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For the developmet of nationally appropriate mitigation actions (NAMAS): A primer on Energy Efficient Buildings in Tropical and Subtropical Climates

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GUIDEBOOK

FOR THE DEVELOPMENT OF NATIONALLY APPROPRIATE MITIGATION ACTIONS (NAMAS)

A primer on energy efficient buildings in tropical and subtropical climates


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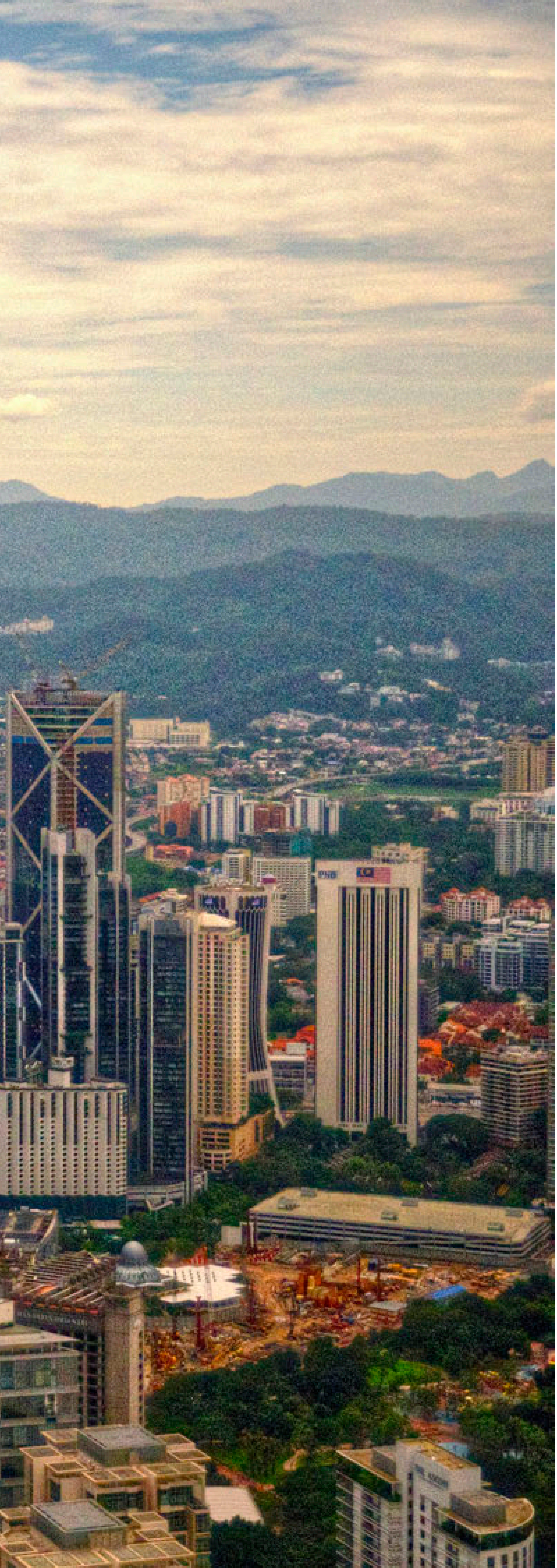

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Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

