Vivir Mejor

Supported NAMA for Sustainable Housing in Mexico
- Mitigation Actions and Financing Packages -

Gobierno Federal

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INFONAVIT

CONAVI

Supported NAMA for Sustainable Housing in Mexico

- Mitigation Actions and Financing Packages -

Supported by:

On behalf of

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

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Supervision:
CONAVI, SEMARNAT, GIZ: André Eckermann, Jakob Graichen, Emmanuel Carballo

Authors:
Thomson Reuters Point Carbon: Olga Gassan-zade, Robert Kaineg, Kjell Olav Kristiansen
IzN Friedrichsdorf: Georg Kraft, Rolf Seifried, Werner Neuhauss, Heiko Störkel
Passivhaus Institut: Witta Ebel, Susanne Theumer, Maria del Carmen Rivero.
Gopa Consultants: Angelika Stöcklein, Salvador Rodriguez.
Perspectives: Matthias Krey, Stefan Wehner.

Photography: GIZ/ENERVALIA (cover)

Av. Presidente Masaryk 214, 1er Piso
Col. Bosque de Chapultepec
C.P. 11580, México, D.F.
E-mail: jlwolpert@conavi.gob.mx; tdkotecki@conavi.gob.mx
Tel.: 52 55 91389991
www.conavi.gob.mx

Av. San Jerónimo 458, 3er Piso
Col. Jardines del Pedregal
C.P. 01900, México, D.F.
E-mail: juan.mata@semarnat.gob.mx
Tel.: 52 55 54902118
www.semarnat.gob.mx

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BANOBRAS	Banco Nacional de Obras and Servicios Públicos S.N.C. (Mexican National Bank for Public Works and Services)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of Germany)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Federal Ministry for Economic Cooperation and Development of Germany)
CDM	Clean Development Mechanism
CEV	Código de Edificación de la Vivienda (Residential Building Code)
CFL	compact fluorescent lamp
CONAVI	Comisión Nacional de Vivienda (National Housing Commission)
CONUEE	Comisión Nacional para el Uso Eficiente de la Energía
CTF	Clean Technology Fund
DUIS	Desarrollos Urbanos Integrales Sustentables (Sustainable Integrated Urban Developments)
FONADIN	Fondo Nacional de Infraestructura (National Infrastructure Fund)
FONHAPO	Fondo Nacional de Habitaciones Populares (National Fund for Popular Housing)
FOVISSSTE	Fondo de la Vivienda del Instituto de Seguridad and Servicios Sociales de los Trabajadores del Estado (Housing Fund of the Institute of Social Security and Services for Government Workers)
GHG	Greenhouse gas
IDB	Inter-American Development Bank
INFONAVIT	Instituto del Fondo Nacional de la Vivienda para los Trabajadores (Institute of the National Housing Fund for Workers)
KfW	Kreditanstalt für Wiederaufbau, German government-owned development bank
LPG	Liquefied petroleum gas
MEPS	Minimum Energy Performance Standards
MRV	Monitoring, reporting, verification
MXN	Mexican peso
NAFIN	Nacional Financiera, Sociedad Nacional de Crédito (National Development Bank)
NAMA	Nationally Appropriate Mitigation Actions
NOM	Normas Oficiales Mexicanas (official standards of Mexico)
NMX	Normas Mexicanas (voluntary standards of Mexico)
OREVI	Organismos Regionales de Vivienda (regional housing agencies)
PDL	Performance-Driven Loan
PECC	Programa Especial de Cambio Climático (Special Climate Change Programme)

PHI	Passive House Institute
PHPP	Passive House Planning Package
PNV	Programa Nacional de Vivienda (National Housing Programme)
PoA	Programme of Activities
PRONASE	Programa Nacional de Aprovechamiento Sustentable de la Energía (National Programme for the Sustainable Use of Energy)
RUV	Registro Único de Vivienda (Unified Housing Registry)
SHF	Sociedad Hipotecaria Federal (Federal Mortgage Company)
SOFOLES	Sociedades Financieras de Objeto Limitado (Limited Purpose Financial Institutions)
SOFOMES	Sociedades Financieras de Objeto Múltiple (Multiple Purpose Financial Institutions)

Exchange rates

1 MXN	=	0.054	EUR	=	0.075	USD
1 EUR	=	1.400	USD	=	18.620	MXN
1 USD	=	0.714	EUR	=	13.30	MXN

Executive Summary

Seeking to demonstrate climate leadership and align sustainable development with growth priorities, the Mexican government has initiated a wide range of programmes aimed at improving the energy efficiency of residential buildings, particularly in the low- and medium-income markets where robust growth is expected over the coming decade. One key aspect of this strategy is the implementation of the world's first Nationally Appropriate Mitigation Action (NAMA) in the housing sector, intended to promote the use of energy-efficient appliances and building design, and permit technology up-scaling to make new homes increasingly efficient as the programme develops. The supported NAMA for sustainable housing discussed in this brochure is just one part of a broader strategy to promote low-carbon urban development within the country.[1]

What is the NAMA?

Mexico has already taken the first steps towards greening its residential sector through programmes such as 'Hipoteca Verde' (*'Green Mortgage'*) and 'Ésta es tu casa' (*'This is your house'*). Both offer supplemental loans that cover the incremental cost of energy-efficient appliances in new homes. Furthermore, Mexico has engaged international support through establishing programmatic CDM activities (PoA) to channel carbon finance towards the sustainable housing sector.

The Housing NAMA concept now being promoted is aimed at extending and expanding the scope of these activities, increasing the overall number of energy-efficient homes built and improving their emissions performance. To this end, Mexico and its partners[2] have developed three performance benchmarks that can be achieved by residential building developers and home-owners. In order of increasingly aggressive efficiency standards, they are Eco Casa 1, Eco Casa 2, and the Passive House.

Unlike previous Mexican programmes, which have focused on promoting and measuring the impact of specific technologies, this NAMA sees building efficiency from the 'whole house approach'. Under this perspective, efficiency benchmarks are set for total primary energy demand, for each building type and taking into account climatic variables. Building developers and home-owners are able to employ a range of interventions to achieve the performance standard.

Such an approach has numerous benefits, including a simple and cost-efficient MRV system. It also enables stakeholders to find the most cost-efficient solutions as opposed to prescribing specific technologies, providing incentives to reduce total energy demand by taking into account the interaction all of the measures implemented. Under the NAMA concept, improved design features such as efficient window design and longer overhangs can compete with technology innovations such as solar water heaters, thus avoiding the perception that the government is 'picking winners'. Furthermore, the tiered benchmark approach enables donors to target their support towards specific activities that align with their development priorities, and provides flexibility for regulators should they seek to increase the stringency of the programme over time.

[1] www.conavi.gob.mx

[2] The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (German Development Cooperation) has supported the development of this NAMA on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

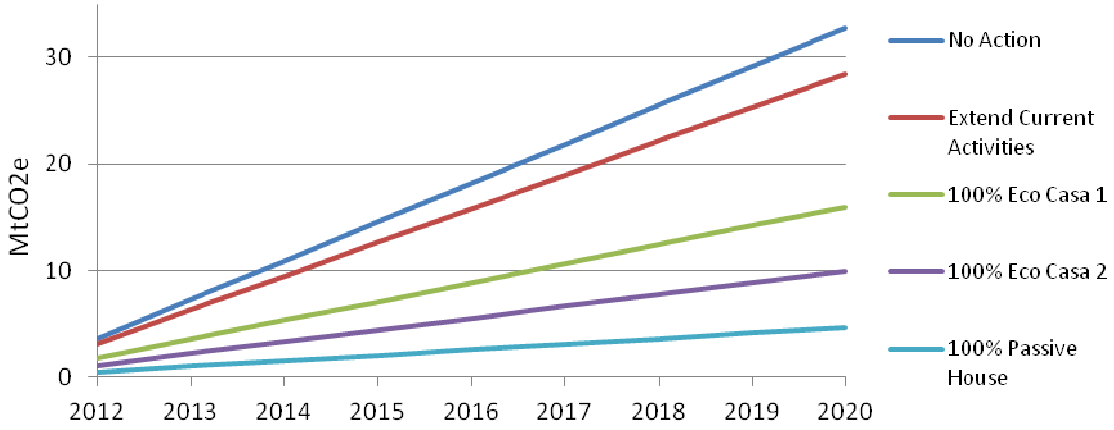
Programme Potential

Taking into account demographic growth rates, Mexico is expected to have an estimated 160 million inhabitants by 2050. It is estimated that Mexico will need to build between 800,000 and 1 million new homes per year over the coming decade. Due the long life-cycle of buildings, investments made now in sustainable development will pay dividends for decades to come, from both an economic and environmental perspective. This section will indicate the extent of the opportunities the NAMA presents and the potential efficiency gains that can be achieved.

Size of the opportunity

Growth in the residential sector is fuelled by demographic pressure as the country's population grows, as well as the increasing affluence of the less economically advantaged Mexican population. Between now and 2020, more than 7 million new housing units will be constructed, contributing as much as 33 Mt CO_2 to the cumulative Greenhouse Gas (GHG) emissions to the country's carbon footprint.

Figure 1. Emissions from newly built houses in Mexico under select mitigation scenarios



Source: Point Carbon Thomson Reuters

Efficiency potential of the NAMA programme

The German Passive House Institute (PHI) has calculated the 'Whole House' energy balance, which is scalable by unit size, based on the four climate zones of Mexico, for three unit types: single-family detached, single-family row house, and vertical multi-family. Three primary energy target values or 'standards': Eco Casa 1, Eco Casa 2 and Passive House Standard, have also been developed for each building type and climate zone.

- Eco Casa 1 represents the level of efficiency if all of the supported technologies under the current Green Mortgage scheme are adopted. This is equivalent to the level of energy efficiency achieved if 2.5cm of insulation are installed in the roof and a single wall, reflective paint, a tankless water boiler, solar water heater and an efficient A/C unit are installed.
- Eco Casa 2 represents a further level of efficiency achieved by insulating all walls, installing better windows and highly efficient appliances.

- The Passive House Standard envisages optimization of all measures to achieve the Passive House certification criteria, including extended overhangs, extensive insulation, and other design features to achieve reduction in primary energy demand.

Table 1. Annual emissions avoided in a 40m^2 house by building type and climate zone, tCO_2

Single & Row House	Hot & Dry Climate	Hot & Humid Climate	Temperate Climate	Semi-Cold Climate
Eco Casa 1	2.0	2.0	0.8	0.8
Eco Casa 2	2.7	3.5	0.9	0.8
Passive House	3.0	4.0	1.0	1.0
Vertical (multi-family)				
Eco Casa 1	1.7	2.0	0.9	0.8
Eco Casa 2	2.2	2.7	1.2	1.0
Passive House	2.6	4.0	1.2	1.1

Source: Passive House Institute

Although this document references specific technologies, for descriptive purposes, home-owners do not need to install all, or indeed any, of the above technologies. In order to be eligible for funding under the NAMA, these stakeholders must reach only the level of energy efficiency that these technologies represent, by using any combination of features. What is important is the overall energy performance of the house, not the specific technologies used.

Expected Results and Next Steps

Existing sustainable housing programmes in Mexico support only a limited segment of the newly built housing market and efficiency levels approaching the Eco Casa 1 standard outlined above. The Mexican government is currently exploring opportunities to scale up these programmes, in terms of market penetration and level of efficiency. That could result in an additional 2 million tonnes of emissions avoided per year.

In order to achieve this level of penetration and up-scaling, however, additional funds are needed beyond what the Mexican government can provide. Carbon finance, international donors, and private finance all have a role to play if Mexico is to expand the scope and impact of this sustainable housing initiative. This NAMA provides a vehicle to attract and leverage additional international funding to support sustainable development within Mexico. Donors and investors interested in getting involved with this NAMA are offered a range of options to support both direct actions (homes with a certain efficiency standard) and indirect (capacity building) ones.

Financing the NAMA

For donors and investors interested in directly supporting new energy efficiency homes, a 'NAMA Fund' will be set up as the initial recipient of donor funds, whether as soft loans or as grants. Funding provided for the NAMA will address both the supply and demand side, providing bridge loans for housing developers and support for home buyers in the form of subsidies and supplemental mortgage finance. Potential donors may get involved by providing

funds directly to home-owners as grants/subsidies or through soft loans to developers and/or by financing the supportive actions for NAMA operation.

Table 2. Examples of financial packages for subsidies to home owners (grants from donors)

Packages				Financing Need			Benefits
Financial packages	Scale of the package	Content of the package		Subsidies to Home-owners, USD million		Total incremental construction cost USD million	Emission reductions over 30 yrs lifetime, tCO_2
		Mainstream roll-out	Passive House Pilot	Mainstream roll-out	Passive House Pilot		
Package 1	Large Scale (27,000 homes)	EcoCasas 1 & 2, 40 and 70m^2	30 buildings of 40m^2	49	0,2	165	1,711,000
Package 2	Mid-Size (13,800 homes)	EcoCasas 1 & 2, 40 and 70m^2	30 buildings of 40m^2	25	0,2	84	866,000
Package 3	Small Scale (5,200 homes)	EcoCasas 1 & 2, 40 and 70m^2	30 buildings of 70m^2	9	0,3	27	311,000
Package 4	Multi-Family (14,940 apartments)	EcoCasas 1 &2, 40 and 70m^2	780 verticals, 40 and 70m^2	27	3	94	865,000
Package 5	Passive House Pilot (890 homes)	890 Mexican Passive Houses (different types)		-	6	12	87,000

Source: IzN Friedrichsdorf

Donors wishing to provide indirect support can provide critical funding that will enable administrative and supportive actions directly to the Mexican government, or via bilateral cooperation initiatives. These include capacity building at the federal and local level, providing professional training services to regulators and verifiers, and establishment and maintenance of monitoring and reporting frameworks. It is estimated that approximately USD 15.6 million in grant financing will be needed between 2012 and 2016 to fund 'indirect' NAMA mitigation actions.

As the example packages illustrate, donors will have significant flexibility to scale the level (number of units) and type (Eco Casa 1, Eco Casa 2, and Passive House) of support, as well as to target their donations towards both direct and/or indirect measures, as per their needs, mandate, and preferences.

Table 3. Main elements of Sustainable Housing NAMA design

Item	Description
Sector	Building sector
Sub-sector	New residential houses (1st phase), primarily for low-income families
NAMA boundary	Entire country
Measures and activities with direct impact on GHG emission reduction	Introduction of a class of ambitious primary energy consumption benchmarks. The construction of houses according to the benchmark level is incentivized by a scaled-up financial promotion system
Measures and activities with indirect impact on GHG emission reduction	Supportive actions for NAMA implementation, operation and support of the wider transformational process in the residential building sector: introduction of

	energy performance requirements in the legal system and permitting process, training of planners, architects, energy advisors and manufactures, creation of model projects
NAMA timeframe	- preparation: 2010-2011 - implementation: 2012-2016 (first phase), - second phase to be scheduled
NAMA roll-out schedules	- 2012 and 2013: focus nearly exclusively on Eco Casa 1 - 2014 and 2015 some Eco Casa 2 houses envisaged. - Passive Houses are considered in limited numbers as pilot projects.
NAMA operation costs (supportive measures)	USD 15 650 000
NAMA type	NAMA framework consisting of unilateral and supported components
Type of support required under the NAMA	Financial, technical and capacity building

Source: Point Carbon Thomson Reuters and Perspectives

1 Introduction

Wishing to demonstrate climate leadership and align sustainable development with growth priorities, the Mexican government has initiated a wide range of programmes aimed at improving the energy efficiency of residential buildings, particularly in the low- and medium-income markets where robust growth is expected over the coming decade. One key aspect of this strategy is the implementation of the world's first Nationally Appropriate Mitigation Action (NAMA) project in the housing sector, which will increase the penetration of energy-efficient appliances and building design, and permit technology up-scaling to make new homes increasingly efficient as the programme develops.

