%
Debt-financed		
Finished housing	496	62%
Self-built housing	43.6	5%
Total	539.6	67%
Total Production	801.7	100%

*Thousands of units. Adapted from CIDOC 2006.

Self-building[10] is a significant economic activity with its own supply chains, labor, and land markets. That almost 50% the poorest quintile of Mexican families owned their home (De Ferranti 2003 in IDB 2005), and that self-builders buy almost a third of all cement sold in the country (US Commercial Service 2006) show the importance of self-built housing.

[7]INEGI Count of Population and Housing 2005.

[8]CONAFOVI, cited in CIDOC 2006

[9]INEGI Count of Population and Housing 2005

[10]Self-building (or auto-construction) does not necessarily imply informality or illegality. The vocabulary related to formal and informal housing can be confusing as both the terms and their meanings vary with local context. In the case of Mexico, informal housing refers to housing that is developed out of compliance with land tenure and use regulations. While self-built housing is strongly associated with *asentamientos irregulares*, illegal settlements, or *colonias populares*, low-income settlements, informality is neither uniquely an attribute of slum settlements nor necessarily the result of popular appropriations of land. Developments targeting high-income purchasers may also begin as legally non-conforming projects. Additionally, due to a history of regularization of informal settlements, many areas that began as informal housing have attained formalized status. Thus self-building may occur legally as well as illegally, and government programs that offer financial and material support self-builders provide an incentive to formalize. While recognizing that informality further complicates housing markets, I will use the "developer-built"/"finished" versus "self-built" rather than the "formal" versus "informal" distinction in describing these sectors.

In self-building, human capital and patience substitute financial capital. The up-front investment required for self-building reflects the price of land and the materials required to build a minimal structure. The owner-occupant and his family provide the labor, only contracting out particular tasks to specialists. Once a plot of land has been secured, the home is built as materials and funds become available, and the owner's space needs change. Over the course of years, the structure may grow horizontally and vertically to accommodate growing families.

Mexico is experiencing an impressive boom in finished housing. As a result of economic and political stability and reforms of the housing finance system, annual developer-built housing production increased almost three-fold between 1996 and 2005, from fewer than 140,000 homes to more than 500,000 (Conafovi)[11].

Price of new finished houses is described in terms of multiples of the official minimum salary in Mexico City (Table 2.3)[12], approximately US $1700 per year.

Table 2.3: Housing Price By Submarket

	x Minimum Salary	USD Estimate
Social	10	17000
Economic	15	25500
Middle	25	42500
Residencial	65	110500
Residencial Plus	65+	110500+

Source: Conafovi 2005

The purchase of a developer-built or finished house entails paying the developer the full price of a fully-constructed home, including land. The large up-front payment required to purchase a finished home is made possible by obtaining a mortgage, which reduces the cash requirement to a fraction of the total purchase price (the down payment). As discussed in the following section, the mortgage market in Mexico is dominated by

[11]Reports on Mexican housing markets use mortgages granted as a proxy measure of housing completions. Data on housing starts or other direct measures of supply are not generally available.

[12]It is generally agreed in the Mexican housing literature that there are at least 5 price tiers, but the price points that mark one tier from the next is greatly debated. Some schemes also include a 'Minimal' tier of approx. 5 minimum salaries that treats the 'pie de casa' as part of the finished housing market, while others consider it a part of the self-building market, much like serviced lots.

government-mandated housing funds. Private lenders make loans exclusively for the higher pricing tiers (residential and residential plus). Thus, a family without access to subsidized loans from the housing funds could not expect to buy a finished house.

2.3 Low-cost Housing Products

Whether built by developers or by residents, low-cost housing as products tend to be small structures. Table 2.4 gives an idea of the size of low-cost housing. Finished homes (and permanent structures in self-built homes) are usually made of masonry (brick or concrete block, depending on local prices) or, in the case of large-scale developments, reinforced concrete. The structures may be single free-standing units, semi-attached with two to four units on a single foundation, or attached units with party walls. Because of their size, it is expected that the residents will make additions. The housing funds, for example, require that developers design for additional floors and provide guidelines on how to build additions. (Sorsby 2006). Thus, even developer-built housing is rarely "finished" and over time undergoes the same process of transformations as self-built housing.

Table 2.4: Characteristics of houses financed by SHF (2002-2005)

Category	Size (sq. ft.)*	Ave. $/sq. ft.	SM**	% Units***
up to 35 m2	355	US$ 54	11	7
up to 40 m2	411	US$ 44	11	10.4
up to 50 m2	478	US$ 46	13	18
up to 60 m2	591	US$ 50	17	21.5
up to 70 m2	706	US$ 48	20	16.9
up to 80 m2	805	US$ 50	24	12.8
up to 90 m2	916	US$ 51	27	6.2
up to 120 m2	1112	US$ 55	36	6.4
bigger than 120 m2	1666	US$ 66	64	0.7

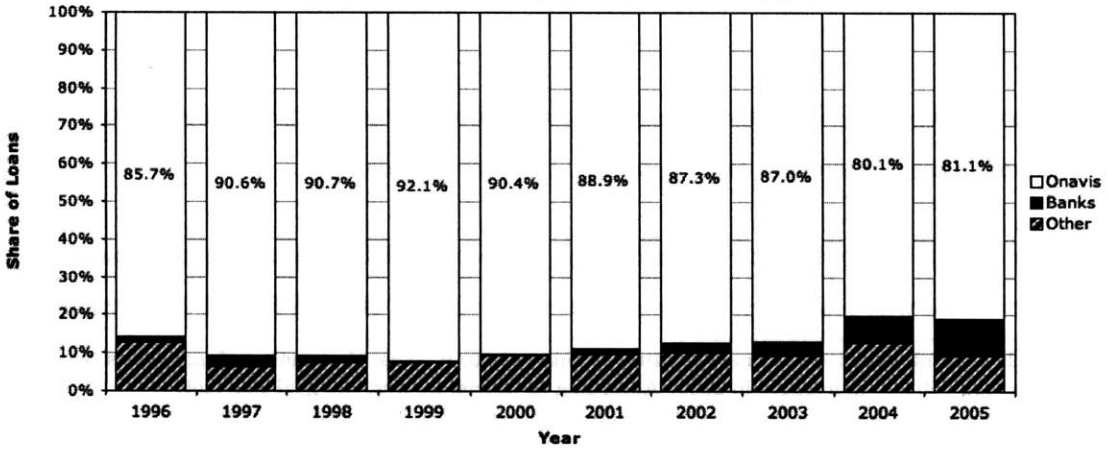
Derived from SHF data cited in Eibenschutz 2005.
*average sq. meters converted
**average price as multiples of minimum salary
***of 98,813 total units financed

2.4 Financing Housing Purchase

The Mexican housing finance system has been undergoing reforms in recent years that attempt to coordinate subsidy schemes, reach further down the income tiers, to make access to housing fund accounts more compatible with market-rate loans via co-financing and mortgage guarantees for higher-income recipients. Despite notable successes, such as in increasing funds available to the housing trusts through securitization of residential mortgages, the system as a whole remains largely centralized around public-sector lenders and narrowly targeting the purchase of newly-built finished homes. The potential for further development of housing finance is evidenced by the fact that the ratio of the value of outstanding mortgages to GDP, an indicator of the penetration of mortgage lending, hovers around 10% of GDP in Mexico (IFC). It is 40% and 80% in the European Union and the US respectively (IDB 2005).

The mortgage market is dominated by the national housing funds (Fig. 2-2), which offer below-market loans to formal (salaried, versus informal cash-economy) employees. Employees are required to contribute a portion of their wages directly to the funds in an obligatory savings scheme, and may make withdrawals only for housing-related expenses or upon retirement.