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DEFINITIONS

ADDITIONALITY	Efforts that are beyond what has already been planned. Project additionality was required under the Clean Development Mechanism to ensure that carbon credits were not awarded for emissions reductions that would happen regardless of whether the project was implemented or not.
BASELINE	Development that is expected without initiating any additional action to reduce emissions. The baseline is also referred to as 'business as usual', meaning the sum of the current emissions and the anticipated development of emissions over a given period of time (typically a project or programme duration).
BIENNIAL UPDATE REPORT (BUR)	Reports to be submitted every two years by a developing country in its National Communications, per UNFCCC decision 1/CP.16. Least Developing Country Parties and Small Island Developing States have more flexibility. Reports include information on greenhouse gas inventories, mitigation actions taken, and support needs.
INTERNATIONAL CONSULTATION AND ANALYSIS (ICA)	The process of analysis of the information submitted in Biennial Update Reports, by international experts to ensure completeness, consistency and accuracy of information. It also includes consultations among Parties on the analysis and Biennial Update Reports under the Subsidiary Body of Implementation of the UNFCCC to collectively assess the efforts of countries to address climate change.
INCREMENTAL COSTS	Costs that are over and above those incurred by following the baseline development. The incremental costs are additional ones affiliated with a choice of a lower GHG emission alternative. The term does not indicate which party bears the costs and is only relevant in cases where there is a positive cost affiliated with a deviation from the baseline, not where a deviation is profitable.
MEASURING, REPORTING AND VERIFYING (MRV)	Measuring includes collecting information on the impacts of a NAMA. Reporting refers to submitting the measured information in a defined and transparent manner. Verifying requires independently assessing the information that is submitted for completeness, consistency and reliability. The UNFCCC Subsidiary Body for Scientific and Technical Advice is developing guidelines for measuring, reporting and verifying for unilateral NAMAs. Measuring, reporting and verifying for internationally supported NAMAs will be guided by the supporters and will follow the guidelines for International Consultation and Analysis adopted at the UNFCCC 17th Conference of the Parties.
NAMA	Nationally Appropriate Mitigation Action (NAMA) refers to a set of policies and actions that countries undertake as part of a commitment to reduce greenhouse gas emissions. The term recognizes that different countries may take different nationally appropriate actions on the basis of equity and in accordance with common but differentiated responsibilities and respective capabilities. It is not legally binding but voluntarily taken by a developing country.
STAKEHOLDERS	All persons and institutions that are affected positively or negatively by a given action.
TRANSFORMATIONAL	The character of an action that emphasizes the permanence of the expected impact. It is contextual, calling for a permanent change to current ways of operation. It prioritizes policy initiatives over projects and sector focus over stand-alone installations, but evaluation is qualitative and non-prescriptive, leaving the evaluation of the transformational character to the stakeholders.
SUPPORTED NAMA	A NAMA that involves contributions from third parties in developed countries in the form of finance, technology or capacity building. Contributions are documented through Biennial Update Reports to the UNFCCC, as per its guidelines in Annex III to Decision 2/CP.17. Developing countries will receive financial and technical support from developed countries for preparation of the Biennial Update Reports.
UNILATERAL NAMA	A NAMA that does not involve contributions from third parties in developed countries and, therefore, is implemented solely with the host country's domestic resources.

ABBREVIATIONS

AMS	Approved Small scale Methodologies
ASEAN	The Association of South-East Asian Nations is made up of the ten member states of Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam
BAPPENAS	Ministry of National Development Planning, Republic of Indonesia
BAU	Business as Usual
BCA	Building and Construction Authority
BUR	Biennial Update Report
CDM	Clean Development Mechanism
COP	Conference Of Parties
DIT	? Only found twice, but never written in full. Maybe not important.
EE	Energy Efficient
ESCO	Energy Service Companies
GEF	Global Environment Facility
GHG	Greenhouse Gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel for Climate Change

LED	Light Emitting Diode
MRV	Measurement, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Action
NAP-GHG	National Action Plan of GHG Emissions Reductions
NCCC	National Council on Climate Change
NDC	Nationally Determined Contribution
NINO	NAMA Information Note
OECD	Organisation for Economic Co-operation and Development
PV	photovoltaic
RAD-GRK	Local Action Plan for Greenhouse Gas Emission Reduction, Indonesia
RAN-GRK	National Action Plan for Greenhouse Gas Emissions Reduction, Indonesia
SWH	Solar Water Heating
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme (or is this UN Environment now?
UNFCCC	United Nations Framework Convention on Climate Change

1 INTRODUCTION

BACKGROUND

An unprecedented migration on a global scale of people to large urban centres is leading to the emergence of megacities. The challenges of building infrastructure to match the global needs for energy, mobility, housing and food are enormous, and require immense amounts of energy. Although global energy resources can meet this growing demand impending climate change is limiting the flexibility with which we produce, distribute and use energy and drives the trends towards cleaner and more efficient use of energy. This megatrend also causes a shift in the type of energy in demand. According to IEA the global increase in energy demand up to 2035 is projected to be 1.3% annually, whereas the growth in electricity demand is set at 2.3%. This is particularly relevant in tropical and sub-tropical climates where electricity for cooling of houses is a significant cause for increased electricity consumption (whereas electric heating in temperate climates is less common and has a number of alternatives).

Energy services in buildings are responsible for a significant share of energy use worldwide. The exact figure depends on where system boundaries are drawn. According to the intergovernmental Panel for Climate Change (IPCC 2007) the global direct total final energy use in buildings was 108 EJ in 2007, resulting in 8.6 Gt of CO_2e emissions or about 33% of global energy-related CO_2 emissions – but almost 60% of the world's electricity is consumed in residential and commercial buildings (IEA 2008a). Obviously, there are significant variations among countries. At the national level, direct energy use in buildings typically accounts for 20–40% of individual country's total final energy use, but varies among regions according to geography, culture, lifestyle, climate, and the level of economic development. It also varies by the type of use, type of ownership, age, and location of buildings (e.g., residential or commercial, new or existing buildings, private or public, rural or urban, leased or owner-occupied) (Chakravarty et al., 2009). There are also significant differences in energy services among commercial subsectors – such as offices, retail, restaurants, hotels, and schools – and between single- and multifamily residential buildings. Different approaches, standards and technologies to how the buildings are sited, designed, constructed, operated, and utilized strongly affect the amount of energy used within buildings.