Mexico has already taken the first steps towards greening its residential sector through programmes such as 'Hipoteca Verde' ('*Green Mortgage'*) and 'Ésta es tu casa' ('*This is your house'*). Both offer supplemental loans that cover the incremental cost of energy-efficient appliances in new homes. Furthermore, Mexico has already engaged international support through establishing programmatic CDM activities (PoA) which have channelled carbon finance towards the sustainable housing sector.

However, such programmes support only a limited segment of the newly built housing market and thus achieve only modest levels of efficiency. The Mexican government is currently exploring opportunities to scale up these programmes both in terms of market penetration and level of efficiency, which could result in an additional 2 million tonnes of emissions avoided per year.

The NAMA concept now being promoted aims at extending and expanding the scope of these pilot activities, increasing the overall number of energy-efficient homes built and improving their emissions performance. To this end, Mexico and its partners have developed three performance benchmarks that can be achieved by residential building developers and home-owners. In order of increasingly aggressive efficiency standards they are Eco Casa 1, Eco Casa 2 and the Passive House.

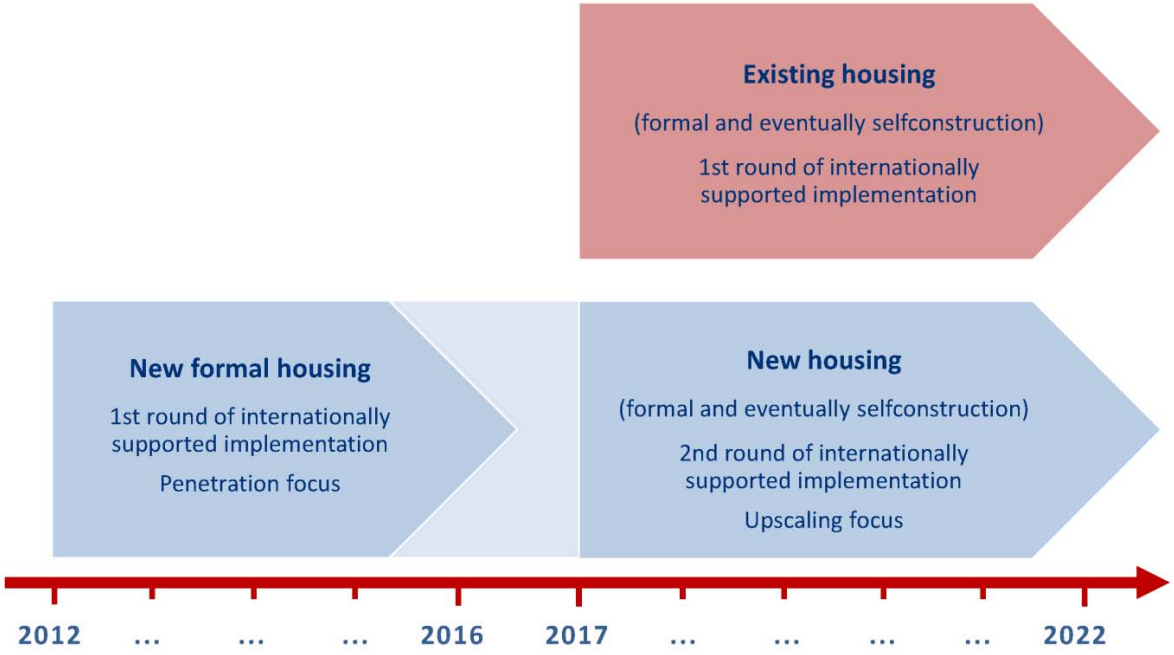
In order to achieve the desired level of penetration, however, additional funds are needed beyond what the Mexican government can provide. Carbon finance, international donors and private finance all have a role to play if Mexico is to expand the scope and impact of this sustainable housing initiative. The NAMA described in this document provides a vehicle to attract and leverage additional international funding to support sustainable development in Mexico.

Unlike previous activities, which have focused on promoting and measuring the impact of specific technologies, this NAMA approaches building efficiency from the 'whole house' perspective. Under this approach, efficiency benchmarks are set for total primary energy consumption, for each building type and taking into account climatic variables. Building developers and home-owners may to employ a range of interventions to achieve the performance standard.

Such an approach has numerous benefits, including a simple and cost-effective MRV system. It also empowers stakeholders to find the most economically efficient solutions as opposed to prescribing specific technologies. Under the NAMA concept, improved design features such as efficient window design and longer overhangs can compete with technology innovations such as solar water heaters, thus avoiding the perception that the government is 'picking winners'. Furthermore, the tiered benchmark approach enables donors to target their support towards specific activities (penetration vs. up-scaling) in line with their development priorities, and provides flexibility for regulators should they seek to increase the stringency of the programme over time.

Mexico envisages the NAMA as a long-term initiative that will start with a focus on new housing programmes and will eventually also include existing housing stock. In the first phase, the residential housing NAMA is aimed at enhancing GHG emissions reductions by expanding the 'Green Mortgage' and 'Ésta es tu casa' programmes. As a second phase, in the medium to long term, it is envisioned that there will be a consolidation of the voluntary programmes and mandatory building codes into DUIS, further decreasing emissions from new urban development.

Figure 2. Phase-in schedule of the Mexican Housing NAMA



Source: CONAVI/GIZ

The following steps define the incremental enhancement through the NAMA described in this report:

- increased penetration (more houses covered during the same time) and/or
- technology choice and up-scaling (more ambitious efficiency standards and/or inclusion of technologies currently not covered).

In addition to providing an in-depth description of the NAMA concept and its potential to impact the emissions profile of Mexico, this report outlines the state of the Mexican housing market, identifies some barriers to low carbon development, describes the MRV system, and explains how the programme can be funded.

2 Overview of the Mexican housing sector

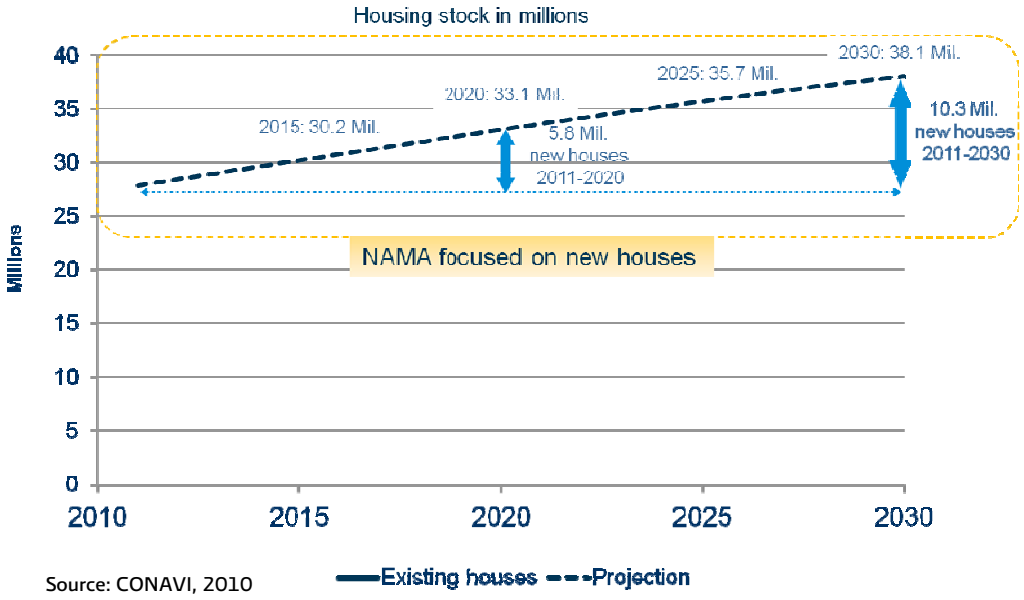
2.1 The relevance of the housing sector

Taking into account demographic growth rates, Mexico will have an estimated 160 million inhabitants by 2050. By the third decade of this century, Mexico will have nearly 50 million households. It is estimated that this will require the construction of nearly 11 million new houses between now and 2030; and an additional 9 million homes will require partial or total refurbishment in the same period. The Government of President Felipe Calderón has granted more loans and subsidies for housing each year than all previous governments: more than 1 million on average, with approximately 6 million new homes expected to be built from 2006 to 2012.

In the context of controlling emissions growth and achieving environmental targets, the residential sector has been identified by the Mexican government as a key opportunity to address national growth and development needs in a sustainable and responsible manner. Residential houses are responsible for 7% of the national greenhouse gas emissions in Mexico, representing 49 Mt CO_2 per year. The long life-cycle of a residential house – minimum 30 years – contributes to the high potential for mitigation of greenhouse gas emissions in the residential sector. Regulators, developers, and financial institutions have an opportunity now to change homeowner incentives and building standards to include and promote the deployment of energy-efficient technologies, including 'passive' design features, and reduce total building energy consumption. Out of the 6 million houses the Mexican government expects to build up to 2012, 1 million are envisaged to comply with sustainability criteria.

This approach to the residential sector is part of a broader Mexican initiative to promote sustainable urban development that includes unilateral actions, programmatic CDM activities and NAMA projects. The goal is to expand these interventions beyond residential housing, holistically including transportation, water, waste, land use and other critical urban services.[3]

Figure 3. Projected growth of the Mexican housing sector



Source: CONAVI, 2010

[3] For further details on the Mexico's strategy in the housing sector, see *Sustainable Housing in Mexico*, CONAVI, November 2011.

2.2 Housing market players and their linkages

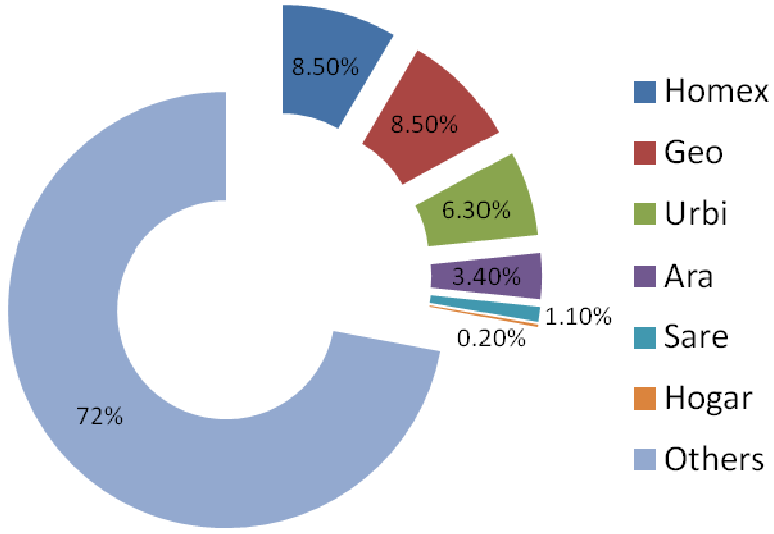
The Mexican housing sector includes a range of key players, including public sector finance, private financial institutions, housing developers and consumers. There are also two distinct market segments: the mortgage market, which serves the individual home-owners; and the developers' market, which finances building developers and construction firms.

Two large public housing providential funds, both over 30 years old, provide long-term saving schemes that function through mandatory contributions. The Institute of the National Housing Fund for Workers (Instituto del Fondo Nacional de la Viviendapara los Trabajadores, INFONAVIT) serves employees in the private sector, and the Housing Fund of the Institute of Social Security and Services for Government Workers (Fondo de la Vivienda del Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado, FOVISSSTE) serves public sector employees. Both collect 5% of employees' salaries, withheld at source by the employer, through individual savings accounts.

In addition to supplying home mortgages, public subsidy programmes are provided directly to low income home buyers through the National Housing Commission (Comisión Nacional de Vivienda, CONAVI) and National Fund for Popular Housing (Fondo Nacional de Habitaciones Populares, FONHAPO). Federal Mortgage Society (Sociedad Hipotecaria Federal, SHF) is a government-owned mortgage development bank and acts as a secondary mortgage market facility.

Residential development is a robust and competitive business in Mexico. There were approximately ten big housing developers and around 2,000 small developers actively constructing housing units in 2010.

Figure 4. Residential market share of newly built units by developers in Mexico 2010[4]



Source: CONAVI, 2011

[4] CONAVI 2011

All new homes are registered before construction begins and until the homes are sold by the Registry of Housing Supply (Registro Único de Vivienda, RUV). RUV reflects the total number and location of new homes built to be financed through individual mortgages granted by INFONAVIT and FOVISSSTE.

2.3 Finance for the Mexican housing sector

Mexico's financial reforms and capacity-building efforts over the past decade have solidified and stabilized the financial sector, as demonstrated during the recent global financial crisis. The limited exposure to foreign-currency risk, relatively low reliance on wholesale funding and strong liquidity left Mexican commercial banks in a comfortable position for coping with negative fallout from the current European financial crisis. As a precautionary measure, Mexican authorities have tightened regulations and supervision of subsidiaries of foreign banks, including limits on dividend distribution (to avoid erosion of capital) and related party lending.

The mortgage sector is segmented according to whether the individual is a public or private worker and by the overall value of the mortgage. INFONAVIT and FOVISSSTE channel mandatory contributions into direct residential mortgage loans to their members. INFONAVIT is responsible for providing mortgages to private-sector employees with social security, and FOVISSSTE serves employees in the public sector. The majority of mortgages in the country originate from these two institutions, particularly INFONAVIT which in 2010 alone financed around 475,000 houses. Together INFONAVIT (loan portfolio USD 47 bn) and FOVISSSTE (loan portfolio USD9 bn) make up around two thirds of the mortgage market. INFONAVIT is also currently the only bank that financially incentivizes energy-efficient building practices through the Green Mortgage programme, initiated in 2007 to improve efficiency in air conditioning, lighting and water heaters.

Commercial banks also provide funding to the housing sector; their share is around a quarter of the total mortgage loan portfolio. They have managed to increase their participation in the market providing co-financing to INFONAVIT and FOVISSSTE.

Limited Purpose Financial Institutions (Sociedades Financieras de Objeto Limitado, SOFOLES) and Multiple Purpose Financial Institutions (Sociedades Financieras de Objeto Múltiple, SOFOMES) are private non-bank lending institutions licensed to lend to particular sectors. SOFOLES and SOFOMES play a large role in lending to consumers who are not covered by INFONAVIT and FOVISSSTE or who seek to finance a mortgage with a higher value than the maximum amount offered by the public institutions. SHF, as a secondary mortgage market facility, does not lend directly to home buyers, but lends to institutions that specialize in the mortgage sector. SHF provides lending to SOFOLES and SOFOMES, as well as microfinance institutions. SHF also capitalizes housing lenders, in particular SOFOLES and SOFOMES, as several of them have run into financial difficulties.

For housing developers, funding primarily originates from private sector banks, the stock market and SOFOLES.