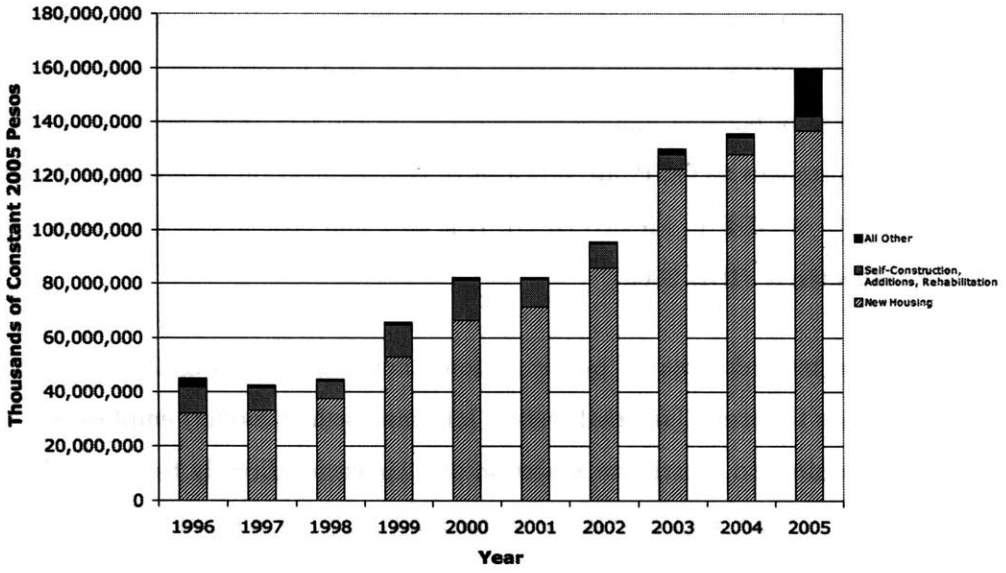
Figure 2-2: Share of New Mortgages by Lender Type, 1996-2005



Data from http://estadistica.conafovi.gob.mx/historicos/. Includes new finished housing and *pie de casa*.

The housing funds offer subsidized loans to individuals for a variety of housing-related activities including construction on land owned by the borrower and renovations of existing homes; most loans, however, are made for the purchase of new houses built by developers (Fig. 2-3). Between 2001 and 2005, an average of 90% of annual housing finance went toward purchasing new finished homes, which expanded the housing stock by less than 2% per year[13].

Figure 2-3: Annual Value of New Housing Loans by Purpose of Loan, 1996-2005



Data from http://estadistica.conafovi.gob.mx/historicos/. Includes housing loans from all sources. *Self-construction, Addition, Rehabilitation* includes loans for building materials and purchase of serviced lots and *pie de casa*; *All Other* includes loans for refinancing, infrastructure, rental, purchase of (unserviced) land, and purchase of used housing.

The maximum value of houses financed through Infonavit is set at 25 times the annual minimum salary for workers earning up to 11 minimum salaries[14].

Because access to the benefits of the housing funds is linked to salaried employment, the lowest earners, who may work in the cash economy rather than in formal employment, are

[13]The Fox Administration's primary housing promise was to increase the number of mortgages issues each year, reaching 750,000 mortgages in 2006. According to official figures, the goal was met.

[14]The limit given in multiples of monthly minimum salaries is 300 nationally and 350 in selected large cities. Workers earning more than 11 minimum salaries may use their housing savings account as a payment guarantee in case of loss of employment for the purchase of a home with a value up to approx. US$174,000 (1230 times the monthly minimum salary). (Conafovi)

Table 2.5: Average Mortgage Values, 2005

	Pesos (000s)	SM***	USD****
Loans in 2005			
Private*	831	49	$77100
Public**	223	13	$20700
2001-2005 Average			
Private	734	44	$68100
Public	238	14	$22000

* Banks and Sofoles

** Infonavit, Fovissste, SHF, Fonhapo

*** Multiples of 2005 minimum salary

**** Based on 12/2005 exchange rate.

unable to access this source of cheap credit. The mortgage subsidy system thus serves to improve housing affordability for the employed middle class rather than as part of the social safety net for the poorest. The 2006 edition of the housing report (CIDOC 2006) states that due to qualification criteria, only only employed people who earn over 5 minimum wages, about 12% of the employed population, have access to the mortgage subsidies[15].

2.5 The Business of Housing Development

Though the houses purchased using the subsidized mortgages must meet criteria set by the housing funds, private for-profit firms, rather than the public sector, are the primary producers of finished low-cost housing.

While a handful of large developers account for a quarter of the market, some 130 mid-sized companies and hundreds of small companies are also active (CIDOC 2006). Large builders have developed sophisticated vertically-integrated production processes tuned for fast production. They tend to build large, multi-phased developments in high-growth areas on land that was purchased and banked with several years of

[15]This figure would suggest that some 15% of all qualified households would have received mortgages in 2006 alone, even if we assume that all households have one earner employed formally.

anticipation. Smaller builders may specialize geographically, or enter smaller markets where the scale of development would not draw the large companies.

Table 2.6: Sales Volume, Market Share, and Growth of 8 Large Developers, 2005-2006

	2005		2006		Growth
	Homes (000s)	Market Share	Homes (000s)	Market Share	2005-2006
Geo	37.4	6%	41.9	6%	12%
Homex	31.8	5%	44.1	6%	39%
Urbi	24.9	4%	29.3	4%	18%
Ara	19.0	3%	22.7	3%	19%
Sadasi	11.0	2%	17.0	2%	55%
Sare	9.7	2%	11.1	2%	15%
Pulte	7.2	1%	9.1	1%	26%
Ruba	10.7	2%	n/a	n/a	
Top 6 Total	133.8	23%	166.1	23%	24%
All Developers	580.0	100%	720.0	100%	24%

2005 sales: El Economista 2/20/06 (Sadasi), Dev. Website (Pulte); 2006 sales: El Universal 11/14/06 (Sadasi), El Financiero 3/27/06 (Pulte); corporate annual reports (all others).; Total sales: Conafovi

Despite low-cost housing development's reputation as a "low-margin" business, the large publicly-listed builders have reported returns on equity significantly better than the Mexican stock market on the whole. The Indice Hábitat, which tracks the six publicly listed developers[16], reported a return on equity that was on average three times better than the index of the *Bolsa Mexicana de Valores* (BMV; Mexican Stock Market) between 2000 and 2006 (Servicio Universal de Noticias 2007). The robustness of financial returns—returns to investors of 75% and even 95% (Servicio Universal de Noticias 2007)—suggest that there may be opportunities to encourage or require measures that improve quality without adversely impacting the willingness of builders to continue to engage in production.

The sheer number of smaller development companies also suggests that low-cost housing development is perceived to be a lucrative business. After the peso crisis in 1994, the number of housing developers shrank from about 1000 to 200. Currently, more than 130

[16]Of the six companies that produced more than 10,000 units in 2006 (Table 2.6), only Sadasi remains privately-held.

firms produce between 1,000 and 5,000 units and an additional 173,000 small firms and single-project entities are registered as developers (CIDOC 2006). That the large developers' share of the market has held at 25% despite annual growth in housing delivery of 10-25% since 2004 also shows that smaller firms are active and successful participants.

Although figures on project-level returns are not generally available, those in the industry suggest that 10% returns are considered the norm (Mayagoitia 2006, Tardan 2006, Sorsby 2006)[17]. Such low returns may reflect the low-risk of housing fund-financed low-cost housing projects relative to other types of development. Since the housing funds pre-qualify housing developments and uniform requirements guarantee minimum standards, it would be reasonable to assume that completed projects face relatively low vacancies. On the other hand the price ceilings imposed by the housing funds combined with the uniformity of product may also serve to depress returns.

With a decade of steady growth behind them, developers have begun to diversify and to consolidate. Geo and Ara have been going up-market, while other developers, notably ICA, have expressed the intention to expand in the low-cost market (ie. social and economic segments as defined in Table 2.3). ICA crossed the 5,000-unit mark in 2006 and has expressed the intention to produce 9,000 units in 2007. The industry has also seen at least two notable instances of consolidation, with the purchase of Beta by Homex, and 50% of Pulte Mexico (renamed Alta Homes) by Groupo Sadasi, which thereby became the 4th largest housing producer by combined volume.

Developers obtain construction bridge loans from banks and Sociedades Financieras de Objeto Limitados (Sofoles), non-bank (ie. not deposit-holding) lenders that specialize in housing. Construction lenders monitor progress and disburse funds according to project milestones, visiting the project site at least once a month (Fitch CBL). Financing is

[17]It is unclear to me whether this 10% figure includes the cost of land. I would guess that much of the supernormal returns to investors reported by the publicly-held companies reflect appreciation of property value through timing of land purchase, lotification, and development. Since the 1992 land reforms, developers have had legal means of purchasing low-value peri-urban lands from rural cooperatives. While attempting to parse these returns was beyond the scope (or data availability) of this project, it would be interesting to investigate the extent to which the ability of developers to pay agricultural land prices to these cooperatives contributes to their earnings.

available for land acquisition, infrastructure, and housing construction. SHF, a development bank that also finances mortgages for households earning two to five-times the minimum salary, provides about two thirds of the capital to Sofoles. Because Sofoles must adhere to SHF lending criteria, their loan portfolios are very siminar. The typical construction bridge loan has the following characteristics: maximum loan term of 24 months, maximum LTV of 65%, floating rate, first disbursement of 20%, interest-only payments, and commitment for *individualización* — an agreement from a mortgage lender that it will issue individual mortgages to purchasers for the project. Lenders evaluate project applications based on characteristics of both the developer and of the project, and make recommendations when necessary to improve the feasibility or marketability of the project.