No global systematic studies have been performed to understand the importance of different energy services in buildings. Figures from the US breaking down the primary energy use in commercial and residential buildings by end-use services demonstrate that five energy services accounted for 86% of primary energy use in buildings in 2006. These were: (1) thermal comfort (space heating, cooling and ventilation) 36%; (2) illumination 18%; (3) sanitation and hygiene (water heating, washing and drying, and dishwashing) 13%; (4) communication and entertainment (electronics) 10%, and (5) provision of food, refrigeration and cooking – 9% (US DOE, 2008). An estimate from 2008 (McNeil et al. (2008)) showed that in non-OECD countries, this figure was 78% (and 93% of the electricity). It is within these five main sources of consumption that efficiency gains may be achieved.

While technology is an important foundation for improving the energy efficiency of buildings other factors are equally determining the actual energy efficiency of buildings. Structural efficiency refers to factors that are beyond the individual building, but influence the relevance of technical options and the technical performance of such options. It is factors that require attention at a higher (political or administrative) level and therefore are beyond the control of individual building developers, owners, tenants and users. Behavioural efficiency, on the other hand, it very much under the influence of exactly these individuals. Behavioural inefficiency can offset most technological improvements: Thermostats are not functioning optimally, if windows remain open; LED lamp efficiencies are offset if the effect of its use is that lights are not switched off. Many of these changes in behaviour are referred to as rebound effects and their potential for offsetting technological efficiency benefits vary among technologies.

The means to achieve energy efficiency gains would seem straightforward – simply choose more efficient technologies and – where technologies need assistance from users – make occupants of buildings behave consciously. But the energy efficiency agenda in general and in the building sector in particular is filled with challenges and dilemmas and difficult choices that have hampered many ambitions of reducing the demand for energy. These challenges are within technology choices, political priorities and conflicts of user interest most of which is ultimately translated into economics. In that regard it must be recalled that any current state of affairs is just as much an expression of a chosen balance among interests as any new balance will be. Fortunately, common for most energy efficiency investments is that they are profitable and therefore do not so much require a distribution of the cost as they need attention to the sharing of the benefit.

This guidebook provides an introduction to designing government-led interventions to scale up investment in energy efficient buildings in tropical and sub-tropical climates. It shows how these interventions can be packaged as Nationally Appropriate Mitigation Actions (NAMAS).

Nationally Appropriate Mitigation Actions (NAMAs) represent a valuable opportunity for developing countries to address greenhouse gas (GHG) emissions while remaining true to their sustainable development priorities and needs. They represent mitigation actions that are naturally framed within the targets specified by a country's Nationally Determined Contribution (NDC). NDCs were established under Article 4 of the Paris Agreement as a means for Parties to jointly achieve the objective of limiting temperature rise to 'well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C'. These contributions are not actions in themselves, but constitute a country's vision of its own development through an alternative path which is 'cleaner' in terms of GHG emissions and that enhances a country's resilience to climate change. The objectives and targets specified therein are to be achieved through measures such as NAMAs. NAMAs are therefore a natural means to help countries realize the vision enshrined in their NDCs.

Together with UNDP and UN Environment, the UNFCCC published in 2016 'Guidance for NAMA Design in the Context of Nationally Determined Contributions: A Tool to realize GHG mitigation under NDCs', which provides informal interpretations of the nature of a NAMA relating it specifically to the implementation of Nationally Determined Contributions. The present SWH Guidebook adopts these informal interpretations.

Many countries have already developed NAMAs as instruments for participating in the global mitigation agenda and as a means of leveraging national and international support for more effective and transformational climate actions. National governments, multilateral organizations, development partners and others are joining forces to ensure that NAMAs contribute to urgent efforts to limit the increase in GHG emissions while pursuing development at the national and local levels, including poverty reduction, job creation and access to energy. The NDCs have given a further impetus to these actions, underscoring the importance of the mitigation agenda and the relevance of NAMAs.