2.4 Mexican housing policy in the context of climate

In support of the goals of the 2007–2012 National Development Plan *(Plan Nacional de Desarrollo)*, in 2007 CONAVI initiated the National Housing Programme (*Programa Nacional de Vivienda,* PNV) for 2008-12, 'Toward Sustainable Housing Development'. The PNV sets out an aggressive plan to construct six million homes by 2012, one million of which are to be sustainable. PNV has four major objectives:

(1) Increase the coverage of financing for housing offered to the population, particularly for low-income families
(2) Promote sustainable housing development.
(3) Consolidate the national housing system through improvements in public management
(4) Consolidate a Federal Government support policy that helps the low-income population to obtain financing for housing and promotes sustainable housing development.

Environmental sustainability is a clear priority for the Mexican government and CONAVI. PNV promotes the dissemination of green-housing technologies, as well as the development and implementation of norms and regulations standardizing green-housing options in order to move towards high-quality, environmentally sustainable housing. PNV also promotes green mortgages and subsidies, as described in section 2.5. In addition, through PNV, CONAVI has supported several pilot training programmes designed to raise general awareness of the benefits of sustainable housing.

Climate Change Policy

In August 2009, Mexico formulated its Special Climate Change Programme (Programa Especial de Cambio Climático, PECC), defining more than 100 greenhouse gas mitigation actions aimed at reducing 51 Mt CO2e per year by 2012. The PECC includes the 'efficient housing and green mortgages' component, which has been conceptualized and operated by CONAVI and INFONAVIT. The programme is expected to contribute 2.4% of emissions reductions towards the PECC 2012 goal.

The PECC sets general guidelines to establish an ambitious Mexican GHG emission reduction pathway of -30% with respect to a business-as-usual scenario by 2020.This pathway will represent Mexico's contribution, if a multilateral agreement is agreed by the UNFCCC and if it includes provisions for adequate technical and financial support for developing economies. Mexico sees the concept of supported NAMAs, as put forward during the Bali UN climate negotiations in December 2007 and described within the Copenhagen Accord in December 2009, as an important means for supporting the goals laid out in the PECC.

Energy efficiency in the Building Code

CONAVI has developed a comprehensive voluntary building code (Código de Edificación de la Vivienda, CEV) including an energy efficiency and sustainability section for residential buildings. However, building standards and codes are established at the level of the states and municipalities, whereas CONAVI is a federal agency: it cannot force the adoption and implementation of its recommendations. Therefore, at present CEV serves only as a model code.

The current Minimum Energy Performance Standards (MEPS) in Mexico correspond to the Normas Oficiales Mexicanas (NOM), which are mandatory, and the Normas Mexicanas (NMX), which are voluntary. The National Programme for the Sustainable Use of Energy (Programa Nacional de Aprovechamiento Sustentable de la Energía, PRONASE), promulgated in 2009, sets as the 2012 target the inclusion of all current NOMs into local building codes as well as promotion of the use of thermal insulation in housing as a standard in relevant climatic areas. Under the Programme, the Mexican Energy Efficiency Agency CONUEE is to promote the inclusion of the building related MEPS into the building codes; and is also to implement the utilization of thermal insulation as a standard in relevant climatic areas.

The current mandatory norms related to energy efficiency on housing are:

- Thermal Insulation Standard, NOM-018-ENER-1997
- Residential Building Envelope Standard, NOM-020-ENER-2011
- Phase-out of inefficient (incandescent) lamps, NOM-028-ENER-2010
- Energy efficiency standards for household appliances (some 20 standards).

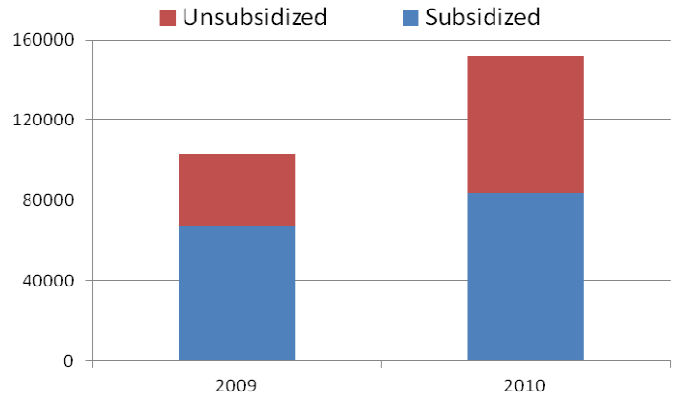
Despite these initiatives, there is a low rate of adoption of MEPS into the building codes on state and municipal level. Even when the MEPS are included, monitoring and enforcement of the efficiency standards is insufficient. Therefore, there is a need to broaden the coverage of energy efficiency in the building code and increase oversight and application.

2.5 Mexican initiatives for sustainable energy in the housing sector

In addition to proposing building codes, CONAVI has developed policies and programmes to develop market conditions to support the weaker sections of Mexican society. Its programme 'Ésta es tu casa'[5] provides financing to lower-income families wishing to improve their homes by means of a subsidy financed by the Federal Government. Under 'Ésta es tu casa' subsidies are given by CONAVI to housing developers to lower the mortgage debt incurred by home buyers. Developers are required to achieve a set of minimum energy efficiency criteria for greenfield development targeting low-income groups. The volume of subsidies allocated in 2011 is expected to reach 376 million USD, with 677 million USD planned for 2012.

INFONAVIT offers 'green mortgages' that provide an additional credit line to the approved entitlement of mortgages for INFONAVIT members wishing to buy new houses which incorporate sustainable and energy-efficient technologies, such as solar water heaters, CFLs, water-saving taps and thermal insulation, among others.[6]

Figure 5 Number of green mortgages offered by INFONAVIT, 2009-2010



Source: CONAVI 2011

[5]http://www.conavi.gob.mx/programas-estrategicos/tu-casa
[6]http://portal.infonavit.org.mx/wps/portal/OFERENTES%20DE%20VIVIENDA/Cual%20es%20tu%20actividad/Desarrollar%20vivienda/hipoteca%20verde

CONAVI, in conjunction with 13 other organizations, (the Secretariat of Energy, the Secretariat of Environment and Natural Resources, SHF, state-owned development bank BANOBRAS, etc.), has also instituted the Integrated Sustainable Urban Development initiative (Desarrollo Urbano Integral Sustentable, DUIS),[7],a certification programme whereby certified developments are eligible for government financing to support infrastructure and housing construction, equipment and land acquisition, bond structuring, promotion of private investment, and technical assistance. The overriding goal of this programme is to promote the coordinated participation of federal, state and local governments to develop holistically sustainable developments infrastructure, transportation, public spaces, utilities and the energy footprint of homes.

2.6 International cooperation with the Mexican housing sector

In addition to the initiatives developed at the national level, there has been increasing international support for emissions reduction activities in the Mexican housing sector. The World Bank and the Inter-American Development Bank (IDB) have agreed to support various priorities in Mexico that address climate change. To date, initiatives supported focused on strengthening the national authorities' efforts to reduce Mexico's carbon footprint, and promoting the installation of energy-efficient lighting and home appliances.

The World Bank is supporting the increased deployment of renewable energy (such as wind energy) and promoting the installation of energy-efficient lighting, home appliances and other electric equipment through USD 250m financing from the Clean Technology Fund (CTF). It also supports regulatory reforms under the Special Climate Change Programme (PECC)of the Mexican government though a USD 401m Low Carbon Performance-Driven Loan (PDL).

Both the World Bank and IDB are highly active in the housing and renewable energy sectors in Mexico. The World Bank has already contributed 1 bn USD to SHF, which capitalizes other housing lenders, and is currently considering an additional 1 bn USD to that organization. However, the World Bank is not yet involved directly in financing green housing. IDB has also given USD 2.5 bn to SHF and intends to use a USD 50m CTF loan together with USD 50m direct IDB loan to engage in a parallel financing with the German Development Bank KfW in favour of SHF, although it is not focused solely on renewable energy. Moreover, the IDB intends to grant a loan of USD 50 m from CTF funds to SHF in order to give house developing firms and construction companies an incentive to design and produce energy-efficient houses.

In addition to the multilateral development organizations, the German bilateral development cooperation has been working together with the Mexican Government in the housing sector for several years. GIZ is has been providing technical assistance to CONAVI, INFONAVIT and the National Commission for Efficient Energy Use (Comisión Nacional para el Uso Eficiente de la Energía, CONUEE) on sustainable energy in buildings since 2009. This work is conducted under the sustainable energy programme financed by the German Federal Ministry for Economic Cooperation and Development (BMZ). The focus of the programme is on developing an energy and water performance-based classification system for INFONAVIT financed houses, improving the Green Mortgage programme, and including sustainable energy aspects in building codes at the state and municipal levels though capacity building. The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has made funding available through INFONAVIT for sustainable housing in Mexico. Modelled on the successful German Market Incentive programme, subsidies are awarded to cover a part of the investment cost for up

[7] http://www.shf.gob.mx/programas/DUIS/Paginas/default.aspx

to 25,000 solar water heaters installed between 2009 and 2012. These incentives are offered through the Green Mortgage programme and demonstrate the opportunities to scale up the penetration of energy-efficient technology through existing initiatives.[8]

The KfW (German Financial Cooperation), in parallel with the World Bank, extended a EUR 50m loan to the Mexican Development Bank Nacional Financiera (NAFIN) in late 2010, to finance energy efficiency measures in private homes and in and in the service sector, especially for replacement of home appliances and electrical manufacturing equipment. There is a new programme in preparation in cooperation with the IDB (see above). The new KfW loan is expected to amount up to EUR 80m.

Furthermore, the international community is getting involved in the Mexican housing sector through the Programme of Activities (PoA) mechanism, which promotes small-scale activities to provide subsidies and/or increased loans for the purchase of homes that use energy-efficient and/or renewable energy technologies to reduce GHG emissions and generate carbon credits.

The Mexican sustainable housing PoAs aim at promoting low emissions development by reducing GHG emissions through the implementation of technologies and design measures to improve the energy performance and reduce electricity and/or gas use in new residences, including: compact fluorescent lighting, efficient heating, ventilation and air conditioning systems, solar water heaters, distributed photo-voltaic generation, and improved insulation. The PoA is divided into two stages: the Programme of Activities I (PoA I), for housing constructed under CONAVI's Green Subsidies programme 'Ésta es tu casa', and the Programme of Activities II (PoA II), aimed at implementing the design in order to increase opportunities for adding more carbon credits to the initiative, such as the Green Mortgage.

[8] For more details see www.infonavit.org.mx.

3 Barriers to a low carbon housing sector in Mexico

Various barriers impede the large-scale development of energy-efficient housing in Mexico. The most notable of them are lack of knowledge and practical experience with energy efficiency in construction, subsidized energy prices, high costs of the necessary building materials and technical equipment, and a weak regulatory environment. Below these issues are discussed in more detail.

Lack of knowledge and awareness: Home-owners, developers, planners and local administration lack information about energy-efficient buildings, how to assess them, and how to implement them. Also building professions in Mexico know relatively little about energy efficiency of buildings. Further, there are few accessible and convincing demonstration projects, as more houses which publicly demonstrate the comfort and feasibility of highly energy-efficient design and technologies are needed to disseminate the concept. Today's home-buyers and builders have no models to emulate to push for energy-efficient construction. There are very few demonstration projects in Mexico to provide proof of concept to the sceptical planner and builder.

Lack of Incentives: Highly subsidized energy prices, especially for the lower-income groups, provide disincentives to home-owners to look for more energy-efficient solutions. Electricity tariffs for individual consumer groups in Mexico are developed politically, or socially embedded. Generally they are not cost-reflective, and the overall average tariffs are not cost-covering, even though average tariffs have increased continuously over the last 10 years. This leads to distorted price signals for home-owners and tenants with regard to electricity and LPG consumption, and thus to inefficient allocation of scarce resources from an economic and environmental point of view.

Technical barriers: The lack of regulation and supervision in the sector has an impact on the quality of products. There is a need for better energy-efficient equipment and construction materials. Economies of scale in the production of energy-efficient building materials and equipment currently do not exist in Mexico. Therefore, prices for energy-efficient materials and equipment are high, since they have to be either imported or are produced in limited quantities only. Supply of services is also insufficient, as there is a lack of qualified personnel to install and maintain energy-efficient equipment, as well as lack of architects familiar with low-energy designs.

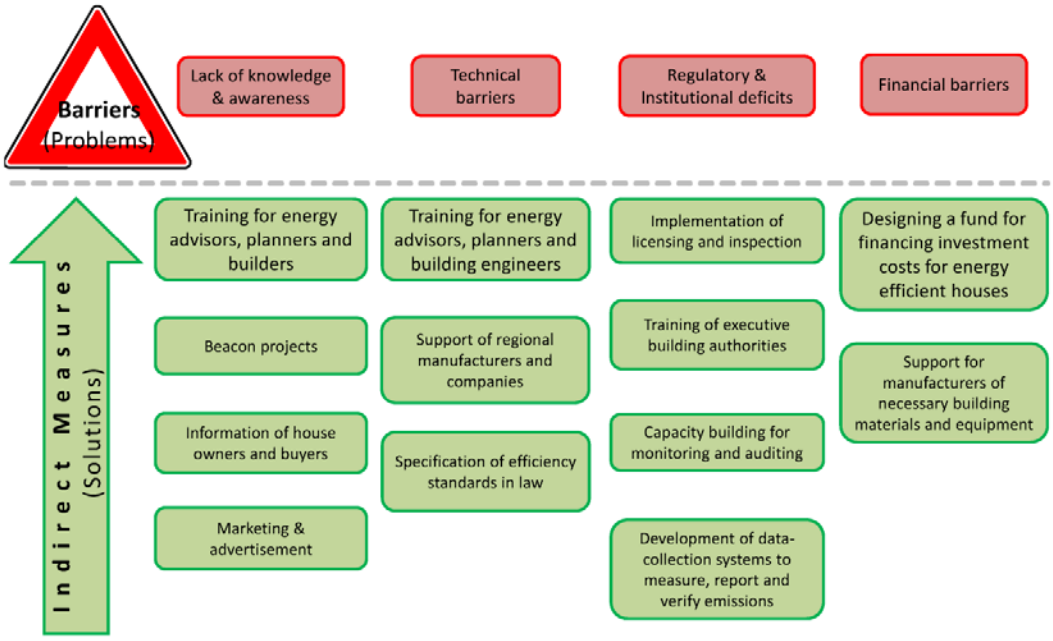
Regulatory and institutional issues: There are no comprehensive and formal regulations for energy efficiency in housing. CEV, the voluntary comprehensive building code developed by CONAVI, is only a model code at present, since CONAVI as a federal agency cannot enforce its adoption and implementation. Existing norms, such as MEPS, the minimum energy performance standards, do not cover all aspects of construction and building equipment and are not yet fully included in the relevant building codes. Furthermore, despite the existence of some norms, the implementation of energy efficiency standards in housing remains weak. Many houses in Mexico have been built informally without permits or reference to statutory standards. The houses built by developers – to which this NAMA is to be applied – are built on the basis of permits. In this formal sector there is, however, no full monitoring of construction results beyond the data base of the RUV, which provides for a register of houses. Such registration does not include a monitoring and inspection of housing and the standards applied. Moreover there are no formal certification schemes for craftsmen or builders; certification schemes for materials or equipment are also lacking. Regarding energy efficiency of buildings and equipment, there is neither regulation of production quality nor standardization of products in the market.