Chapter 3

Barriers to Sustainable Housing Construction

This chapter summarizes the barriers to implementing sustainable construction in low-cost housing development in Mexico. With few exceptions, interviewees[1] described the state of sustainable construction in Mexico as "in diapers", but making steady progress. They identified four primary barriers to wide-spread adoption of sustainable construction: lack of consumer awareness, increased first costs, a non-enabling regulatory environment, lack of coordination, and lack of professional education in sustainability. Some interviewees considered technology a fifth barrier. As an administrator of the Conavi Sustainable Housing Pilot Project put it: "The first challenge is to create a consciousness about the benefits so that people want and ask for these types of houses. The second great challenge is financing such that there is no additional cost to the developer. And of course, creating

[1]The developer interviews were conducted with representatives of GEO, Urbi, ICA, Bracsa, BCBA Impuse, and Migdal Arquitectos. GEO, Urbi, and ICA count among the largest housing developers. Bracsa, a second-generation family-owned company, is a medium-sized developer working primarily in second-tier cities. The residential division of BCBA Impulse undertakes developments servicing the upper half of the housing market (medium to residential-plus). Migdal Arquitectos is an architectural design firm that has a relationship with Grupo Imobiliario Metta, a privately-owned large developer. GEO was included in the interviews because it was the largest low-cost housing builder at the time. Urbi, ICA and Bracsa were chosen based on their participation in Conafovi's Vivienda Sustentable pilot project. Additional interviews were conducted with representatives of the government organizations that have sponsored pilot projects in energy efficiency (CONAE, FIDE, and CONAFOVI), and with individuals identified as key advocates of sustainable construction through peer recommendation. The complete list of interviewees is included in Appendix A.

the standards, though the first two are the more difficult than the last, which, in the end, is just a question of lots of work." (Gonzalez 2006)[2]

Table 3.1: Interview Responses: Barriers to Sustainable Construction

	Developers (5)	Architects (6)	Public Sector (7)	NGO (12)	Total (30)
Awareness*	4	3	3	9	19
First Costs	5	3	3	7	18
Regulations	0	4	3	6	13
Cooperation	4	2	1	5	12
Training**	1	3	0	4	8
Technology	1	1	0	2	4

*Consumer Awareness; **Professional Capacity

3.1 Consumers don't care about sustainability.

Lack of consumer awareness of the benefits of sustainable construction was the most often-cited barrier to wide-spread adoption of sustainable construction in housing. Interviewees opined that environmental concerns were not generally a part of the home-buying decision in Mexico. Developers claimed that according to their market surveys, most consumers are unconcerned about energy and environmental issues, and that the primary considerations were price and size of the home. Even in the case that the building process or product resulted in environmental benefits, these would not be a part of the marketing pitch.

Several interviewees pointed to the low compliance for the residential trash separation program in Mexico City as an indication that residents are not yet wiling to change their habits for the sake of environmental issues. In the case of low-income clients in particular, interviewees speculated that difficulty in meeting basic needs makes environmental

[2]Interviewees held a common assessment of the situation, at times using identical phrasing describing the challenges and the steps that need to be taken in the short- and medium-terms. Since many of the interviewees had personal relationships and had shared histories of work on particular initiatives, the extent of agreement on the basic outlines of the problem is not surprising; however, these opinions were shared even by those interviewees who seemed not to be involved in the advocacy community.

concerns seem irrelevant to their day-to-day experience, especially where making the "green" choice would cost more. Executive Secretary Diego Arjona of Conae observes: "There are a lot of people in this country that have never even had a hot shower in their lives. We can't begin to talk to them about a $2000 solar water heater. There is an issue of awareness that needs to be created about the comfort of the house. Most people on the street have never thought about it."

Explicitly or tacitly subsidized energy prices deter consumer interest in green measures by undermining the benefits via operating cost savings. According to Odon de Buen, "Mexicali, one of the hottest areas, has the lowest electricity rates, because lowering the rate has been a politically expedient. It's the greatest threat to sustainability. Nationally, some $4,000,000,000 in subsidies goes to the residential sector." Conafovi's Gonzales observes "You can't focus on prices per se because in many places the collection is spotty. So it's better to focus on creating consciousness about the issues than to make a 'savings' argument."

Both developers and sustainable construction advocates cited the case of roof insulation in Mexicali was seen to be a promising exception to the rule. Mexicali was the site of various energy-efficiency pilot programs and the original site of Fipaterm, the roof insulation pilot program discussed in the following chapter. According to one developer, the success of the pilot programs consists in convincing buyers in Mexicali that insulated homes are more comfortable and cost less to cool. He added that developers would have difficulty in selling uninsulated houses in Mexicali.

3.2 Green development increases first costs.

Interviewees identified the increased first costs as second primary barrier. Houses for the low-cost market are delivered with the minimum of finishings under common practice. Making even modest improvements, like adding insulation, represent a cost that must be absorbed by the consumer, the developer, or the government (Morillon). Even the

energy-saving measures with modest costs are expensive when compared to the modest total cost of the house. For a typical house, adding insulation alone would represent an additional cost of $1200 (Morillon), increasing the purchase price of the house by 5-7%.

Housing development is a low-margin business with returns in the 6-10% range for low-cost housing (Tardan), and developers are not willing to take on costs that cannot be passed on to consumers. Low-cost building production has become sophisticated and industrialized (Gastelum, Mayagoitia, de Buen), and any change in the building process entails costs for transitioning to new methods or materials. According to Tardan, "Homebuilders already have their methods and they don't want to hear about insulation because it implies cost and time in changing their building systems".

In the case of improvements where the costs at the time of construction are higher but recouped over time, as in energy-efficiency or water-saving measures, the relationship between the capital expenditure and the operating cost savings must be explicitly established at the beginning as a part of the decision criteria. The argument that the net present value of savings will be greater than the cost premium of the measure falls flat when the decisions about initial capital costs are made without regard to future operating cost savings, as is the case if the costs and benefits accrue to different parties (Arjona).

3.3 Regulatory environment is inconsistent

Another challenge to implementing green development is an incomplete and inconsistently-implemented regulatory environment. Mexico's energy-efficiency regulations are divided into two tiers: obligatory and voluntary standards. The Mexican Official Standards (Normas Oficiales Mexicanas or NOMs) began to be applied in the 1990s and cover everything from products to building energy performance. Once adopted at the national level, NOMs must be incorporated into regulations at the appropriate state or local level of government — in the case of building-related regulations, by municipalities. Compliance with NOMs governing energy-efficiency of lighting systems in non-residential

buildings, for example (NOM-007 and NOM-013), is promoted by forcing facilities to demonstrate compliance before they are allowed to connect to the grid (Arjona). Mexico adopted building energy standard NOM-008 (non-residential) in 2001 and is currently developing NOM-020 (residential).

Updating local building codes to reference the standard has progressed slowly. The reluctance on the part of the municipalities reflects, in part, resistance among developers: "It's been very hard to push the application of building energy standards because of resistance from the developers in light of the financial impact on their costs" (Urteaga).

Even in cases where the standard is referenced, it may not have been put in the critical path of construction in a way that would ensure compliance. The Director Responsable de Obra charged with auditing compliance with the building code, is too often not up to date with the standards at the time that the construction permit is issued (Tardan, de Buen). In Mexico City, where NOM-008 is part of the building code, only one building (Torre Mayor, the tallest building in Latin America), had been certified as of 2006. "Many buildings meet the standard, but verification is not required by the government, even though compliance is required by the building code" (Arjona).

3.4 Cooperation and information-sharing is difficult

Several interviewees identified intra- and inter-firm information sharing as a further barrier to wide-spread adoption of green building using existing techniques. Mexico ULI Director John Newcomb describes professional practice in Mexico as having "a closed information culture". CMES president Ulises Treviño echos the sentiment, adding that competing firms view collaboration-based initiatives with suspicion, making the kind of cross-industry collaboration necessary for developing a green building certification program very difficult.

Having identified information-sharing as a barrier, several interviewees were quick to note that inroads were being made through organizations like ULI, CMES, and AEAEE.

Newcome notes, for example, that ULI sees this as one of its primary tasks: "Sharing information, rather than holding on to information, is power. It's our biggest opportunity" (Newcomb). Developers point to the efforts of Conafovi to foster collaborations through projects like the Vivienda Sustentable as playing a key role (Mayagoitia, Morillon) and affirm that other companies' proposals have motivated them to explore new options in their own practice (Sorsby, Silva).