A NAMA can be regarded as any mitigation action tailored to the national context, characteristics and capabilities, and embedded in national sustainable development priorities. Countries can submit their NAMAs to the UNFCCC's NAMA Registry for assistance in preparation, recognition or international support. Submissions to the NAMA Registry are voluntary. Anyone can develop or promote a NAMA, but only a national authority can approve submission of a NAMA to the UNFCCC NAMA Registry.

GETTING STARTED

This Guidebook aims to be a practical resource for governments (ministries of energy, environment, housing, climate change, finance, planning and others), private sector investors and civil society organizations by illustrating how to create a NAMA for energy efficient buildings based on a country-led national strategy, possibly articulated as a Nationally Determined Contribution. Some countries may already have developed a strategy for energy efficient buildings or may be in the process of developing one, such as Singapore's Green Mark initiative or Mexico's NAMA on Sustainable Housing, 'EcoCasa'. Other countries may have an interest in formulating a NAMA as the concrete implementation model for such an NDC, indicating how the country will turn the NDC into practice. And still others may wish to develop a NAMA without having developed an NDC or a sector-wide strategy first.

No matter the point of departure, articulating a NAMA requires communication with stakeholders, including citizens, the private sector, and national and international financiers. This guidebook is divided into five main sections: an introduction to NAMAs; an Overview of Technologies and Possible Intervention Areas, the Structuring of NAMAs for Energy Efficient Buildings; Measuring, Reporting and Verifying NAMAs; and Financing for NAMAs. The latter four may be regarded as the fundamental building blocks for NAMA development. Throughout the text the main messages are illustrated by the example of Singapore's recently introduced policy for energy efficiency improvements in existing buildings.

Chapter 2 gives a generic background for the NAMA concept, origin and founding principles, its relation to NDCs as well as current interpretations among international stakeholders and the UNFCCC Secretariat.

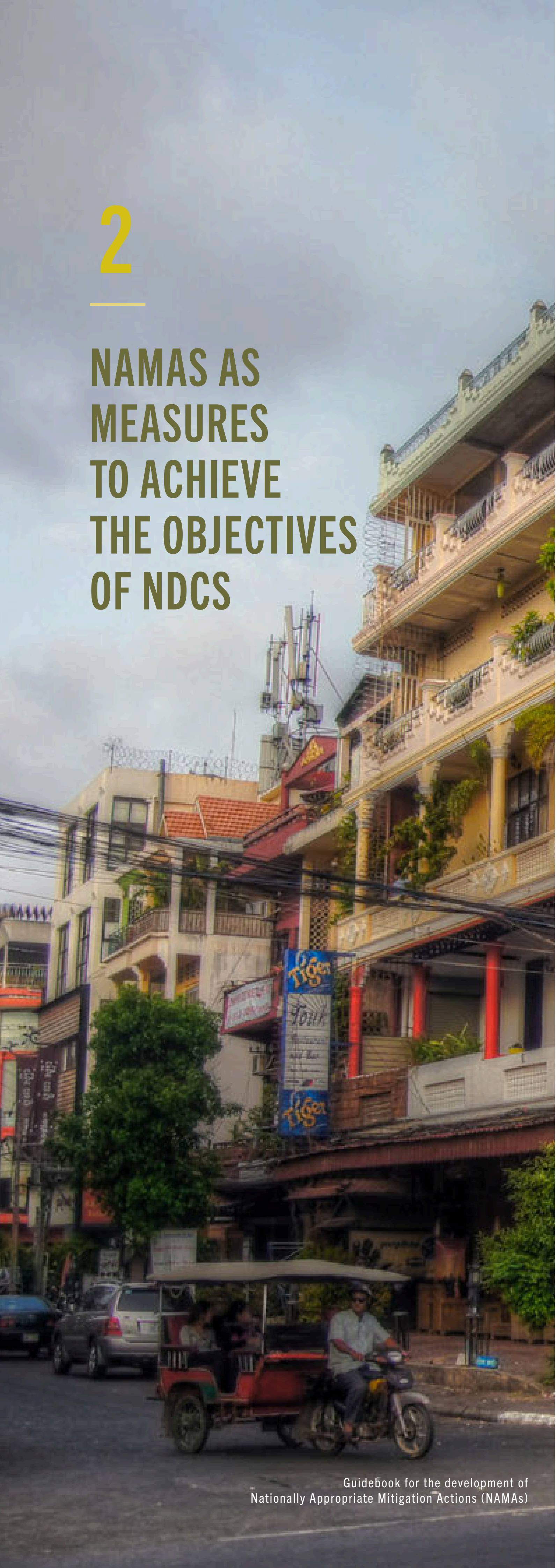
Chapter 3 presents a rudimentary catalogue of relevant technologies for energy efficiency in buildings in tropical climates divided among the five categories identified above as the most prominent sources of consumption. It aims at illustrating the costs and benefits of achievable efficiency gains without aspiring to provide a tool for technology prioritization.