Financial barriers: The economic benefits of energy efficiency for home-owners accrue over the medium to long term. Builders and buyers, however, focus on up-front acquisition costs and not on life-cycle economics, particularly if they do not intend to occupy the property beyond the payback period of energy-efficient equipment. Thus, even

though life-cycle economics of energy efficiency are clearly given, the long-term savings in energy costs are not convincing. Developers serve existing demand, and have no interest in building energy-efficient houses if these are not requested for and paid for by buyers. The main financial constraints on the implementation of energy efficiency in housing are the short-term perspectives of buyers and builders.

Figure 6 illustrates the barriers as a rationale for the chosen indirect and supportive measures, described in Chapter 4.

Figure 6. Barriers to low carbon housing in Mexico and measures proposed to overcome them



Source: IzN Friedrichsdorf

4 The NAMA: Potential, objective and actions

4.1 The Mexican NAMA for Sustainable Housing

At the centre of the proposed NAMA is the enhancement of the financial system that promotes the construction of new residential buildings with high energy performance in the national mortgage market. The financial incentives will be coupled with a country-wide system of minimum primary energy target values for the energy demand of the entire house ('whole house approach') for a set of classified domestic building types. The NAMA targets typical low-income residential dwelling units and introduces different target values for minimum primary energy demand as regards three building types: Eco Casa 1, Eco Casa 2 and Passive House Standard (best energy performance).

The goal of the Mexican Sustainable Housing NAMA is to promote cost effective energy-efficient building concepts across the residential housing sector, with a particular focus on low-income housing where most the growth is expected. Since buildings have an extremely long life-cycle, the increased penetration of energy efficiency buildings achieved by this programme will have a significant impact on Mexico's cumulative GHG emissions, and can represent an attractive solution for achieving sustainability goals.

The NAMA has been designed as a framework consisting of components implemented and financed by the Mexican government to constitute Mexico's contribution to the NAMA and supported components for which donor funding is needed (e.g. for the incremental costs of achieving the ambitious performance standards, technical assistance and capacity building), qualifying it as a Supported NAMA.

The Sustainable Housing NAMA is aimed at enhancing GHG emissions reductions through expanding the 'Green Mortgage' and 'Ésta es tu casa' programmes. It differs from the CDM PoAs in adopting a whole-house approach, described below, whereas the PoAs focus on specific technologies. In the medium to long term, it is envisioned that there will be further decreasing emissions from new urban development, to be introduced through an Urban NAMA.

The following steps define the incremental enhancement through the NAMA described in this report:

- increased penetration (more houses covered during the same time) and/or
- technology choice and up-scaling (more ambitious efficiency standards and/or inclusion of technologies currently not covered).

4.2 Whole House Approach

Existing initiatives discussed in Chapter 2 above have focused on the implementation of a specific technology or intervention. The Sustainable Housing NAMA introduces the 'whole house approach', which envisages setting and monitoring values for total primary energy demand from a building, instead of focusing on the performance of individual energy-efficient technologies or solutions.

The promotion of target values for primary energy demand instead of specific technologies has the following advantages:

- target values represent an incentive to reduce total energy consumption, since they take into account the interaction between different measures
- the house-builder is free to choose his technical measures as long as he can prove that he is achieving the target value for the whole house

- target values promote further technical development and adapted cost effective solutions
- target values can be tightened up, step by step, in line with environmental policies and technical development
- target values allow the establishment of different support levels in parallel.

The introduction of the whole house approach based on target values for the primary energy demand of a building will also greatly simplify the MRV requirements, reducing overall programme costs, and allow flexibility for building developers and home-owners seeking to achieve efficiency targets.

4.3 Objective of the NAMA

The aim of NAMA is to supplement on-going initiatives for energy-efficient housing as laid out in the PECC and as currently operated by INFONAVIT. The two objectives of the NAMA are:

(1) **extend penetration of basic efficiency standards** to the entire new housing market in Mexico

(2) **upgrade efficiency standards** to more ambitious levels.

The design of the NAMA is to take into account Mexican development priorities while also being attractive for Annex 1 countries to support. In this regard the NAMA needs to target the mortgage market and provide financial incentives for the construction of residential homes with an energy performance above present Mexican programme standards.

The priority of the Mexican government is currently the penetration, or expansion of basic energy efficiency improvements into further market segments, beyond the INFONAVIT market with part of the NAMA: e.g. the FOVISSSTE market and the SHF-refinanced segment. The next stage of the NAMA is up-scaling, or stepwise tightening of efficiency standards in all market segments and the realization of passive house pilot projects.

The houses to be constructed under the NAMA will pave the way for the dissemination of new technologies and approaches in the building sector. In the long term, this will have positive spill-over effects on the Mexican building sector as a whole.

4.4 Scope of the NAMA

The NAMA will target the Mexican mortgage market which finances annually some 800,000 new residential homes per year, of which around 50% are financed by INFONAVIT.

The NAMA will operate in parallel with the Green Mortgage programme and will be open for participation from INFONAVIT, FOVISSSTE, SHF and other financial institutions. Initially, the NAMA will target only new and formal homes. The NAMA in a second stage could be extended to the entire mortgage market covering new and existing as well as formal and informal housing (self-construction).

NAMA measures will concern only the building and its technologies, not urban planning issues or aspects in the direct environment of a house (e.g. local street lighting). However, it is envisioned that this approach to efficient housing could, in the future, be nested into a more holistic approach to urban sustainability.

For sustainable urban development, the NAMA design will incentivize the development of 'vertical' units: multi-storey buildings. However, responding to Mexican housing traditions and local tastes, the NAMA will start with a

high share of row and single houses (around 90%) and move gradually to a 50/50 distribution between one-storey houses and multi-storey buildings.

The NAMA provides financial incentives to two distinct customer groups (i) house-buyers/owners and (ii) construction companies. The financial incentive framework under the NAMA will ensure that:

- the better the level of energy efficiency achieved, the more favourable the financial support conditions;
- house-buyers/owners will receive a subsidy to the loan granted by a financial institution (e.g. reduced interest or lower reimbursement instalments, or redemption grant), if they purchases a house built in accordance with whole-house energy efficiency standards under the NAMA in order to cover a part of the additional investment costs;
- construction companies (developers) receive a subsidized 'bridge loan' provided they commit themselves to build a house according to one of the whole-house energy efficiency standards under the NAMA; this must be proven when the house is finished.

The possible technical measures for reaching the energy benchmarks under the NAMA are described in the next chapter. Table 4 illustrates the design of the NAMA.

Table 4. NAMA design elements (1)

Item	Description
Sector	Building sector
Sub-sector	New residential houses (1st phase), primarily for low-income families
NAMA boundary	Entire country
Measures and activities with direct impact on GHG emission reduction	Introduction of a class of ambitious primary energy consumption benchmarks. The construction of houses according to the benchmark level is incentivized by a scaled up financial promotion system
Measures and activities with indirect impact on GHG emission reduction	Supportive actions for NAMA implementation, operation and support of the wider transformational process in the residential building sector: introduction of energy performance requirements in the legal system and permitting process, training of planners, architects, energy advisors and manufactures, creation of model projects
NAMA type	NAMA framework consisting of unilateral and supported components
Type of support required under the NAMA	Financial, technical and capacity building

Source: Point Carbon Thomson Reuters and Perspectives

4.4.1 Energy efficiency standards for houses under the NAMA

The three 'standards' for maximum energy demand – Eco Casa 1, Eco Casa 2 and Passive House – have been developed in cooperation with the German Passive House Institute (PHI). Three unit types, of approximately 40m² and 70m² in area each, typical of the Mexican market have been analysed:

- **'Aislada',** a single unit detached house,
- **'Adosada',** a row housing unit,
- **'Vertical' units**, multi-storey housing units consisting of six floors with an average of two apartments each.

To develop three different energy efficiency standards for houses under the NAMA, as a first step, preliminary design of the buildings was examined and an energy balance of the three building types in the **four different climate zones** in Mexico was set up. (See figure 5 below.) Energy demand of the baseline buildings was then calculated with the help of the Passive House Planning Package (PHPP).[9] Finally, the possibilities of optimizing buildings in energy efficiency without fundamentally changing the building design were analysed.

On the basis of this analysis, three different energy efficiency standards for houses under the NAMA were defined, two intermediate cases and the ultra-low energy Passive House:

- The first intermediate housing concept, **Eco Casa 1**, incorporates all the measures of the current Green Mortgage scheme: Approx. 2,5cm insulation in the roof and on one of the walls of the building, reflective paint, use of tankless gas boiler, solar water heating and efficient A/C, as needed. In addition, various efficient appliances were considered, such as efficient lighting and cooking facilities.
- The second intermediate case, **Eco Casa 2**, represents a further optimization towards the Passive House Standard through insulation, better windows and highly efficient appliances.
- Finally, the **Passive House** envisages optimization of all measures achieving the Passive House certification criteria.[10]

Given that the current priority of the Mexican government is the penetration of basic energy efficiency improvements into further market segments, the following roll-out schedule is proposed for the energy efficiency standards under the NAMA (see Table 5):

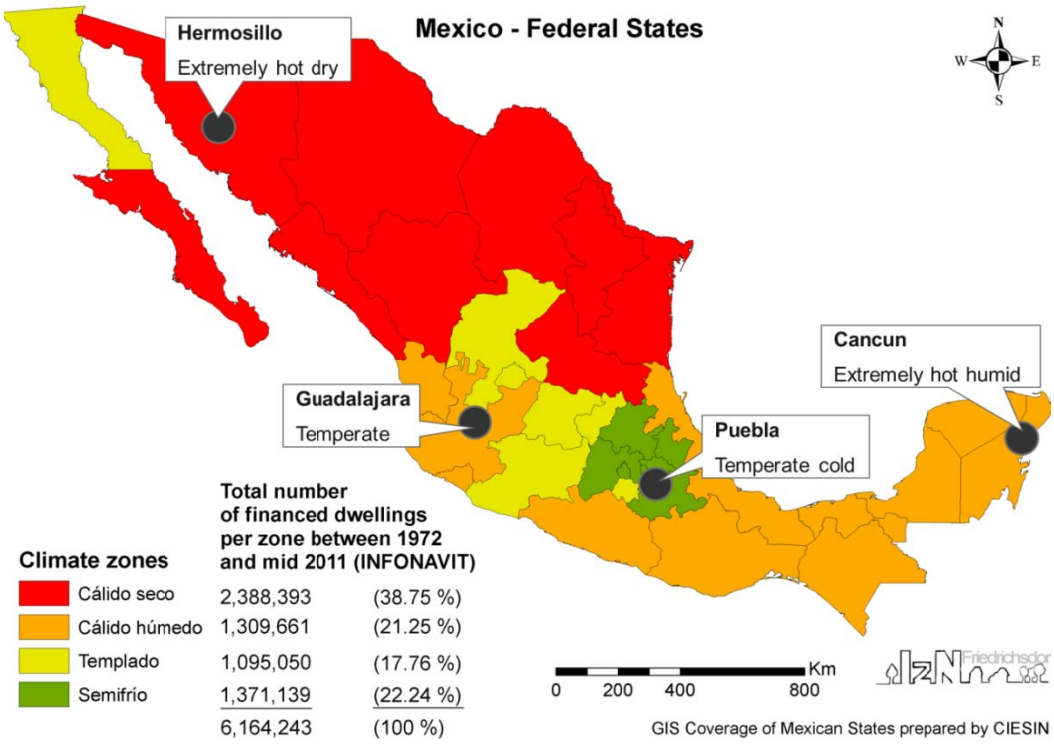
Table 5. NAMA design elements (2)

Item	Description
NAMA roll-out schedules	- 2012 and 2013: focus nearly exclusively on Eco Casa 1. - 2014-2016: Eco Casa 2 grows quickly. - Passive Houses are considered in limited numbers as pilot projects.

Source: Point Carbon Thomson Reuters and Perspectives

[9] The Passive House Planning Package (PHPP) is a software developed by the Passive House Institute to support the design of energy efficiency housing. More information about the tool is available at: http://www.passiv.de/.
[10] For more information, see the website of the Passive House Institute: http://www.passiv.de/07_eng/index_e.html

Figure 7. Mexico's climate zones and the location of the four buildings used for the NAMA calculations



Source: IzN Friedrichsdorf

An optimized urban design as well as building design adapted to the climatic conditions would be highly recommended before implementation of the NAMA. However, in order to compare building types, business as usual was assumed and energy measures (insulation, air-tightness, improved u-values of windows and doors, ventilation system or similar) were applied. No changes to the orientation or size of the windows were assumed and no additional shading via roof overhangs or canopies was analysed. This resulted in the need to assume high levels of insulation in order to compensate for the current building designs. Should these optimization potentials be realized, it will result in a better building design and cost-reduction. The most compact building type is vertical and therefore it is used as an example to present the PHPP results.

4.4.2 Mitigation options under the NAMA energy efficiency standards

The following section provides a brief overview of the results of the energy balances considering the measures to be undertaken for the buildings analysed (Vertical, Aislada and Adosada) in four locations (Hermosillo, Guadalajara, Puebla and Cancun).[11] Specific energy demand was tracked across four uses: space heating, space cooling,

[11] As a boundary condition, a temperature range of 20°C to 25°C was chosen. This temperature is based on the ISO7730 norm and establishes the ideal range for human comfort. All calculations are based on this temperature range except for the calculation of CO_2 emissions of the baseline case, which was changed to 18°C to 28C with the aim of achieving a more accurate estimate of current CO_2 emissions. In addition, although the building types all are usually built for four inhabitants, occupancy

dehumidification, and all other demand – which includes water heating, cooking, and electricity demand from appliances. The results are illustrated and exemplified by the vertical building type, but similar results, with more demanding values, were achieved for the other house types, Aislada and Adosada. Interested donors will have access to these data.

Demand for heating, cooling, and dehumidification vary significantly between climate zones. Specific primary energy demand is generally much higher in hot climates than in the temperate regions. Because of these regional differences, the types of mitigation options employed are specific to each of the climates encountered in Mexico. As shown in Table 6 below, this can mean using entirely different types of technologies, or that interventions such as insulation and glazed low-e windows are scaled to the demands of the region.