The difficulty of managing information exchanges within a development company is illustrated by the contrast between the experience of GEO and that of Urbi, which has developed a reputation as the large developer that has made the most progress on sustainability. Urbi is the third-largest housing developer in Mexico, producing 23,000 - 25,000 homes annually. It is unique among the low-cost housing developers in that it has a 7-person department dedicated to sustainable construction. The sustainable construction group aims to develop and propagate ways to improve environmental performance of Urbi's housing at no cost premium. The group is explicitly charged with helping the development units implement sustainability best practices. Urbi's construction activity takes place mainly in areas of Mexico with extreme climates, Mexicali among them. Like Geo, Urbi began engaging energy efficiency through pilot programs. The sustainable housing group was created because Urbi decided that it wanted to take a leadership position in crafting the sector-wide approach to sustainability (Mayagoitia).

GEO, the second-largest low-cost housing developer, is comprised of 16 regional subsidiaries that together service about 8% of the total housing market (Fitch 2006). Engineer Miguel Silva is in charge of energy technology for the parent company and has the responsibility for developing company-wide standards, a role he has fulfilled for three years. He estimates that 10% of his time is dedicated to issues related to "sustainability". GEO does not have an explicit policy regarding sustainable construction, although it has in the past participated in FIDE's energy-efficiency pilot program and in the development of the voluntary standard that addresses thermal performance in the building envelope of residential structures. He points out that the corporate structure of GEO makes it difficult to know what initiatives are taking place within each of the regional subsidiaries.

Geo of Guerrero, for example, was awarded a Premio Nacional de Vivienda in 2004 in the sustainable housing category for its "Valle del Palmar" project, but it was an isolated effort that did not tie back in any way to the parent company. Silva suggests that economies of scale could reduce cost premiums for sustainability measures if Geo were to plan integrally, but there are no existing mechanisms that would allow for such coordination. The same applies for measuring performance to establish existing baselines. According to Silva, "someone may very well have taken empirical measurements, but no one else would know about it." He is optimistic, however, that Geo will begin to address sustainability in a more comprehensive fashion: "In the objectives for 2006, we're beginning to work with this idea at the corporate level. I'm seeing growing interest in the management."

3.5 Professional capacity and commitment to sustainable construction is lacking

The question of the value of sustainability takes a different form when applied to the producers. Several interviewees suggested that a paradigm shift is necessary to achieve wide-reaching change. For Architect Jaime Varón, considering the sustainability of design, especially as it relates to maintenance for longevity, is a matter of professional ethics rather than a purely economic consideration. Architect José Picciotto, judged by the interviewees as among the most progressive in applying bioclimatic architecture in his practice, advocates a radical re-working of the practice of development, from materials suppliers to developers: "If you align the different participants, the guy who makes the windows, the cement supplier, some key players — you could get a completely different product. There's no reason why GEO should be building the same house in Mazatlán as in Morelos." He goes on to observe that other industries have delivered high-quality goods to low-income markets: "My construction workers all have cell phones. Someone figured out how to get cell phones, pretty advanced technology at one time, into the hands of every *albañil*[3]. Why haven't we done that with housing?"

[3]Literally, "bricklayer" but often refers to semi-skilled construction workers in general.

While developers tended to view sustainability as a question of financing and applying state-of-the-shelf technologies in energy and resource conservation, architects defined the problem as creating a sea-change in the culture of design. This tendency may be attributable to a greater participation by these designers, who judge themselves to be in the minority of Mexican architects in their views on sustainability, in an international design discourse through magazines, competitions, and the like. Varon observes: "In Europe, there's more of a culture of long-term planning and designing in the context of an energy crisis. In Mexico, there's none of that yet - from architectural education on up. We need to change the paradigm, and soon." He proposes that sustainability be thought of as a matter of professional ethics: "Designers need to have the creativity and exercise the professional ethics to change the model. Architects have an important responsibility to do the things that we can do. There are things that we can't do, but neither can you wait for the government."

Architects observed that sustainable design was not a theme with coin within the local design culture in general, and in architecture education in particular. The Universidad Iberoamericana has recently begun to offer a program (funded in part by the Holcim Foundation) that attempts to teach sustainability in the context of architectural design (Castillo, Gastelum, Kanahuati). The Holcim Foundation's Gastellum observed that students need to "understand better what sustainability in construction means. It's more than green buildings — it's the physical and social contexts, viability, education."

3.6 Market for appropriate technology is immature

Immature markets for materials and technology make it more costly and difficult for a developer to adopt sustainable construction. Interestingly, most interviewees rejected the notion of technology as a limiting factor. When asked if there were gaps in materials or technology in Mexico that made green building difficult, developers held the view that appropriate technology was available, but that information and cost are problems. Several

developers cited the example of solar thermal systems (solar water heaters), which are available, but cost too much in relation to the sale price of low-cost houses.

In the case of insulation and other material affecting the thermal performance of the building envelope, lack of basic information, such as cooling and heating-degree-day information and confusion regarding appropriate R-values for the various climate zones in Mexico, lead the AEAEE, an industry group, to advocate for drafting standards based on ASHRAE 90.x. Tardan of AEAEE notes that products need to be consistently labeled with R-values, calling the current state of product labeling "a chaos".

Uncertainty about the construction materials market may also deter some producers from adjusting their production to include construction uses. Insulation makers, for example, provide a wide range of industrial insulation products and the construction market is too small in comparison for some producers to consider it (de Buen).

The range of energy-efficient materials available to designers working on high-end projects, furthermore, is limited in comparison to both the US and Europe. As the Canadian architect of Torre Mayor put it, "North America is 10 years behind what's common in Europe, and Mexico lags behind US and Canada" (Vokac).

3.7 Summary

Neither the market nor regulatory environment aligned to encourage the adoption of sustainable construction. As consumers don't consider sustainable qualities in housing purchase, developers must avoid using methods that result in cost increases to the consumer. Although technologies may be available to achieve improvements in performance, high prices relative to the final sale price of the housing limits their adoption. Meanwhile, local jurisdiction over building regulations means that adoption of even existing regulations will be accomplished slowly. Difficulty of sharing information across and within firms also slows down the process of adopting new construction practices, while professional education has not yet made sustainability a key educational component.

Despite these challenges, interviewees suggested that the housing sector is awaiting a developer to take a leadership role. ULI's John Newcomb argues: "We need Latin American models of sustainability. We need one Mexican developer to do it. All of them are looking at it, but no one is ready to do it yet" (Newcomb 2006). Picciotto echos the sentiment: "I think the economy is ready and the market is ready for one of these big companies take the first shot. There's a lot to be done, but the first step is to allow the discipline of sustainable design to enter into the problem" (Picciotto 2006).

Interviewees pointed to the history of energy-efficiency pilot projects and the new sustainable housing pilot projects as examples of progress. These programs are examined in the next chapter.

Chapter 4

National Sustainable Construction Programs in Mexico

In 2004 the residential sector accounted for 25% of electricity (OLA 2005) and 16.5% of total energy consumption (SENER 2007). Sustainable construction efforts in Mexican housing have focused primarily on reducing energy consumption through insulation and replacement of inefficient lighting and appliances. sustainable design and energy efficiency pilot projects for new construction that began in 2003 and 2004. These later pilot projects both incorporate the energy-efficiency measures of Fipaterm and Ilumex, applying them to houses as they are being built. The sustainable housing pilot is unique among these efforts in looking beyond energy-efficiency and incorporating other aspects of sustainable construction.

4.1 Antecedents

Mexico began experimenting with demand-side management of residential energy consumption in the late 1980s. In 1989, the Comisión Federal de Electricidad (CFE), a public electricity company, funded a program (Fipaterm) to insulate roofs in Mexicali. In 1995, the World Bank and the governments of Mexico and Norway funded a 3-year pilot

Table 4.1: Overview of Sustainable Construction Programs

	Years	Scope	Outcomes
Fipaterm/Así (CFE)	1989 - present	Electric demand management in existing homes (Insulation, efficient lighting/appliances, energy audit)	152,000 AC's replaced; 179,000 refrigerators replaced; 102,000 homes insulated (2005) Program replicated to achieve national coverage.
Ilumex (CFE)	1995 - 1998	Subsidized sale of compact fluorescent light bulbs	Model for combined bill financing of efficiency measures. Commercialized CFLs in Mexico and lowered prices.
New Construction Pilot Project (FIDE)	2003 - present	Electric demand management in new developer-built homes (Insulation, efficient lighting/appliances, windows)	11,000 housing units contracted (2006)
Sustainable Housing Pilot Program (CONAVI)	2004 - present	Electric demand management and water efficiency	5,000 housing units contracted (2006)

program (Ilumex), based on smaller pilot projects in 8 cities, to commercialize compact fluorescent lights (CFLs). The very successful CFL project became the basis not only for a nation-wide program but also the model for similar efforts in Costa Rica, Nicaragua, Argentina, and Peru (World Bank 2006). These two programs laid the foundation for the sustainable design and energy efficiency pilot projects for new construction that began in 2003 and 2004.