Table 6. Mitigation options by climate type for vertical building type

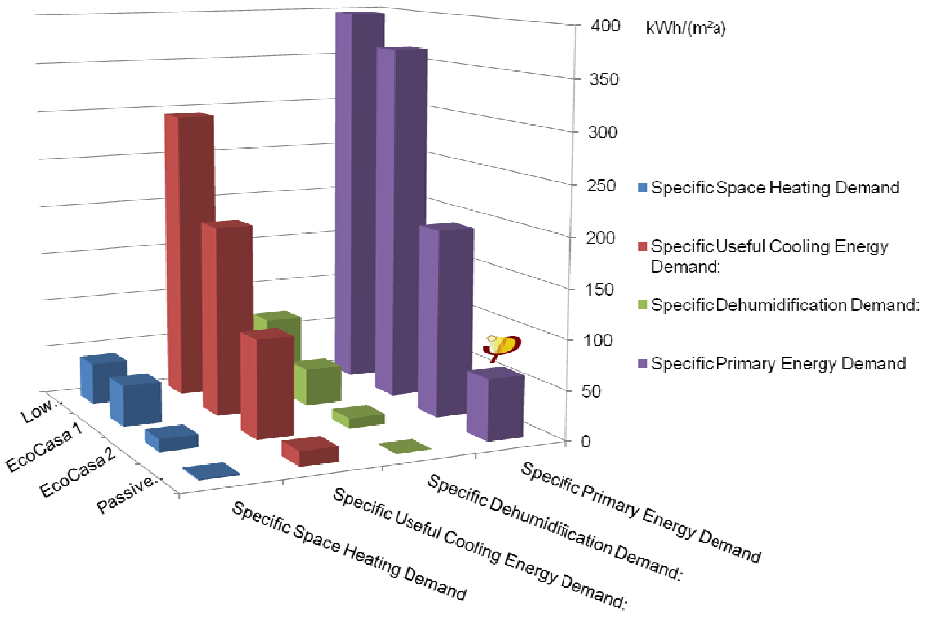
	Hermosillo (extremely hot and dry)	Cancun (extremely hot and humid)	Guadalajara (temperate)	Puebla (temperate cold)
Exterior Walls	10cm (Vertical)- 30cm (Aislada) insulation, Reflective paint	7.5cm insulation Reflective paint	5cm insulation	5cm insulation
Roof	30cm insulation Reflective paint	10cm insulation Reflective paint	18cm insulation-	25cm insulation
Windows	Triple glazing with sun protection	Triple glazing with sun protection	Double glazing	Double glazing
Floor	10cm insulation	10cm insulation	-	12.5cm insulation
Heating, ventilation, air conditioning	Energy recovery ventilation, Recirculation cooling	Energy recovery ventilation, Humidity control, Recirculation cooling	Pure extract air system Natural ventilation	Pure extract air system
Other	10cm (Vertical)-30cm (Aislada) insulation, Reflective paint	7.5cm insulation Reflective Paint	5cm insulation	5cm insulation
Efficient Appliances	CFL lamps, Solar water heater Tankless gas boiler Ceiling Fan	CFL lamps Solar water heater Tankless gas boiler Ceiling Fan	CFL lamps Solar water heater Tankless gas boiler Ceiling Fan	CFL lamps Solar water heater Tankless gas boiler
Baseline Emissions	88kg/(m²a)	125kg/(m²a)	47kg/(m²a)	54 kg/(m²a)
Min. achievable emission level	14kg/(m²a)	19kg/(m²a)	11 kg/(m²a)	11 kg/(m²a)

Source: Passive House Institute

The result of implementing these mitigation actions is illustrated in Figure 8, which shows energy savings for vertical housing units in a hot and dry climate.

was set to two persons per building to reflect long-term reality, as it is assumed that this will be the average occupancy over 30 years (period under observation).

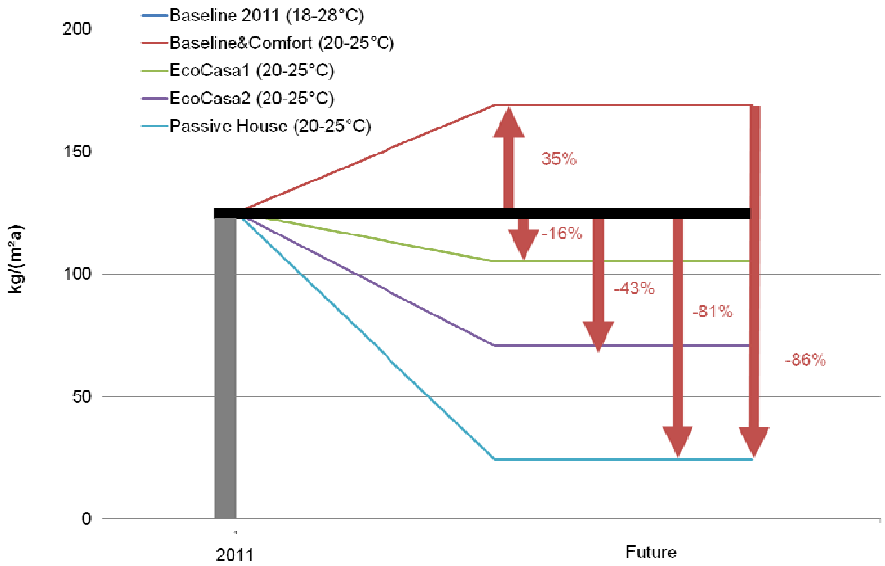
Figure 8. Specific energy demands in Hermosillo (hot & dry, vertical 40 m²)



Source: Passive House Institute

Demand for specific energy uses changes drastically across the climate regions, as one would expect. In general, energy demand is much higher (more than 2x) in hot regions than in the temperate and cool climate zones. Therefore, there is a higher potential to reduce energy demand and associated emissions reductions in the hot regions than in the more temperate areas, where energy efficiency is more easily achieved. Figure 9 below presents various energy efficiency scenarios under the standards elaborated for the NAMA on the example of Cancun in relation to two possible baseline cases: with reduced comfort (18-28°C) and with a good comfort level (20-25°C).

Figure 9. CO_2 levels under various energy efficiency scenarios in Cancun (extremely hot & humid, vertical, 40m²)

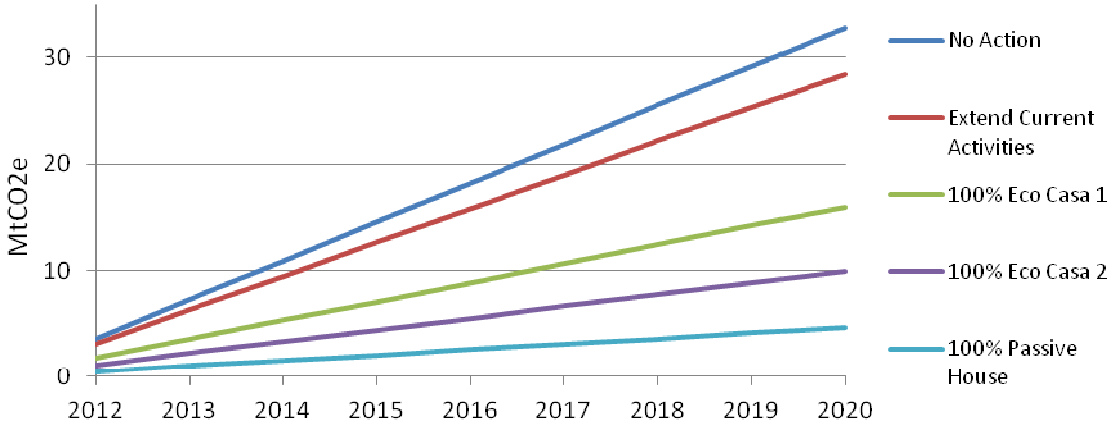


Source: Passive House Institute

4.5 Mitigation potential

The calculation of the mitigation potential will follow three NAMA scenarios representing a 100% penetration of the efficiency standards Eco Casa 1, Eco Casa 2, and the Passive House across all climate zones and building types. To provide a frame of reference, two baseline scenarios were calculated, one which represents an extension of current Mexican efforts with no scale-up of activities,[12] and a 'No Action' scenario in which it is assumed that existing programmes cannot be sustained.

Figure 9. Emissions from newly built houses in Mexico and select mitigation scenarios



Source: Point Carbon Thomson Reuters

In practice, the actual emissions reductions achievable by the NAMA will be highly dependent on the level of financing that can be attracted. Instead of forecasting our expectations for the programme, this section provides general scenarios that illustrate the overall potential of the NAMA to affect the long-term emissions profile of the Mexican housing sector.

Emission reductions are shown for the implementation period assuming 800,000 houses are built each year and that they will remain at the same level of efficiency over the lifetime of the houses. Houses are assumed to be 40m^2 and to have 4.2 occupants.

The CO_2 emissions of the baseline and the NAMA have been calculated based on information about the mix of fuel and power consumption in typical houses, provided by CONAVI. For the grid emission factor a value of 0.52 t CO_2/MWh has been applied. Combined with 10% distribution losses in the Mexican grid, this yields an effective grid emission factor 0.57t CO_2/MWh.

The resulting analysis shows that cumulatively, assuming 100% penetration of a particular pathway represented in Figure 9 above, the NAMA can achieve emission reductions ranging from 84 MtCO2 (Eco Casa 1) to 140 MtCO2 (Passive House) by the year 2020.

[12] Estimated as continuation of Green Mortgage programme with the current level of penetration.

4.6 Supportive and administrative actions

The application of a promotional system via the NAMA will have positive effects on the whole system of energy efficiency in the building sector in Mexico:

- It will demonstrate that it is possible to introduce primary energy demand target values into the Mexican building sector, encouraging the further development of building regulations. Furthermore, as the licensing and planning procedures for new buildings increasingly incorporate energy efficiency concerns, it may become feasible to include statutory requirements as to energy efficiency of new buildings in the permitting process.
- It will create a demand for energy advisors, energy auditors and qualified architects able to apply specific calculation and design tools. Thus it will lead to additional employment and strengthened capacities while building on existing platforms and personnel such as RUV and housing verifiers (verificadores).
- It will also create demand for more energy-efficient buildings and building equipment and more appropriate construction materials. Energy-efficient equipment and construction material which have to be imported today could then be produced in Mexico and be offered at more attractive prices on the local market, thus making energy-efficient houses more competitive.
- Passive house pilot projects will demonstrate the feasibility of very advanced energy efficiency standards for residential buildings for low-income families.

In order to overcome the barriers outlined in chapter 3, these developments will need to be supported by information campaigns, training and advisory services during the implementation of the NAMA. Table 7 shows the supportive and administrative actions that will be required during the first implementation phase (2012–2016):

Table 7. Supportive and administrative actions

No.	Action
1.	Institutional set-up and NAMA administration
1.1	Designing fund for financial resources, incl. legal agreements
1.2	Designing, establishment and operation of "NAMA Programme Office Unit"
1.3	Baseline, MRV and additionality framework
1.3.1	Development of data-collection systems to accurately measure, report and verify emissions: Set up and operation of a comprehensive data base (baseline and MRV) of houses and energy consumption and demand
1.3.2	Capacity building and capacity build-up for monitoring and auditing Establishment of a professional and specialized inspection and supervision system
1.3.3	Comprehensive household monitoring and auditing surveys (i.e. simulation using data base and detailed surveys)
1.4	Technical Assistance to FOVISSSTE and SHF in the establishment of their institutional set-up for the implementation of the NAMA
2.	Building Codes and permitting procedures
2.1	Technical Assistance to local governments and organizations at state and municipal level for introduction of a minimum energy performance standard, the whole building approach and target values for primary energy consumption as well as sustainability criteria. Elaboration of a national guideline for Building Code adaptation.

3.	**Capacity building**
3.1	**Training for energy advisors, planners and construction workers** on energy efficiency building mainly through the PHPP tool
3.1.1	Scaling up of university/commercial school curricula on EE buildings and RE in buildings with focus on supporting for the NAMA implementation and operation
3.1.2	Translation and adaptation of European/PHI training material to Mexican climate and building traditions; check after experience
3.1.3	Training through a 'Train the trainer approach' with local partners. The local partners consecutively, provide training and design of energy-efficient buildings (eco-casa, PHPP) for developers and planners throughout Mexico and special training for construction workers
3.2.	**Training to local authorities and stakeholders**
3.2.1	CONAVI will also perform capacity building for local, state and federal authorities by attendance courses, virtual learning and the construction of an inter-institutional platform. Objective: local authorities and stakeholders are able to introduce and implement sustainability criteria in their daily processes and decisions involved in housing master plans and house construction level
3.3	**Training to house-owners/users**
3.3.1	Production of a manual for house-owners/users in order to understand and optimize the use of energy-efficient houses
3.3.2	Campaigns to increase awareness of energy efficiency not only for buildings but also with appliances
3.4	**Encouragement and support of regional manufacturers and companies** to increase the availability of suitable products
3.4.1	Guideline and support for manufacturers through local partner and international advisory
3.4.2	Adaptation of certification criteria for local Mexican products
4.	**Beacon Projects and software adaptation**
4.1	Quality assurance of all Passive House design constructions and constructions; and adaptation/implementation of PHPP calculation and design tool
4.2	Technical assistance in design and construction of Beacon Projects in different locations in Mexico
4.3	Monitoring of Beacon Projects and transfer of results and lessons learned into capacity building, demonstration projects and dissemination
5.	**Marketing and advertising**
5.1	Website (development & maintenance)
5.2	Mass media campaign (TV, radio, newspaper)
5.3	Promotion for participation (brochures and marketing material)
5.4	Demonstration and dissemination: make success visible

Source: IzN Friedrichsdorf

4.6.1 Institutional set-up and NAMA administration

The goal is to establish an inter-institutional platform that can articulate the requirements for sustainable housing. This can be achieved by establishing a coordinating agent, or an even wider body, with the establishment of an inter-sector commission where government, private industry and social organizations collaborate to implement the different programmes for sustainable housing. To address this issue, NAMA support measures envisage the establishment and operation of a 'NAMA Programme Office Unit'. Technical Assistance will be also provided to FOVISSSTE and SHF for establishing their institutional set-up for NAMA implementation. Administrative issues to be dealt with will include developing the legal arrangements for the NAMA Fund, the set-up and operation of the MRV system, including development of data-collection systems, relevant data bases, and capacity building for monitoring and verification.

4.6.2 Development of mandatory building codes and licensing procedures

As discussed in Chapter 2, the building codes applied in the Mexican housing sector do not cover the full spectrum of potential energy efficiency measures. Moreover, weak enforcement of building codes contributes to low levels of energy efficiency in standard newly built houses. The NAMA will help to introduce a **countrywide licensing procedure** for new buildings and developments focusing on energy efficiency aspects. As the local governments have the authority regarding enforcement of the building codes, technical assistance will be provided to local governments and organizations at the state and municipal levels for introduction of a minimum energy performance standard. They will be also introduced to the 'whole building' approach and target values for primary energy demand as well as sustainability criteria. In addition, as part of the supportive actions, national guidelines for adaptation of the Building Code will be developed.

4.6.3 Capacity building

One of the key prerequisites to achieving the objectives of the NAMA is the transfer of knowledge and experience related to energy efficiency in buildings. This is particularly important for the whole-building approach as it will require energy advisors and auditors that can design, monitor, verify and certify the target values for primary energy demand. This can be achieved on several levels: through specific training, broader educational experiences, and capacity building and outreach.

To increase the knowledge about energy efficiency of buildings among building professionals, capacity building and information campaigns will be necessary, aimed at architects, engineers, developers and constructors. Included should be an introduction of the Passive House Planning Package (PHPP Trainings) for auditors and other relevant actors involved in the certification of energy-efficient houses. Such trainings should also address certification of houses according to certain standards. The PHPP will be made available to relevant stakeholders.

In order to promote the 'whole building' approach in buildings and environmental friendly development, there is also a need for capacity building at municipal and state level regarding the Public Sustainable Housing Policy. Therefore, CONAVI has developed a National 'Capacity Building Strategy for Sustainable Housing and its Surroundings' (CONAVI, 2011) targeting local authorities as well as social and institutional agents with competence in these issues. Implementation foresees involvement of the Regional Housing Agencies (Organismos Regionales de Vivienda, OREVIs) and agents of the construction housing sector. In the medium term, local academia as well as training institutions should also be attracted as multipliers.

Consideration should also be given in the context of the NAMA to the supply-chain in the building sector. These stakeholders need reliable information, individual support (consultancy), and clear criteria in order to develop solutions and orient their business activities towards sustainable investments.

Additionally, building up local production and installation of energy-efficient building materials and equipment can be supported by information and training of interested enterprises, construction technicians (non-academic background), plumbers, masons, electricians, building service installers, among others.

4.6.4 Beacon Projects: demonstrating the Passive House Concept

In order to make quality and energy efficiency visible, several prototypes (beacon projects) should be designed and built in different locations of Mexico, in all relevant climate zones. Besides meeting the MRV requirements, these

beacon projects will provide an excellent training opportunity for project developers. Moreover, these houses will offer opportunities:

- To gather information not only on the results but also on the reasons for the performance achieved and generate learning opportunities (when necessary);
- To demonstrate successful building projects as a paradigm for designers, builders, engineers and clients - creating demand on the energy efficiency market and showing the quality to be achieved;
- To generate information on the performance, the indoor conditions, the user needs, the needs of the workforce on-site, and experiences with new constructions - under the conditions of an adequate preparation and quality assurance, thus giving inputs for developments on the energy efficiency market as well as training as a prerequisite for successful performance in the general implementation;
- To gather data for the comparison of results with the goals and the results expected;
- To demonstrate to the public, to investors, to financing institutions, sponsors and to international organizations a successful way for allocation of investments and funds.

Since the measured prototypes are unique but cost-intensive,, there are good chances for assessment of overall results, learning and future amendments as well as for making success visible. Demonstration projects should be selected carefully and with a view to the possibility to generate valuable information on users, boundary conditions, and reliable measurement of the energy and comfort performances.

An important part of the beacon concept is to demonstrate the potential for energy efficiency achievements. With the data delivered by the local partners, the Passive House Institute will conduct an evaluation of the beacon buildings' performance based on the common monitoring concept.

For the prototypes suggested above, investment costs might be higher due to inexperience of designers and craftsmen, but also because of the limited availability of suitable industrial products. It is essential to choose solutions that will become less costly when produced on a large scale. Successful beacons and the funding schemes will help to create demand, and motivate manufacturers to develop the products needed; this will also create chances for the early adopters in the energy efficiency markets now emerging around the world, especially in warmer climates.

4.6.5 Raising public awareness

An 'internal' marketing strategy in Mexico using several communication channels could be launched to raise general awareness and obtain broader participation. This could be done through mass media campaigns on TV, radio and newspapers as well as the distribution of information brochures and marketing material. In addition, the creation of a website to explain and promote the benefits of the NAMA is suggested. The beacons are an excellent means to promote rapid dissemination: a built example offers better proof than any brochure, publication, or discussion.

5 The MRV system: Monitoring, Reporting and Verification

The primary purpose of an MRV system of any NAMA would be to measure the impact of the measures implemented, with the view to assessing their contribution towards the national and international energy and climate policy objectives. Specific guidelines for the MRV of NAMAs are currently being negotiated at the international level. Although many proposals have been made, it still remains unclear what will be the required level of stringency, data intensiveness, and degree of external verification in the MRV of NAMAs. The proposals discussed range from monitoring alternative non-CO_2 related indicators to international verification of specific GHG reduction estimates. Here it is important to distinguish methods and baselines adopted in *ex post* MRV from the methodology and baselines adopted in projections of GHG emissions and estimates of potential results of programmes.

The general consensus appears to be that the MRV of NAMAs, unless they are credited, should allow for more flexibility and simplicity than the current approaches under the CDM, and that MRV procedures should be practical, rather than a burden or a barrier to the implementation of the NAMA. Specifically, unilateral and supported NAMAs should demonstrate that the proposed actions have been taken and that measurable progress toward GHG reductions has been achieved. Since NAMAs may contain a component of international donor and private financing, it is reasonable to assume that providers of finance will be concerned about measurable results and the quality of reporting. Donors and financiers may hence present their own and stringent preconditions regarding MRV. Furthermore, it may be advisable to take into account that a supported NAMA or components of such a programme might at some point be transferred to a creditable NAMA. The initial choice of MRV approach should take this eventuality into consideration.

The objectives of the MRV system of the Whole House Approach

The technical design of the Sustainable Housing NAMA makes it both possible and practical to conduct an estimate of resulting emission reductions through the use of a limited number of metrics which also lend themselves to *ex post* monitoring as part of an MRV methodology. The objectives of the MRV system of the Whole House Approach should be to determine the appropriate baseline approach, identify the methodology for the estimation of the emission reductions and recommend the approach towards collection of the monitoring data and possible external verification, should this be required.

The MRV system can also be used to track alternative performance indicators that would enhance the understanding of the effects of the NAMA, including specific performance benchmarks, sustainable development indicators, and qualitative indicators. International consensus also indicates that the climate financing received in support of the NAMA should be monitored, from the donor and from the recipient side. In the context of the Mexican residential sector, the MRV system could be used to track the energy subsidies avoided, and this information used to build support within the government. However, these are not the primary objectives of the NAMA MRV system, and hence are not considered in greater detail in this document.

Specific considerations for the NAMA MRV system in Mexico

For Mexico's Whole House NAMA, there are several considerations that influence the selection of the MRV approach:

- The Whole House NAMA is envisaged as a supported action. In the absence of internationally agreed approaches and procedures for supported actions, the NAMA may be bound by the requirements of the donors supporting it, especially if the funding is provided bilaterally though Fast-Track Finance rather than the Green Climate Fund, and also by requirements of multilateral or private finance institutions.
- Once the Green Climate Fund and the UNFCCC NAMA registry are established, specific requirements will probably be developed as to provision of information at the funding stage and accountability for the actions taken and their impact. The MRV approach should be as broad as possible to prepare for the likelihood of introduction of new requirements, within the limits of remaining practicable.
- The possibility of the addition of a credited component to the NAMA or a transformation of the programme should not be discounted. To the extent possible, the MRV approach should identify the implications of upgrading and extension in order to ensure that the systems put in place will not obstruct future extension of NAMA.
- Mexico has pledged an ambitious emission reduction pathway of -30% from business as usual by 2020.The Cancun Agreements envisage monitoring and assessment of the developing countries' GHG emission pathways. Because the NAMA is meant to contribute towards Mexico's national GHG reduction pledge, it is important that the MRV system of the NAMA be coordinated with the national MRV system.
- The MRV system needs to take into account that Mexico has already adopted carbon finance through CDM (e.g. PoAs) in its housing sector. This involves certain internationally recognized MRV methodologies, including the need to develop and observe appropriate metrics and data from the housing sector. Significant synergies can be achieved by coordination between NAMA and carbon finance programmes in terms of methodologies and data.

Baseline estimation

Since the proposed NAMA concerns energy efficiency on a whole-house level, the most natural approach for both baseline setting and monitoring would be to adopt a key performance indicator and measuring achievements towards a benchmark. With building efficiency programmes, a key performance indicator is commonly expressed in GHG emissions or energy consumption per gross floor area of a building and is established based on actual energy consumption data obtained from a sample of buildings.

The baseline chosen can be static, based on historic performance of buildings of similar type outside of NAMA boundary built within reasonably recent period of time, or dynamic, allowing for comparison with similar buildings outside of NAMA boundary overtime. Dynamic baseline is the standard approach required under the CDM for housing-sector energy efficiency and renewable generation projects.

Static baseline. Chapter 4 of this document provides projections of mitigation potential using a baseline benchmark of specific emissions per m^2 of housing unit area based on primary energy consumption in typical houses as provided by CONAVI. As a NAMA is not a CDM project and particularly since a less cumbersome approach to determining additionality is urged in NAMAs, this approach can in principle be adopted as the actual baseline for the NAMA.

Comparing the actual performance metrics to an overly simplified benchmark might not provide a realistic estimation of achieved emission reductions, as energy consumption can vary depending on the climatic conditions in a specific year (such as a very cold winter or an extremely hot summer) and specific characteristics of the occupant's use of the house. A static baseline also would be unsuitable in long-term programmes, as the baseline

would not consider the improvement of energy efficiency of conventional buildings over time or accommodate income elasticity of energy demand. This approach is therefore not recommended for the whole-house NAMA.

Dynamic baseline. A dynamic baseline allows for monitoring performance of a sample of comparable buildings (including same building type, size, and vintage) in corresponding climatic zones that are not covered by NAMA and therefore have not experienced the effects of any of the NAMA measures.

CDM methodologyAMS-III.AE, developed for the PoA in the Mexican housing sector described in Chapter 2, applies the dynamic baseline approach. The baseline for the PoA is set as the average of energy performance of the baseline buildings built in the past five years. It requires the energy consumption and climate condition data to be updated annually, whereas other building characteristics can be updated every third year.

The dynamic baseline approach is highly data-intensive for a supported NAMA in view of the lack of current rules. However, of particular interest to the Whole House NAMA is the fact that the PoA currently being developed focuses on a similar housing stock for low-income demographic. Due to the similarity between the initiatives, the Whole House NAMA can rely on the information and statistical samples collected by the PoA for its baseline estimation.

While additionality determination for the NAMA does not appear to be as critical as for offset projects, the use of benchmarking approach offers the additional benefit of simplifying the additionality assessment. Regardless of the choice of baseline approach, for the purposes of this NAMA, it would be sufficient to assume that as long as the performance of NAMA houses exceeds the benchmark, additionality has been achieved.

Possible approaches to the MRV of the Whole House NAMA

The whole-building approach to building efficiency improvements applied under the NAMA allows for the use of performance-based methodology of monitoring the resulting emission reductions, where the assessment of the relevant metrics is performed at the building level, but not at the equipment level. The monitoring of whole-building emission performance accommodates a complex interaction of measures, and thus avoids the challenging monitoring of the emissions impact of each such interaction.

Given the potentially large number of residential buildings to be built under the NAMA, the first choice of monitoring data collection method would be large-scale data analysis, which looks at the performance of the programme as a whole. Such large-scale data analysis is most commonly used for programmes that involve large-scale building efficiency programmes with many participants. It is used primarily for residential programmes with relatively homogeneous participants and measures when project-specific analyses are not required or practical.

Emission sources for the operation of a building unit include emissions from energy consumption and refrigerant leakage. The former is related to the consumption of electricity, and central building/district energy (e.g. steam, hot water, chilled water). The latter is associated with the use of air conditioners and refrigerators. As part of the larger carbon footprint of the building unit, indirect emissions from utility services can also be considered.

Depending on the measures applied, the metrics required for monitoring the performance of the housing efficiency measures could include the various components making up the overall carbon footprint of the housing unit. In case of Mexico, these could be energy usage data (typically collected from the meter data reported on utility bills), fuel consumption (e.g., LPG, which is the main source of water heating, and natural gas), consumption of water and cooling water.

The two main options available for collection of monitoring data under the large-scale data analysis method are the aggregate approach and the continuous sample approach. The aggregate approach conducts statistical analysis on utility usage data for all or most of the participants and possibly non-participants in the programme (sample comparison group). In the continuous sample approach, several predefined samples of housing units with characteristics adequately representing the project building units are chosen. Emission reductions are then determined through regression analysis of a sample of the project data. Under AMS-III.AE, the size of the typical sample consists of 100 project residences. The same approach, or a simplified version, can be applied under the NAMA.

Table 8. Key data requirements for the Mexican Sustainable Housing NAMA

Data to monitor	Type of monitoring
Electricity consumption	Direct and continuous metering of electricity consumption (including generation from PV). If available, utility billing records can be used.
Emission factor of the grid electricity	As per CDM Tool to calculate emission factor for an electricity system, or use published data.
Transmission & distribution loss	Data from utility or an official government body.
Fuel consumption	Direct and continuous metering of fuel consumption. If available, utility billing records or fuel purchase invoices can be used.
Net calorific value of the fuel	Values provided by the fuel supplier in invoices, own measurement, or regional or national default value.
Gross floor area of a building unit	Building plan, or onsite measurement. All housing units covered under this NAMA are expected to have the floor area of 40 m2.

Source: Point Carbon Thomson Reuters and Perspectives

Monitoring frequency. Building energy-consumption levels change greatly over time. Climate conditions have particularly strong impacts on energy consumption levels, so actual climate conditions need to be taken into account. This requires annual monitoring of the energy consumption data. Such annual monitoring can also incorporate autonomous improvement of the building energy performance (e.g., by adoption of further efficient appliances over time).

In new residential buildings in Mexico, space cooling is supplied solely by electricity and there is no need for space heating. Fuels (mostly LPG, with minor share of natural gas) are used for hot water supply and cooking, and this demand is not strongly influenced by temporal variations in climate conditions. Thus, it is reasonable to consider that the number of days requiring cooling plays a decisive role in determining the electricity consumption, so electricity consumption would require the highest frequency of monitoring. Other data (refrigerant leakage, gross floor area, emission factor of energy consumed) are much more predictable, so frequent updating of these parameters is not required.

In terms of baseline sampling frequency, the main approach used is to update the baseline sample every three to four years, to capture changes in energy-use patterns in the baseline group. In between these years the baseline is

only adjusted for climatic variations using adjustments for cooling degree days.

Barriers and challenges

The major barrier to implementation of the MRV system tends to be access to data. Lack of necessary institutional frameworks and procedures, trained personnel, and/or resources can provide additional challenges.

With the Whole House NAMA, the possibility of access to information about the energy and other utility consumption of the NAMA housing unit is currently unknown. If the data are available in a centralized manner, through utility billing, the barriers of access can be possibly removed through agreements with utility companies supported by non-confidentiality clauses in the home-owners' mortgage contracts. The issue becomes more complicated if any of the housing units are served by off-grid generation or small-scale dispersed fuel suppliers. The access question may become more complex in the case of the baseline group of homes where incentives may have to be introduced to gain access to the same amount of data.

Another challenge involves balancing the need for robust and reliable estimates and the need to maintain flexibility, simplicity and cost-effectiveness of the MRV system of the proposed NAMA. The NAMA MRV system would ideally be as accurate as necessary and as simple as possible. However, what is necessary is currently unknown and is not likely to be known for at least several years, while there is no limit to the simplicity that can be theoretically considered. This challenge primarily concerns such methodological issues as selection of baseline approach, selection of the monitoring data collection methods, selection of monitoring metrics and their monitoring frequency.

In the coming months, as the proposed NAMA concept is refined and developed further, additional analyses will be conducted to establish data availability, suitability of the identified approaches, and the possibilities for synergies arising from the need for coordination between the various climate initiatives in the housing sector in Mexico.

6 Financing the NAMA: Required resources and institutional set-up

6.1 Incremental investment costs and energy savings

The investment costs were calculated through a cost estimation of the additional measures for each case, from Eco Casa 1 to Passive House. A first estimate, 'current costs' reflects the costs that would be incurred if the enhanced building standards were instituted immediately. This presumes that Passive House components such as efficient windows and ventilation units with heat recovery are not offered on the Mexican market and are thus very expensive.

A second scenario builds on the (more realistic) assumption that once energy-efficient building has become common in Mexico through the NAMA, the costs of energy-efficient components could be reduced significantly through local production of building components and a competitive market situation. This scenario is called 'future (investment) costs'.

Moreover, from an economic point of view, in addition to capital investment costs, energy supply costs and other operating costs should always be factored in when assessing the pros and cons of enhanced energy efficiency measures. As shown in the following graphs, reduced energy supply costs (and reduced subsidies) outweigh higher investment costs for the construction of more energy-efficient buildings (see examples below).