As a publicly-owned utility, the CFE has the dual ob jective of meeting its financial goals while providing access to electricity at prices affordable to all segments of Mexican consumers. The Ilumex pilot took place during a period when Mexico was considering its options to privatize electricity production.[1] CFE's revenues have been used to cover shortfalls in the public budget, leaving little for investment in maintaining or expanding its operations. As energy is considered a part of the national patrimony, thus not to be sold to private investors, the utility has had to seek creative solutions to its growth issues. Demand-side management programs address CFE's needs in two ways: they reduce the need to expand electricity generating capacity, and they help consumers respond to price signals.

As CFE is prohibited from selling anything other than electricity, the administration of the demand-side management programs are done through CFE-funded trusts (fideicomisos).

4.1.1 FIPATERM / ASÍ (1989)

Fideicomiso para el Programa de Aislamiento Térmico de la Vivienda en el Valle de Mexicali (Fipaterm) was established by CFE in 1989 as a revolving fund to finance insulation of roofs in Mexicali, the third largest city in the border region.

With summer high temperatures over 100° F and easy access to used air conditioners from the US, Mexicali's residential sector has the highest energy consumption in the nation,

[1] While a 1992 law enabled CFE to buy electricity from private producers, privatizations is still a controversial issue. In the 1990's CFE expanded capacity primarily by building plants that burn natural gas for fuel. Starting 2000, the price of natural gas rose precipitously. CFE attempted to improve finances by cutting back on subsidies, and in 2002, consumers experienced significant price hikes.

some two-thirds greater than the national average (De Buen 2003). On average, lighting, refrigerators, and air conditioning account for 43%, 20%, and 20% of domestic electricity consumption. In Mexicali, electricity consumption during the summer months was as much as four times the baseline winter consumption (Ramos 2001).

Fipaterm's original suite of services included roof insulation, peak demand curtailment, and a level-billing program. In 1997, Fipaterm expanded the program to include replacement of old air conditioners with new energy-efficient models, air-sealing doors, and sale of CFLs. In its fully-developed form, renamed Programa de Ahorro Sistemático Integral (ASI), a computer model of electricity consumption was created to evaluate the appropriateness of the energy-efficiency options offered under the ASI program. Before applying for a loan, the client was required to participate in an energy audit based on the previous 12 months of electricity usage. Fipaterm also required that the roof be insulated before loans for equipment purchase would be made available, and offered loans only in the case that estimated savings from the improvement was sufficient to service loan payments (Ramos 2001).

In 2002, Fipaterm expanded the geographic area served to include four CFE service regions, including all of the norther states. It also assisted FIDE to launch a similar program in the service area of Luz y Fuerza, the regional monopoly utility in the center of the country. In 2003 the program was expanded once again to include replacement of refrigerators. The program was expanded to all areas serviced by CFE in 2005. As of 2005, the program had financed the replacement of 151,860 air conditioners and 178,719 refrigerators, and insulated 101,700 homes (Gomez 2005).

4.1.2 Ilumex (1995-1998)

The Ilumex program was funded by Comisión Federal de Electricidad (CFE) from 1995 to 1998 in the Jalisco, Nuevo León, and parts of 4 other adjoining states. Fide, Luz y Fuerza del Centro (LyFC, the utility serving Mexico City), and others adopted the approach thereafter. It required the CFE-funded trust in each participating State to purchase CFLs

in bulk, and offer them at a subsidized price to consumers. Because the CFLs were expensive even at the subsidized price compared to the regular incandescent bulbs, which sold at a nationally fixed low price, Ilumex offered a financing plan that allowed the consumer to pay back the cost of the purchase incrementally using the money saved by the investment, as a part of the electric bill. Once the loan had been repaid (in 2 or 3 years, depending on the program), the customer could expect to benefit from lower bills.

Ilumex was successful in reducing the price of CFLs significantly, improving their availability, and increasing consumer awareness (World Bank 2006). The World Bank identified the key features of the program as: the bulk purchase of high-quality CFLs, sales through local utility centers, low-interest financing through the electric bill, and subsidized prices. Ilumex issued specific technical criteria for CFLs that translated into high-quality products. That the CFLs sold should be reliable in its claims — period of useful life, flicker and color-rendering — was seen to be a key component in getting a positive customer response. Bulk purchase by Ilumex (and later, Fide) reassured manufacturers of the "sustainability of the market to invest in distribution channels and marketing" (World Bank 2006). Sales through the local utility centers meant that a customer had access to immediate support and financing at the time of purchase. According to the World Bank's assessment, "ILUMEX succeeded by exposing consumers to the technology who otherwise would not have considered it, by putting a strong emphasis on product quality, and by making the case for the financial and energy benefits" (World Bank 2006).

Ilumex changed energy-efficient compact fluorescent lamps (CFLs) from an expensive and hard-to-find item to a commodity available in most stores. Executive secretary of Conae Diego Arjona notes: "10 years ago, you had to go to Victoria St. downtown to a specialty shop and pay $40. Now you can get it anywhere and pay $4-6 for a much better product" (Arjona 2006).

4.2 Pilot Project for New Construction

4.2.1 FIDE New Construction Pilot Program (2003)

In 2003, the Fideicomiso para el Ahorro de Energía Eléctrica (Fide), the Instituto del Fondo Nacional de la Vivienda para los Trabajadores (Infonavit), and the Instituto Nacionál de Ecología (Ine) launched a pilot project to finance the addition energy efficiency measures to new low-cost housing. Whereas the previous programs financed retrofits of existing houses, this pilot project works with developers to install energy-saving measures at the time of construction. According to the terms of the program, Fide provides both the equipment and installation of Infonavit plays the role of recruiting developers for participation while Fide manages the contract with the developers and service providers.

The pilot program targets four electricity-saving measures: energy-efficient lighting (CFL and T5), air conditioners, insulation, and double-glazed windows. Lighting and air conditioners must carry the Sello Fide, an energy-efficiency product labeling program akin to US EPA's Energy Star label. Developers are free to select vendors based on Fide's list of product performance criteria. Fide then makes arrangements to pay the vendor directly. Purchasers of the energy-efficient homes file a request for financing from Fide at the time that they apply for the Infonavit credits. As with previous programs, Fide recovers the cost through the electric bill. Fide performs a cost-benefit analysis for the measures to be included for each development to assure that the homeowner will be able to pay back the cost through savings in electricity use over 36 months.

As of May 2006, developers had delivered 2,500 units of 11,000 contracted with the pilot program. Of the program's achievements, program manager Ruben Zagal of Fide states: "We've overcome the challenge of convincing developers to modify their construction process. We've managed to get the attention of the housing institutes and involve the suppliers" (Zagal 2006).

Fide applied its experience in bulk purchase to obtain air conditioners at prices 48% lower on average than on the retail market. Fide also spurred the design of appropriate lighting units (Urteaga 2006).

Although an ambitious program in itself, the singular focus on energy savings is a limitation of the Fide program. Like publicly mandated energy-efficiency authorities in the US (New York's NYSERDA, for example), Fide is limited in its mandate to addressing measures that impact electric energy consumption. For example, gas, used for cooking and hot water, falls outside its jurisdiction, thus could not be addressed through the program.

The cost-benefit analysis required by Fide builds in flexibility to combine the four energy-efficiency strategies based on the particular location of the construcion. Fide's efficiency measures, however, show a bias toward requiring efficient products rather than energy efficiency as a performance attribute of house as a whole. The case of double-glazed windows provides an example. Practitioners in the US view double-glazed windows as an efficiency measure that is essential in cold climates, but one that provides only small performance improvements on its own in hot climates. Shading and orientation are cheap and effective ways to control overheating due to sunlight entering the house (solar gain), the primary concern for windows in hot climates. Cost-benefit analysis that a particular measures can be included without jeopardizing the financial feasibility of the project (ie. cost-recovery) does not imply that it ought to be included. It may be that the developers and vendors participating in the pilot program have access to information and expertise to judge the appropriateness of such measures; the program itself does not explicitly make reference to such capacity-building training.

4.2.2 CONAVI Sustainable Housing Pilot Program (2004)

The new Ley de Vivienda (Housing Law) of 2006 created the *Comisión Nacional de Vivienda*, The National Housing Commission (Conavi) as an independent organization with a separate budget and a mandate to institutionalize the advances in housing development of the Fox administration. Prior to 2006, Conavi existed as a part of the

Secretariat of Social Development[2]. The new status as a "decentralized organism" with its own funds increases its autonomy and elevates its public profile.

Conavi defined the scope of its sustainable housing initiative to include quality of housing products, urban design, policy and regulation, evaluation and indicator design, and financing solutions. Specificially, Conavi aims to adapt housing standards for better environmental performance, defining the criteria for sustainability in housing, promote international technology transfers and the use of eco-efficient technology, and implement financial incentives to promote sustainable housing. This broad mandate has placed Conavi in the role of convener of multi-sector working groups.

In 2002, Conavi and the Secretariat of the Environment and Natural Resources (Semarnat), entered into an agreement to address water and energy efficiency in housing developments. This agreement was subsequently expanded to include other organizations working in related areas, including Fide and the housing institutes.

Conavi's pilot project was initiated through a partnership with Canada. In 2004, Conavi entered into an agreement with the Canada Mortgage and Housing Corporation (CMHC), the Canadian national housing agency, for 2 years of technical assistance in developing a sustainable housing program. The effort was a part of a broad initiative of bilateral cooperation called the Canada-Mexico Partnership designed "to further cooperation on bilateral trade, investment, public-private sector partnerships, business – to – business links, good governance practices, education, institutional reforms and citizen-focused government" (Canada 2005).

The housing component stemmed from a program initiated in 2004 as part of the North American Energy Working Group (NAEWG). Called *La Casa Nueva La Comunidad Nueva* (Casa Nueva), it put the Canadian energy agency in the lead position to design bioclimatic social housing for Mexico. On the Mexican side, the project was housed within Sener, the Energy Secretariat. According to developers who participated in the Casa

[2]Although the agency was called Conafovi at the time, the remainder of this chapter refers to Conavi using its new name

Nueva, Canada's primary interest in the pilot was to explore opportunities to create markets for Canadian products, such as solar thermal water heaters, which were, by in large, deemed too expensive by the participating developers. Casa Nueva's current status is not well known.

The Conavi pilot project recruited three developers (Urbi, Pulte/Casas Beta, and Bracsa) and two state housing institutes (Nuevo Leon and Tamaulipas) for a total of 5,000 houses in 7 cities. Urbi, the biggest contributor in number of participating units of the concurrent Fide New Construction Pilot, again topped the list in terms of units participating in the program. Pulte/Casas Beta participated in the Casa Nueva project with 100 bioclimatic houses (Morillón 2006) and in the Fide new construction pilot with several hundred houses.

The developers chose the combination of water and energy efficiency measures that fit the context of the participating housing development. The measures most often applied (38-55% of units) were those that had already been the mainstays of the retrofit program: energy efficient lighting, air conditioning, and roof insulation. 45% of the houses used high-albedo (reflective) coating/paint or concrete, perhaps reflecting a low cost-premium of this type of measure. 200-600 units used water-efficient accessories, xeriscaping and solar voltaic panels , and groundwater recharge ponds. Water recycling, solar shading, and bioclimatic design were used in fewer than 60 units.

The measurements resulting from the pilot project are expected to make a key contribution to the development of housing standards (Gonzáles 2006). Baseline measures were taken in houses of the same type in the same development to determine the savings in the pilot program houses(Gonzáles 2006, Sorsby 2006). Developers had to make sure that the purchasers of the houses would facilitate the measurements. In Acapulco, for example, the developers had to screen purchasers to assure that they intended to live in the house year-round (Sorsby 2006). These results are expected at the end of 2007.

4.3 Summary

Mexico's first efforts in sustainable construction focused on improving energy efficiency in existing homes. These had as their impetus, the need for demand management by the state energy company. Fipaterm, the pioneering pilot project, focused on insulation and energy-efficient appliances. Ilumex attempted to create a market for compact fluorescent lights. Both programs were considered successful in meeting their goals and became the basis for later scaled-up efforts across the country.

The early programs targeted consumer awareness explictly (Table 4.2). Experience in Mexicali, where Fipaterm began, shows that consumer preferences can and do change as information and options become available. The retrofitting of 80,000 homes has educated the home-buyers in Mexicali to expect lower bills and a more comfortable house (de Buen). Conae's Arjona observes "In Mexicali, it's starting to become part of the culture. What we want is when young people get married and they have to buy a house, they say 'we will be happier in an insulated house'". According to de Buen and Urbi's Mayagoitia, the market preference for insulated houses in Mexicali is so well established that projects without insulation sell slowly or not at all. AEAEE's Tardan also points to Mexicali as a successful instance of market change, noting that vendors selling air conditioners now also sell insulation material, having understood that customers who install air conditioners in insulated homes are happier with the results.

Table 4.2: Pilot Programs' Responsiveness to Barriers

	Fipaterm/Así	Ilumex	Fide Pilot	Conavi Pilot
Consumer Awareness	primary	primary	low	low
First Costs	secondary	secondary	primary	primary
Regulations	-	-	-	-
Cooperation	-	-	low	moderate
Professional Capacity	-	-	-	-
Technology	primary	primary	low	low

The two pilot projects for new construction directly adopted the strategies used in Ilumex and Fipaterm. The Fide project for new construction's scope limits it to energy-efficiency

measures, but provides a clear framework that enables the program to accommodate growth. Between 2004 and 2006, Fide more than doubled the number of housing units in the program and by mid-2006 had recruited a dozen developers by mid-2006. The Convi pilot is promising in its inclusion of passive-solar, bioclimatic design and water efficiency, and is developing Conavi's capacity to convene stakeholders.

Unlike Fipaterm and Ilumex, which targeted consumers directly, the FIDE and Conavi new construction pilot programs are designed to mitigate the developers' first costs. Once the decision to participate in the pilot program has been made by the developer, the purchaser of the house is obligated to make the loan payments as part of the electric bill. Thus the developer is empowered to make the decision to use energy-saving measures without absorbing cost and without being obligated to market the housing product at a higher price.

Because the new construction pilot programs work directly with the producers, they also provide an opportunity for information sharing. Participating developers interviewed stated that the participating in the programs provided them with new information about products and insight into efforts of other developers. Additionally, the Conavi pilot specifically addresses the issue of information exchange by incorporating an on-line forum for participating developers.

While the primary focus of the early pilot programs included developing local capacity for energy-saving technology, the recent programs do not, for the most part, make new advances in this area. The Conavi program expands the list of energy-saving measures to include solar water heaters, however, does not seem to make the kind of concerted effort at popularizing it that the previous pilot programs made in regard to electric energy-efficiency technology. Future evaluation may reveal the extent to which these efforts are successful.

Chapter 5

Conclusion

This thesis examined how sustainable construction is being incorporated into the practice of developing low-cost housing in Mexico to identify the barriers and learn how current efforts are shaped by them. Chapter 2 described some of the key conditions of the low-cost housing market. Chapter 3 discussed the major barriers identified through interviews with representatives of the public and private actors in the housing development industry. Chapter 4 described the two sustainable construction programs currently underway, and two antecedents. This chapter summarizes the findings and offers for debate a few ideas about opportunities to promote sustainability in housing construction.

5.1 Summary of Findings

Efforts to promote sustainable construction in low-cost housing have come at a moment of transition in Mexican housing policy. The public-sector has reformed its policies to promote greater participation by the private sector, especially in the mortgage market, and increased access to subsidized mortgages through the expansion of the national housing funds' resources (via securitization). These efforts have fueled a boom in the construction of developer-built low-cost housing for those who can access the resources of the national housing funds.

The primary barriers to sustainable construction identified are: 1. consumers don't value sustainability; 2. sustainable construction increases first costs to developers; 3. decentralized implementation of building regulations makes it difficult to mandate changes; 4. Inter- and intra-firm cooperation and information-sharing is difficult; 5. professionals lack of experience and training in sustainable construction; and 6. price and availability of technology may not meet the needs of the low-cost market.

Mexico's first efforts in sustainable construction respond to this context. The early pilot programs in energy efficiency, Fipaterm and Ilumex, attempted to create a consumer consciousness that investment in efficiency makes for a more comfortable house and results in lower utility bills. In order to popularize the use of the energy-saving technologies and products, they lowered the cost to the user by providing financing that used the money saved on utility bills for the first three years to pay back the loan. The innovation of collecting payments via the utility bill allowed them to minimize default risk on the loans. Bulk purchasing reduced costs of the materials used while encouraging the growth of their supply by guaranteeing sales. Proponents point to both the wide-spread availability of CFLs and the market acceptance of housing with insulation in Mexicali as indications of success. The experience in Mexicali shows that providing opportunities for consumers to experience the benefits is an effective way to create this consumer consciousness.