In the following graphs, the life-cycle costs of the buildings are depicted as the annuity of the investment costs and the energy costs over the lifetime of the building. The basic assumptions for the calculation are shown in Table 9).

Table 9. Boundary conditions for calculating life-cycle costs

Indicator	Value	Unit
Real interest rate	2.00%	p.a.
Life cycle	30	Years
Gas price	1	MXN/kWh
Gas price increase	2.1%	p.a.
Electricity price	1.1	MXN/kWh
Electricity price increase	4.0%	p.a.
Electricity price subsidy	1.9	MXN/kWh
Subsidy increase	6.0%	p.a.

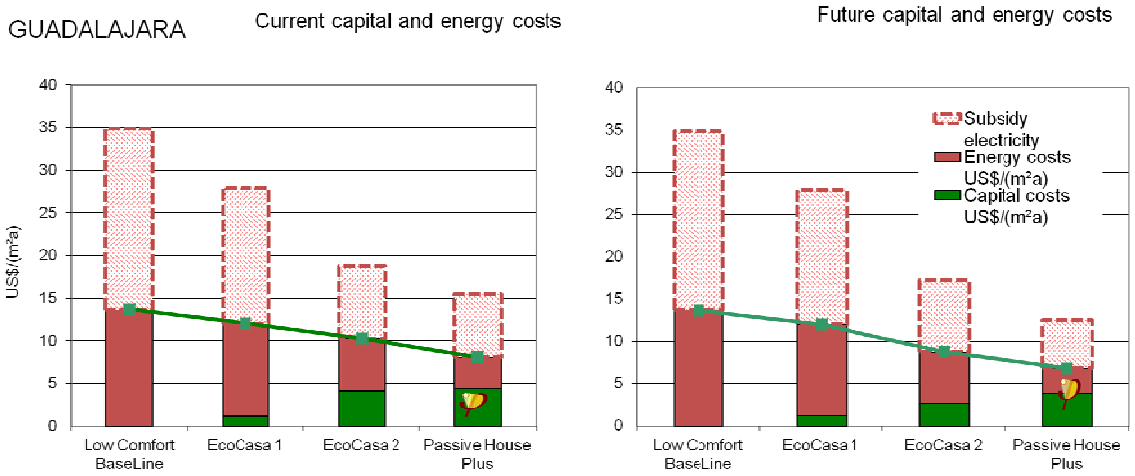
Source: IzN Friedrichsdorf

The following graphs demonstrate the incremental life cycle costs of vertical buildings in four climate zones. Compared to the base case, annual incremental capital costs (annuities) are shown in green, average energy costs for the individual owner are shown in red, while implied annual subsidies for the energy consumption of the owner are shown in dotted red.

In all four climate zones, introducing energy efficiency measures brings significant energy savings. The savings achieved affect also the total life-cycle cost of the house; however, part of it is a saved subsidy, which does not directly reach the home-owner. The most economical are the two intermediate energy efficiency standards, Eco Case 1 and Eco Casa 2. The incremental costs for them do not differ significantly regardless of the climate zone. The most expensive option in capital costs is the Passive House, although this cost is ultimately offset by the savings in

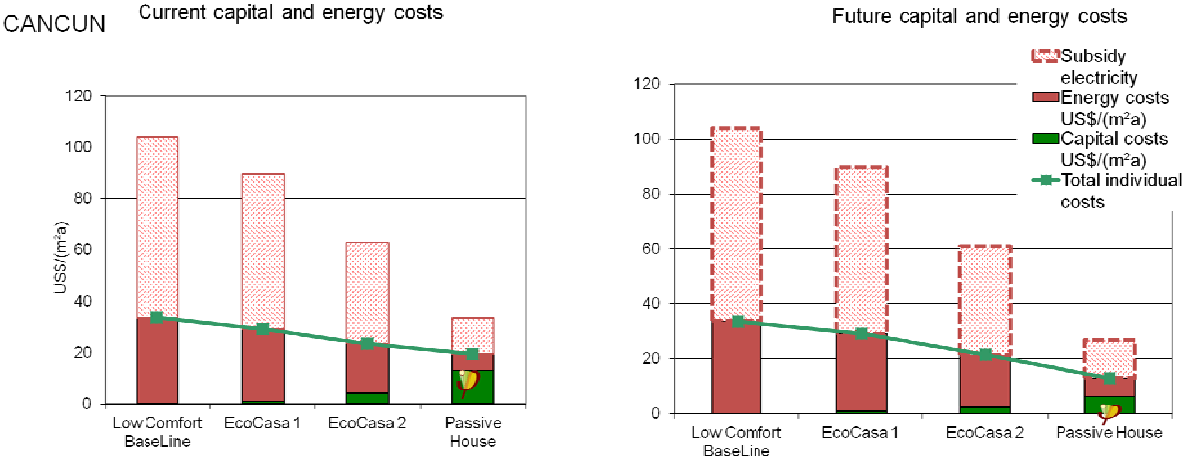
energy cost and subsidies, making it the most economical option in the long term. It is the easiest to achieve in the temperate climate of Guadalajara – at a cost only marginally higher than Eco Casa too - and also relatively easy to achieve in the temperate cold climate of Puebla. The costs of Passive House rise dramatically in hot climates of Hermosillo and Cancun. Over time, it is expected that the costs of upscaled options such as Eco Case 2 and Passive House will decrease due to the gradual decrease in the cost of materials and associated services.

Figure 10. Current and future costs for energy efficiency measures in Guadalajara (vertical, 40m^2)



Source: Passive House Institute

Figure 11. Current and future costs for energy efficiency measures in Cancun (vertical, 40 m2)



Source: Passive House Institute

6.2 Required resources for NAMA implementation

6.2.1 Direct mitigation actions

Table 10 below summarizes the actual financing needs (grants to make subsidies available to partly cover additional investment costs) and associated benefits (savings in energy expenditure for the households, in subsidies for the government and CO_2 emission reductions) for implementation of the three energy efficiency standards under NAMA in an illustrative manner per 1000 housing units of differing size and type.

Table 10. Costs and benefits for three energy efficiency standards per 1000 housing units

	Houses	Total additional investment costs	Cost of subsidies to home owners	Total CO_2 savings over lifetime	Saved energy costs (individual)*	Saved energy costs (electricity subsidies)**
Aislada + Adosada	# House units	USD mio.	USD mio.	tCO_2	USD mio.	USD mio.
Eco Casa 1 40m^2	1000	1.72	0.34	26 052	5.134	7.094
Eco Casa 1 70 m^2	1000	2.55	0.51	38 752	7.636	10.552
Eco Casa 2 40 m^2	1000	5.31	1.59	53 982	10.637	14.699
Eco Casa 2 70 m^2	1000	7.90	2.37	80 298	15.823	21.864
Passive House 40 m^2	1000	14.45	7.22	70 242	13.841	19.126
Passive House 70 m^2	1000	21.49	10.75	104 485	20.589	28.450
Vertical	# flat units	USD mio.	USD mio.	tCO2e	USD mio.	USD mio.
Eco Casa 1 40 m^2	1000	2.10	0.42	10 212	2.012	2.781
Eco Casa 1 70 m^2	1000	3.13	0.63	15 190	2.993	4.136
Eco Casa 2 40 m^2	1000	4.73	1.42	44 772	8.822	12.191
Eco Casa 2 70 m^2	1000	7.04	2.11	66 598	13.123	18.134
Passive House 40 m^2	1000	10.90	5.45	80 100	15.784	21.811
Passive House 70 m^2	1000	16.21	8.10	119 149	23.479	32.443
Total		97.54	**40.92**	**709 833**	**140**	**193**

Source: PHI and IzN Friedrichsdorf

6.2.2 Indirect mitigation actions (supportive actions)

The cost of supportive actions was estimated for the first phase of the NAMA from 2012 to 2016. The estimates were based on assumption of total roll-out of approximately 60,000 houses over five years under various standards. Because of the nature of the NAMA, the cost of supportive actions is not likely to increase significantly in case of faster roll-out. At levels of up to 200,000 houses, the costs are likely to remain stable, although they can increase at higher levels.

Several donors and bilateral/multilateral agencies for development cooperation (GIZ, UK embassy, etc.) are currently implementing activities in Mexico. The realization of supportive actions will need to be coordinated with these efforts.

Table 11 Supportive actions cost

No.	Type of supportive actions	Financing Need
1	Institutional set-up and NAMA administration	USD 3 009 000
2	Building Codes and permitting procedures	USD 910 000
3	Capacity building	USD 4 482 000
4	Beacon Projects and software adaptation	USD 1 830 000
5	Marketing and advertising	USD 5 419 000
	TOTAL	USD 15 650 000

6.2.3 Mexican contribution

An emerging economy like that of Mexico is able and willing to offer substantial co-financing. In particular, the noteworthy subsidy savings to be achieved represent a significant incentive for the Mexican government to consider substantial co-funding.

Therefore, the estimates of additional donor support that would be required for the financing of the NAMA are based on the two following premises with regards to the Mexican contribution:

- NAMA grants on the demand side cover only a part of the additional investment costs (20%, 30% and 50% depending on the standard Eco Casa 1, Eco Casa 2, Passive House).
- Likely amount of subsidies that CONAVI will have for 2012 is MXN 9,000m (USD 677m), compared to MXN 5,000m or USD 376m in 2011)

Overall, the Mexican government puts on the table a large amount of subsidies to assure sound urban development and well-equipped settlements, and seeks complementary international founds to improve the quality of the units in terms of their energy demand.

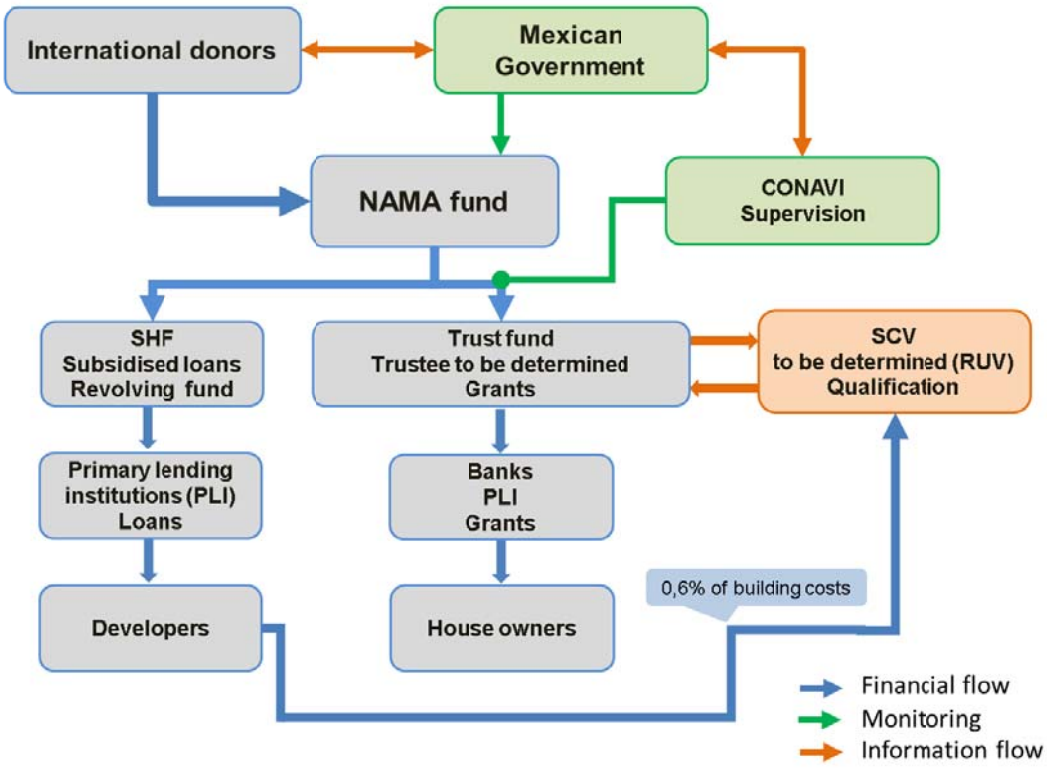
6.3 Financing scheme for public funding

A financial vehicle the 'NAMA Fund' will be set up to be the initial recipient of donor funds, whether in the form of soft loans or grants. A contribution will be also made by the Mexican government. The channels and opportunities for private finance are currently under development. The NAMA Fund will then allocate these monies to either the demand or the supply side. It may be that donors are legally impeded from disbursing their contributions directly into such a financial vehicle. Depending on the legal structure of the NAMA Fund, such donors may need an official borrower or recipient – which normally would be the Ministry of Finance or a local development bank. Such contributions could be formally attributed to the NAMA fund as pledges or commitments.

With the **demand side**, a Trust Fund will receive the monies as grants. The trustee has not been named yet. The grants will then be used to give an incentive to home-owners to buy energy-efficient homes, involving higher upfront costs. The grant will be used in form of subsidies covering a part of the additional investment costs to reduce the home-owner's debt burden. This subsidy can be conceived as a 'redemption grant' or as an 'interest subsidy'. Technically it will work in such a way that the house-owner does not really see the money. Instead it will go to the lender institution, which will reduce the borrower's obligation. This is a procedure already familiar in Mexico.

With the **supply side**, SHF will play a leading role. As a second tier bank it will provide finance indirectly (through financial intermediaries such as SOFOLES, SOFOMES or commercial banks) to developers in the form of 'bridge loans'. The market interest rate will be reduced by subsidies so that the amount of subsidies will be positively correlated with the level of energy efficiency incorporated in the house to be financed.

Figure 12. Financing mechanism of direct mitigation measures



Source: IzN Friedrichsdorf

The procedure for capturing and executing international public financing for the NAMA is described in the following two sections.

6.3.1 Financial support for home-owners (demand side)

This considers the incentive to be given to the house owners (demand side) interested in buying a home with a high degree of energy efficiency. It could also be executed in line with procedures already used by Mexican finance institutions.

- Step 1: The building is completed or has reached an agreed rate of termination (e.g. 80% according to the rules of the financing institution); loan financing is then provided by the relevant institution (e.g. INFONAVIT, FOVISSSTE) and paid to the developer.
- Step 2: The borrower (house-owner) will be charged with the loan amount and has to pay interest and the instalments (=debt servicing) over the lifetime of the loan. Normally the banking institution will calculate the loan so that payments do not exceed a certain percentage of the borrower's regular income. Including the extra capital cost for energy saving houses in the loan amount might mean that the ratio of debt servicing to income would exceed the upper limit.
- Step 3: To provide an incentive to buy energy saving houses, a grant (subsidy) will be used to reduce the

debt burden, keeping it within the limits. This subsidy can be conceived either as a 'redemption grant' or as an 'interest subsidy'. More detailed calculations will be needed to determine which alternative is preferable. The amount of the subsidy will depend on the level of energy efficiency incorporated in the house to be financed. In any case the funds needed should be reserved with a Trust Fund (to be created) at an early stage of building activities in order to prevent delays. If a lender (like INFONAVIT or FOVISSSTE) cannot finance the extra cost of the energy saving house, consideration should be given to including a commercial bank in the financing package. In that case the subsidy would go to that bank.

- Step 4: In any case, an energy efficiency calculation must be performed (perhaps using the Passive House Planning Package) as certification that the house complies with the conditions for the subsidy. This procedure requires qualified and available staff.
- Step 5: When the calculations show that the required efficiency standard has been achieved, the grant funds are disbursed to the bank, which reduces the borrower's debt servicing obligations.

6.3.2 Financial support to construction companies (supply side)

This concerns the incentive to be given to developers (supply side) interested in sustainable housing as an element of low carbon economy. It could be executed in line with standard procedure, with SHF acting as a second tier bank (apex bank or banco de segundo piso). Funds would be channelled through the SOFOLES/SOFOMES banks, but also through conventional commercial banks.

- Step 1: Project preparation: the developer is informed about the requirements of the different building standards (e.g. Green Mortgage, Eco Casa 1, Eco Casa 2) and decides on the level of energy efficiency he wants to achieve.
- Step 2: The developer declares the intended level of energy efficiency to his bank. The bank reserves the loan funds including additional upfront costs for improved energy efficiency as against the 'standard/base' case.
- Step 3: A standard loan agreement is concluded, with the subsidized interest rate reflecting the intended level of energy efficiency. The loan – basically a bridge loan - will be disbursed by the bank and reimbursed by the developer as soon as he has the necessary funds. These funds will normally originate in a payment from the bank (including INFONAVIT) that is financing the purchaser.

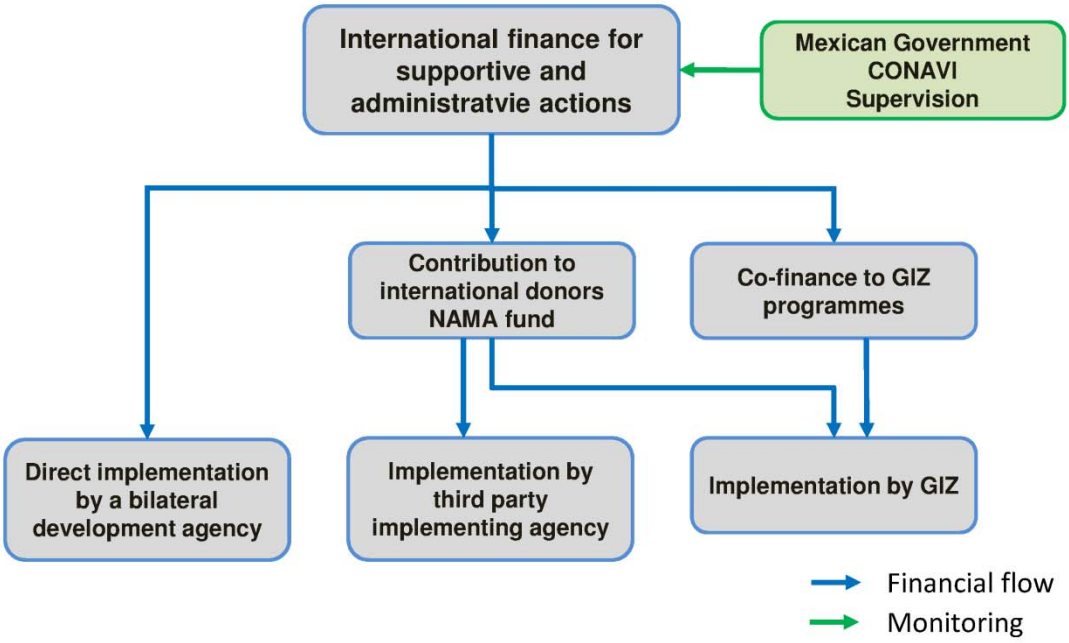
As the construction period is relatively short (roughly two months) and as INFONAVIT, by far the most important creditor in the housing market, disburses 100% of the house price to the developer immediately after the appraisal, the term of this bridge financing is also fairly short.

6.3.3 Financial support for supportive and administrative actions

Technical assistance for supportive and administrative actions can be channelled in three ways:

- payment in the international NAMA Fund and operation by a specific agency (be it national, international or both);
- implementation of new bilateral programmes for technical assistance between a certain host country and Mexico implemented according to standard procedures used by the different donor countries;
- implementation by GIZ on behalf of a certain donor country in form of a co-financing to current GIZ bilateral programmes that were commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) or the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) in the frame of the German–Mexican bilateral cooperation.[13]

Figure 13. Financing mechanism of supporting actions



Source: IzN Friedrichsdorf

6.4 NAMA financing packages offered to the international donor community

Analysis of the performance of various types of houses shows that the specific savings (reductions of primary energy demand per square metre of living surface) are much more favourable with terraced houses (Adosadas), multi-storey buildings (Verticals) and passive houses in the modalities Eco Casa 1, Eco Casa 2 and Passive House, compared to the traditional single freestanding or detached family homes. Vertical housing units in particular prove

[13] Such co-financing needs approval by the respective ministry (BMZ, BMU).

not only to be more efficient as to the performance of the building itself, but also allow urban settlements to remain closer to the city centre, thereby avoiding undesirable urban sprawl.

However, as noted, given Mexican housing traditions and local tastes, the NAMA will begin with a high share of row and single houses (around 90%) and move gradually to a 50/50 distribution between one-storey houses and multi-storey buildings. The funds will be used to create the necessary incentive for developers and house-owners to incur the additional upfront costs involved. Donors can either contribute by soft loans or grants to be credited to the 'NAMA Fund', from where they will be forwarded to their utilization (see Figures 12 and 13).

On the basis of the above, different types of financing packages have been formulated as examples of how international support could advance the NAMA. Financing needs are split into three categories:

- subsidies to home-owners (grants from donors),
- bridge loans to developers (soft loans from donors) and
- operational costs of the NAMA/ supportive actions (grants from donors).

Several important considerations apply for the financing packages presented in the following subsections:

- **Flexibility of grant packages for subsidies:** The packages shown below have the character of example packages. Actual packages can be shaped to fit specific requirements of interested donors (e.g. adjustments can be made in terms of financial volume, type of buildings and efficiency standards covered, etc.).
- **Combi-packages:** The Mexican government is willing to offer combinations of grant packages for subsidies to home-owners, soft loans for bridge finance to developers and/or grant packages for supportive actions.
- **Mexican priorities between soft loan and grant packages:** The implementation of the NAMA is critically dependent on the support of the international donor community for subsidies to home-owners and supportive actions ensuring the functioning of the NAMA. The soft-loan component of the NAMA has a complementary character, and represents an important element in the overall finance strategy. The Mexican government has a clear priority to ensure grant financing first, and will try to obtain soft-loan financing in parallel.

6.4.1 Type 1 financing packages: Subsidies to home-owners (grants from donors)

The financing needs for the subsidies to home owners indicated in Table 12 cover only a part of additional investment costs: 20% in case of Eco Casa 1, 30% of Eco Casa 2 and 50% of Passive Houses, the rest of the subsidy financing needs will be covered by the home-owners and/or the government of Mexico. These estimates do not include the operational costs of the NAMA (supportive actions) described in Section 6.1.2 and 6.4.3. The table shows five examples of financing packages for which the Mexican government is seeking financial support from the international donor community.

Table 12. Examples of financial packages for subsidies to home-owners (grants from donors)

Packages				Financing Need			Benefits		
Financial packages	Scale of the package	Content of the package		Subsidies to Home Owners, USD million		Total incremental construction cost USD million	Saved energy costs (individual)* USD million	Saved energy costs (subsidies)** USD million	Emission reductions over 30 yrs lifetime, tCO_2
		Mainstream roll-out	Passive House Pilot	Mainstream roll-out	Passive House Pilot				
Package 1	Large Scale (27,000 homes)	EcoCasas 1 and 2, 40 and 70m²	30 buildings of 40m²	49	0,2	165	337	466	1,711,000
Package 2	Mid-Size (13,800 homes)	EcoCasas 1 and 2, 40 and 70m²	30 buildings of 40m²	25	0,2	84	171	236	866,000
Package 3	Small Scale (5,200 homes)	EcoCasas 1 and 2, 40 and 70m²	30 buildings of 70m²	9	0,3	27	61	85	311,000
Package 4	Multi-Family (14,940 apartments)	EcoCasas 1 and 2, 40 and 70m²	780 verticals, 40 and 70m²	27	3	94	170	236	865,000
Package 5	Passive House Pilot (890 homes)	890 Mexican Passive Houses (different types)		-	6	12	17	24	87,000

Source: IzN Friedrichsdorf

* saved energy costs (individual; at household level) as Net Present Value over 30 years for the households' total energy demand (electricity and LPG)

** saved subsidies (government perspective) as Net Present Value of saved subsides for electricity over 30 years (conservative approach, since saved subsidies on LPG are not considered)

6.4.2 Type 2 financing packages: Bridge loans to developers (soft loans from donors)

The total incremental cost of construction indicated in Table 12 is equivalent to the volume of soft loans that the developers would require in the form of bridge financing in order to build the houses to higher energy efficiency standards. By their nature, the bridge loans are short-term, the developers will be able to repay them as soon as the house is sold on the market. Considering the quick construction cycle in Mexico, the loans are expected to be repaid within a period of six months. This creates opportunity for a revolving fund for bridge financing. Such a revolving fund may combine a blend of commercial funds and government grant money, aimed at creating soft conditions for lending. Table 12 shows the accumulated and per year requirements for the revolving fund on assumption of joint implementation of all five financing packages for subsidies to home owners, i.e. the need of bridge financing associated with the construction of the approximately 60,000 houses covered by the five subsidy-packages. An estimate of the minimum grant element required to subsidise the interest rate of the bridge loans in a way that the

loan qualifies as a soft loan is provided in the last line of the following table. The total amount of a soft loan required to refinance the construction of all 60,000 houses in form of a revolving fund is USD 48.46 million.

Table 13. Soft loan revolving fund for bridge financing, million USD

	2012	2013	2014	2015	2016	Total
Accumulated revolving fund size	5.68	12.67	24.64	50.51	98.97	192.47
Additional financing requirement per year	5.68	6.99	11.97	25.87	48.46	
Minimum grant component required to subsidise interest rate	1.14	1.40	2.39	5.17	9.69	

Source: IzN Friedrichsdorf

6.4.3 Type 3 financing packages: Supportive actions (grants from donors)

The following table shows the supportive actions for NAMA operation described in more detail Section 6.1.2 and the associated costs for which the Mexican government is seeking support by the international donor community:

No.	Activity	2012	2013	2014	2015	2016	Subtotal	
1	**Institutional set-up and NAMA administration**	**988.000**	**658.000**	**455.000**	**454.000**	**454.000**	**3.009.000**	USD
1.1	Designing fund for financial resources, incl. legal agreements	210.000	-	-	-	-	**210.000**	USD
1.2	Designing, establishment and operation of "NAMA Programme Office Unit"	238.000	238.000	155.000	154.000	154.000	**939.000**	USD
1.3	Baseline, MRV and additionality framework							
1.3.1	Development of data-collection systems to accurately measure, report and verify emissions: Set up and operation of a comprehensive data base (baseline and MRV) of houses and energy consumption and demand	150.000	35.000	35.000	35.000	35.000	**290.000**	USD
1.3.2	Capacity building and capacity build-up for monitoring and auditing - Establishment of a professional and specialized inspection and supervision system	90.000	50.000	20.000	20.000	20.000	**200.000**	USD
1.3.3	Comprehensive household monitoring and auditing surveys (i.e. simulation using data base and detailed surveys)	210.000	245.000	245.000	245.000	245.000	**1.190.000**	USD
1.4	Technical Assistance to FOVISSSTE and SHF in the establishment of their institutional set-up for the implementation of the NAMA	90.000	90.000				**180.000**	USD
2	**Building Codes and permitting procedures**	**280.000**	**210.000**	**210.000**	**210.000**	**-**	**910.000**	USD
2.1	Technical Assistance to local governments and organizations at state and municipal level for introduction of a minimum energy performance standard, the whole building approach and target values for primary energy consumption as well as sustainability criteria. Elaboration of a national guideline for Building Code adaptation	280.000	210.000	210.000	210.000	-		USD
3	**Capacity building**	**1.377.000**	**1.070.000**	**700.000**	**668.000**	**668.000**	**4.482.000**	USD
3.1	Training for energy advisors, planners and construction workers on energy efficiency building mainly through the PHPP tool						**0.000**	USD
3.1.1	Scaling up of university/commercial school curricula on EE buildings and RE in buildings with focus on supporting for the NAMA implementation and operation	65.800	65.800	65.800	65.800	65.800	**329.000**	USD
3.1.2	Translation and adaptation of European/PHI training material to Mexican climate and Building tradition; check after experience	66.000	66.000	20.000	10.000	10.000	**172.000**	USD
3.1.3	Training through a "Train the trainer approach" with local partners. The local partners consecutively, provide training and design of energy efficient buildings (eco-casa, PHPP) for developers and planners throughout Mexico and special training for construction workers	100.000	60.000	30.000	30.000	30.000	**250.000**	USD
3.2	Training to local authorities and stakeholders						**0.000**	USD
3.2.1	CONAVI will also perform capacity building for local, state and federal authorities by attendance courses, virtual learning and the construction of an inter-institutional platform; objective: Local authorities and stakeholders are able to introduce and implement sustainability criteria in their daily processes and decisions involved at housing master plans and house construction level	840.000	700.000	420.000	420.000	420.000	**2.800.000**	USD
3.3	Training to house owners/users							
3.3.1	Production of a manual for house owners/users in order to understand and optimise the use of the energy efficient houses	50.000	25.000	25.000	25.000	25.000	**150.000**	USD
3.3.2	Campaigns in order to increase the consciousness of energy efficiency not only for buildings but also for the use of efficient appliances	150.000	75.000	75.000	75.000	75.000	**450.000**	USD
3.4	Encouragement and support of regional manufacturers and companies to increase the availability of suitable products						**0.000**	USD
3.4.1	Guideline and support for manufacturers through local partner and international advisory	70.000	50.000	50.000	28.000	28.000	**226.000**	USD
3.4.2	Adaptation of certification criteria for local Mexican products	35.000	28.000	14.000	14.000	14.000	**105.000**	USD
4	**Beacon Projects and software adaptation**	**310.000**	**310.000**	**450.000**	**410.000**	**350.000**	**1.830.000**	USD
4.1	Quality assurance of all Passive House design and constructions; and adaptation/implementation of PHPP calculation and design tool	250.000	100.000	70.000	50.000	50.000	**520.000**	USD
4.2	Design and construction of Beacon Projects in different locations in Mexico (Construction --> direct measures, not included here)	60.000	110.000	80.000	60.000	-	**310.000**	USD
4.3	Monitoring of Beacon Projects (--> experience, also necessary for learning, capacity building, demonstration and dissemination)	-	100.000	300.000	300.000	300.000	**1.000.000**	USD
5	**Marketing and advertisement**	**1077.000**	**1089.000**	**1089.000**	**1089.000**	**1075.000**	**5.419.000**	USD
5.1	Website (development & maintenance)	42.000	14.000	14.000	14.000	-	**84.000**	USD
5.2	Mass media campaign (TV, radio, newspaper)	1000.000	1000.000	1000.000	1000.000	1000.000	**5.000.000**	USD
5.3	Promotion for the participation (Brochures and marketing material)	35.000	35.000	35.000	35.000	35.000	**175.000**	USD
5.4	Demonstration and dissemination: make success visible	-	40.000	40.000	40.000	40.000	**160.000**	USD
	TOTAL	**4.032.000**	**3.336.000**	**2.904.000**	**2.831.000**	**2.547.000**		

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