The two recent pilot projects that incorporate sustainable construction into new housing draw substantially from the the earlier energy-efficiency programs. Although the developer must design the houses to accommodate the specified energy efficiency measures, the cost recovery mechanism allows the costs to be passed on directly to the purchasers. The Convi pilot is promising in its inclusion of passive-solar, bioclimatic design and water efficiency. It remains to be seen, however, whether Conavi will be able to devise new ways to finance measures that may involve a cost premium. Where there is no mechanism for cost recovery like the utility bill, Conavi is working to have the cost amortized as part of the total purchase cost as a "green mortgage".

5.2 Questions and Propositions

Identifying the major barriers to wide-spread adoption of sustainable construction in developer-built low-cost housing and the reviewing existing programs and their responses to these barriers raise the many questions for further study, and as the results of the two pilot programs will surely yield more directions for exploration. In this section, I present two such question and their related opportunities and responses.

5.2.1 First, an analogy....

Imagine a game where players trade wooden nickels for cupcakes. There are only three types of players: a banker, many bakers, and many buyers. The rules of the game are set by the banker and known to all players.

Bankers distribute wooden nickels to buyers. Bakers make and sell cupcakes to buyers and collect wooden nickels. Buyers want the biggest, most delicious cupcake that a wooden nickel can buy. They receive wooden nickels from the banker trade them for the cupcake of their choice from the baker of their choice. There are more buyers than wooden nickels, and buyers can get one only by promising the banker that he will not give it away to another buyer, or trade it for anything that is not a cupcake. The banker wants as many buyers as possible to have at least one cupcake, so she gives one wooden nickel to each player. She also wants to assure that the cupcake is really a decent cupcake and not, for example, a teacake. She sets the rule that buyers may exchange their wooden nickels only for cupcakes that she, the banker, has approved as a good cupcake.

Since the baker knows that a buyer can trade only for cupcakes with his wooden nickel, he knows that if he makes anything that is not a cupcake, no buyers will give him a wooden nickel. He wants to collect as many wooden nickels as possible using the flour, sugar, butter, and eggs he has in his kitchen, so he wants to make the smallest possible cupcake that the banker is likely to approve as a good cupcake. He doesn't know, however, how

many cupcakes other bakers might bake, so wants to do his best to make his cupcakes attractive to as many buyers as possible. Sometimes, a baker may ask buyers what they want in their cupcakes and what other bakers are selling.

At the end of each round, bakers exchange the wooden nickels that they've collected for flour, sugar, butter, and eggs for the next round. The bakers that have collected more wooden nickels, of course, get to buy more ingredients and thus make more cupcakes in the next round.

After several rounds of play, the market features a single type of cupcake: a small plain one with no icing. Someone, no one is sure who, has proposed that it might be nice to have some cupcakes with icing. From the baker's perspective, making cupcakes with icing means using some of the sugar and butter for each cupcake. He thinks there might be a possibility that iced cupcakes might sell better, but his buyers might not like icing. When he chats with them about what they want, icing has never come up – generally, they say they would like bigger cupcakes. He's pretty sure that as long as no one else is offering iced cupcakes, buyers will keep buying his un-iced ones. At any rate he would still only receive one wooden nickel per cupcake.

5.2.2 Should housing policy promote sustainable construction in low-cost housing?

The first goal of housing policy is to meet housing goals. Some successful housing policies may have beneficial outcomes beyond housing, but a housing policy that fails to improve the housing situation but achieves some other social or economic goal could not be said to be a successful *housing* policy (Angel 2000). Is sustainable construction a legitimate housing policy goal? If so, how ought housing policy balance the need to increase the quantity of units funded versus the quality of the units funded? Who ought to bear the cost of providing higher-quality, more expensive housing products?

Sustainable construction aims to create superior building products, with emphasis on the human experience and environmental consequences. It recognizes, too, that the quality of

the product is dependent on manipulating the context of development, and attempts to remodel both the process of design and construction ("integrated design process") and the regulatory framework. Lastly, proponents of green buildings go to great lengths to demonstrate the value of green building in terms of enhanced value to actors at each point of the housing decision process, recognizing that green development is dependent on capital, asset, and space markets.

Mexican housing policy has adopted an activist stance toward promoting sustainability in housing, as a part of its national sustainability efforts. If sustainable construction is a necessary and desirable component of housing policy, the opportunity for the public sector lies in leveraging its central role as the source of housing subsidies and arbiter of construction quality.

5.2.3 Is sustainable construction tightly bound to the developer's best interest?

Current international discourse on green development emphasizes early design-stage decisions as being the most important in financial feasibility of a green building. Incorporating green design as a driving factor in early design ensures that siting, orientation, and materials selection decisions support rather than undermine the energy and environmental performance of the final product. In addition, they suggest that the design process and teamwork are key factors in success, as buildings are built over time and with the input of many people, resulting in a vast array of possible points of failure. The value that the housing developer brings to the development process is the ability to knit together all of the phases of development and drive it toward the goal of product delivery. Ultimately, only the developer is responsible to all of the stakeholders in a project: the equity funders, lenders, regulators, and clients. Thus, at the implementation level, it is the developer who is in the best position to incorporate sustainable construction into the housing delivery process.

The Cost vs. Quality Debate

While it may seem at first only too obvious to say developers avoid cost-increasing measures, developers regularly opt for them when it would improve the overall return of the project either through higher sale price or faster sales. As developers depend heavily on referrals for sales, they have a clear incentive to cultivate a reputation for quality. The drive to maintain a high standard for quality is partly responsible for the vertical integration of production.[1] The same need has spurred large developers to introduce post-sales service centers and to move toward building infrastructure and community facilities as part of the development in desarollos integrales. That sustainable construction improves the quality of the product could be an important factor in convincing developers to adopt these measures.

Quality is important for marketing to new buyers and to minimize the costs associated with post-occupancy service calls. In low-cost housing, pre-sale contracts are non-binding and do not require payment at the time of contract signing. According to one developer, each unit is sold one and a half times on average, because the original purchaser chooses to break the pre-sale contract (Sorsby 2006). The ability of the purchaser to wait to see the final product puts pressure on the developer to compete on quality at the time of delivery, even if the development has been substantially pre-sold. Developers also rely heavily on word-of-mouth recommendations from prior purchasers. As much as half of their sales come from referrals from prior clients (Ramirez 2005, Sorsby 2006).

Developers are required to service call-backs for three years in addition to providing a 10-year structural warranty (Sorsby 2006). According to Softec, the primary source of residential market data in Mexico, post-occupancy surveys show that at one month of occupancy, 80% of respondents were dissatisfied with the purchase and would not buy again. At 6 months, however, a majority had improved their outlook and were happy with their purchases (Ramirez 2005). Developers say that many service calls are the result of misuse or misunderstanding by the purchaser. These anecdotes support the hypothesis

[1] An example of this is the on-site production of cement blocks for quality control (Sorsby 2006)

that the cause of the high incidence of initial dissatisfaction are due to the discomforts of adjusting to the new surroundings. Developers try to manage such issues by delivering information from the home owners' manual — required, but often unread — through video presentations at the time of purchase and to coach owners on proper maintenance and cleaning. Where competition is intense, large developers have introduced on-site post-sale service centers to help owners with tasks small and large, from filling out paperwork for municipal services to building additional rooms.

The need to provide amenities has contributed to the strategy of building *desarollos integrales*, where the developer builds neighborhood services and community facilities in addition to housing. Because the areas where these housing projects are sited are generally being urbanized for the first time, lacking infrastructure and public services, housing developers take on the task of building the roads, putting in sewers and water, putting in the electricity and street lighting, etc., then turn over their management and upkeep to the municipality. Where there is a need for schools or wastewater treatment facilities or other such works, the developers prefer to build them as well rather than pay exactions to the city because it gives them more oversight and control over the delivery of these services — after all, they can't sell their houses until these services are built and working. As the concept has developed from one of practical considerations about timely delivery of basic services to providing amenities like convenience stores, pharmacies, churches, and playing fields, developers have discovered that they are able to charge a premium in these projects (Ramirez 2005)

The above example shows that developers innovate to deliver high-quality products when this goal is well-aligned with their business objectives. The experience of LEED in the US suggests also that the most compelling reasons for undertaking green construction is occupant comfort and productivity. Though a well-designed building that provides a pleasant and healthy indoor environment may also achieve good energy performance, experiences of the 1970s show that designing for minimum energy consumption does not necessarily make for good indoor environmental quality. Though practitioners cast the choice as a false one, the emphasis on occupant comfort has been used to promote green

buildings across building types. Whereas existing programs have focused on payback periods of efficiency measures at the unit level, packaging the benefits of sustainable construction as an issue of quality may entail looking beyond the single unit to the district scale, where developers are already making investments in quality. According to one interviewee, the costs of sustainable construction are dwarfed compared to long-term cost of retrofitting poorly designed houses, or, compared to the total value of large housing developments: "Pulling two sets of pipes for recycling water is a marginal cost if you look at the total value of the development project, and if you want to do the right thing" (Varon).

5.2.4 Propositions

Adopt Sustainability as a Key Organizational Objective

The Mexican government could make the issue of sustainability central to housing policy and practice by amending the national housing institutes' charters to explicitly embrace sustainability as a core value. A strong leadership stance at the national policy level would provide a clear mandate for discovering and exploiting opportunities for pushing sustainable construction practices forward.

Conavi plays a key role in bringing stakeholders together and is seen by private and public-sector actors alike as the appropriate organization to do so. It is, however, the national-level organizations that are in the critical path of policy innovation are without question the housing institutes. The lion's share of subsidized housing production, the majority of new residential construction, is overseen by the housing institutes. They already have the review and information dissemination mechanisms necessary to push the adoption of green construction on a large scale. Their clout as the largest underwriters gives them a privileged position in discussions within the development industry. The previous experiences of successfully implementing long-range reforms ought to indicate a capacity for taking on the challenge of redesigning its processes in light of new goals.

Build Regulatory Capacity

The only way to overcome the lack of experience and training in sustainable building is to offer training and opportunities to work on sustainable construction projects. While educational institutions and NGOs will no doubt play an important role in this area for the industry as a whole, one group of practitioners unique to the Mexican building process stands out as deserving special attention: the Directores de Obra, architects and engineers licensed to review plans for code compliance. Because these auditors are involved in virtually all construction projects, changing their outlook and understanding of sustainable construction has the potential to have wide-reaching impacts. One way to reach this group could be to reform the rules of licensing to require knowledge of sustainable construction. For example, a three-year plan to phase in a sustainability requirement could begin by announcing a date by which all auditors coming up for renewal must demonstrate their sustainability knowledge by exam or by attendance in approved training programs. This approach would use the existing licensing system while spurring growth in educational offerings for a key tier of architecture and engineering professionals.

Sustainability Standards and Incentives

When asked how housing policy should foster sustainable construction, most interviewees replied that they favored mandatory and uniformly applied regulations . This response, contrary contrary to the US experience in which adoption of green building has been driven forward primarily by adopting the voluntary LEED certification system, is consistent with the role that regulation plays in a highly-competitive but centrally-organized system. Developers perceive that they face an extremely price-elastic demand, and thus are unwilling to adopt any measure that would increase price. Uniformly applied regulations mitigate risk by creating a common point of departure so that all firms in the market take equivalent risks and compete on the same terms. Where regulations are not uniformly applied, the company that chooses to conform to a higher quality standard at a cost exposes itself to risks that competing firms avoid.

At the moment, developers are faced with fragmented implementation of existing requirements as different municipalities adopt new regulations at their own pace. Though the pace of adoption of new building regulations depend on local governments, the national government influences the characteristics of low-cost housing through its financing. Thus a regulatory response that could set a higher quality standard for everyone could come through lending criteria rather than through building regulations.

Setting higher minimum standards administratively through the mortgage lending criteria would still require that the government (via the subsidy system), the developer, or the consumer absorb the costs increases. Whether developers would be willing to bear the cost of higher standards, given the super-normal returns publicized by listed developers, would be an interesting question to answer, and one that would require analysis of to what extent the value of a development project comes from the housing product (rather than operational leverage, appreciation of land value, or financial leverage). Uniform construction lending criteria (via the SHF), and reportedly low margins over cost of construction would suggest that low-cost housing developers' profits depend heavily on the land appreciation component.

If the cost of higher standards is can not be absorbed by the developers, even in the case that all developers are subject to the same criteria, then the cost could be born by the public sector through redesigning the subsidies. This does not imply that the developer will enjoy the financial benefits of a perception of improved quality (faster sales, fewer call-backs, more repeat custom), merely that developers would be left in the same position financially, but building to different specifications.

Mandatory minimum standards, however, may run contrary to the goal of increasing housing production, if it means that resources must be allocated differently — building 10 improved houses rather than 11 ordinary ones. The competing goals would come into conflict more clearly as the scope of "sustainable construction" expands beyond the limited number of strategies that define the current sustainability initiatives. If, adopting minimum standards that are set "too high" may undermine the volume goals (already

experienced by many developing countries in their early housing construction programs). An alternative approach would be to offer incentives financially (through "green mortgages") or procedurally, through streamlined "fast-track" administrative treatment for developers demonstrating use of sustainable construction. Since ultimately mortgage allocations work on a first-past-the-post system for regional quotas, a quota reserve for sustainable construction projects could serve the same purpose.

Finally, the sustainable housing pilot or other programs like it ought to move toward performance-based metrics to allow for greater flexibility for developers to incorporate sustainability into their practice. Strategies for improving the environmental performance of buildings across the basic criteria (energy-efficiency, water conservation, sourcing and disposal of materials, and occupant comfort) are numerous and sometimes incompatible. The strength of flexible systems like LEED lies partly in that the developer is free to pick and choose among all of the options available to her, as long as certain baseline criteria and performance metrics are met.

Appendix A

List of Interviews

A.1 Developers

- Mayagoitia, Fernando. Urbi - March 23, 2006
- Morales, Rodrigo. ICA - March 30, 2006
- Padilla, Carlos. BCBA - April 21, 2006
- Silva, Miguel. Casas Geo - April 24, 2006
- Sorsby, Steven. Bracsa. - May 2, 2006

A.2 Architects

- Castillo, José - March 30, 2006
- López Obeso, Jorge
- Marquez, Victor - March 21, 2006
- Picciotto, José. - May 3, 2006
- Varon, Jaime. - April 11, 2006
- Vokac, Dalibor - April 25, 2007 (By phone)

A.3 Public Sector

- Arjona, Diego. CONAE - April 19, 2006
- del Valle, Beatriz. Gob. Distrito Federal. - May 4, 2006
- Gonzalez, Maria Christina. CONAFOVI/CONAVI - April 24, 2006
- Laguna, Israel. INE - March 21, 2006
- Ojeda, Ramon. Gob. Estado de MÈxico - May 8, 2006
- Urteaga, José Antonio. FIDE - April 11, 2006
- Zagal, Ruben. FIDE - April 11, 2006

A.4 NGO / Consultants

- Bernal, Pedro. ITESM - January 23, 2006
- Bucio, Franco. ONNCCE - March 29, 2006
- De Buen, Odon. - April 17, 2006
- Gastelum, Gustavo. Holcim Foundation for Sustainable Construction, Mexico - May 3, 2006
- Kanahuati, Jorge - April 5, 2006
- Lacy, Rodolfo. Centro Mario Molina
- Lino, Moises - May 9, 2006
- Morillón, David. UNAM - March 24, 2006
- Newcomb, John. KMD Arquitectos, ULI Mexico - April 11, 2006
- Tardan, Jenny. AEAEE - March 23, 206
- Treviño, Cesar Ulises. CMES - January 23, 2006
- Tijerina, Estela. CMES - January 23, 2006

Appendix B

Sample Interview Questions

B.1 Background

1. Please describe your role at [organization].

2. Please describe your personal history of involvement in green building.

B.2 Developers

1. Please describe the scale and nature of housing development undertaken by [company].

2. What green building policies or initiatives does [company] have?

3. How does [company] evaluate green building technology?

4. To what extent does [company] consider environmental issues in siting? Ie. resource availability, infrastructure, access to transportation, etc?

5. Who has championed green building at [company] ?

B.3 Green building

1. How would you describe the state of green building in Mexico?

2. What is the primary challenge to wide-spread green building?

3. What is the "state of the shelf" technology available? Is it sufficient to achieve higher environmental performance?

4. What group or organization has taken the leadership role in promoting green building?

5. What issues are unique to Mexico? Most pressing environmentally? Most achievable?

6. What role do you see for certification programs along the lines of BREEM or LEED in Mx?

7. What policy or financing changes could promote green building (in general)? In housing?

8. Should siting be considered a part of green building?

Appendix C

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