Chapter 4 provides specifics on how to develop a NAMA for energy efficient buildings. The UNFCCC has not yet promulgated strict requirements for NAMAs, but best practices from developed NAMAs as well as donor and investor due diligence requirements provide a basis for identifying the evidence needed to present NAMAs. Specific challenges related to NAMAs for energy efficient buildings are addressed, particularly stakeholder conflicts of interest and rebound effects.

Chapter 5 introduces the measuring, reporting and verifying of the NAMA impacts, including emissions reductions and co-benefits. While basic requirements are given by the decisions of the Conference the Parties, current practices in designing and implementing NAMAs show that accurate interpretation of measuring, reporting and verifying systems adapted to the substance of the NAMA are crucial.

Chapter 6 explains the structuring of the financing for NAMAs, and ways in which NAMAs for energy efficient buildings could be financed. It identifies sources of finance and their different roles in investment finance as well as financing of recurrent spending.

Chapter 7 reviews and summarizes the information contained in this Guidebook, and offers brief advice on what steps to take in order to tap the potential of energy efficient buildings NAMAs.



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NAMAS AS MEASURES TO ACHIEVE THE OBJECTIVES OF NDCS

NAMAs were introduced by the Bali Action Plan (2007) and were given further impetus through the Cancun Agreements, in which developing countries agreed to take action to lower their emissions below business as usual scenarios in the form of NAMAs. Over the years, the approach and use of NAMAs has been under constant evolution: they emerged as part of an international agreement and were viewed by many as implicit commitments, but increasingly they are used by governments to identify and implement concrete projects, programs and/or policies nationally. In many cases, NAMAs have also been used as mechanisms for technical assistance or financial cooperation.

Experiences with NAMAs so far have generated valuable knowledge on the different aspects and elements of mitigation action and have also identified what constitutes good practice. UNFCCC, together with UNDP and UNEP DTU Partnership has published 'Guidance for NAMA Design in the Context of Nationally Determined Contributions: A tool to realize GHG mitigation under NDCs' in 2016, which is the main reference point for this publication. Practical experiences with NAMAs have played a major role in informing the conceptual development of NDCs under the Paris Agreement. As already noted, some countries have used them as building blocks for their own NDCs, others as a means of implementing measures. An important development with the emergence of NDCs is that NAMAs will no longer be regarded as implicit international commitments, a factor that prevented many countries from preparing and implementing them. NAMAs should now rather be considered a concept to help countries meet commitments they have already made (albeit not binding ones) through the NDC. Thus, the Paris Agreement, through the NDCs, provides both the context and the mandate for NAMAs to play a major role in action to combat climate change. For further details on the linkage between NAMAs and NDCs please refer to the above mentioned Guidance document.

Among international donor agencies there is increasing emphasis on the requirement for NAMAs to be transformational. While there is no definition of 'transformational', the NAMA Facility states that, "Transformational NAMAs are projects, policies or sector programmes that shift a technology or sector in a country onto a sustainable low-carbon development trajectory". Such fundamental shifts are most likely to succeed if supported by policy or regulatory initiatives. Without embedding initiatives in national legislation the permanence of the change and thus the transformational character of the initiative may be uncertain.

International interest in NAMAs for energy efficient buildings is likely to focus on policy instruments and much less on stand-alone projects. For example, international financiers may require that a NAMA host government first establishes and implements a national goal for the employment of energy efficient building technologies and materials and devises supportive measures like financing schemes as part of the NAMA development, and then invites international participation in a supported NAMA. Even with the emphasis on policy, NAMAs are actions with a clear emphasis on implementation. An 'energy efficient buildings' NAMA relates to the implementation of national energy strategies and details tangible, financeable and verifiable activities.

The NAMA development process is entirely dependent on existing preconditions and steps that need to be taken may be many or few depending on the starting point. A NAMA in itself often represents only a part of a longer process that may start with the development of a sector specific low emission strategy and end with sub-sector implementation. Below is a more detailed checklist of things that need to be done partly when developing a NAMA, but mostly when submitting a NAMA to the UNFCCC NAMA Registry and promoting it for recognition or funding (see Annex A). But NAMA development involves much more than fulfilling the quite limited requirements for submission of a NAMA proposal to the NAMA Registry; it is an ongoing time-consuming process similar to policy development.

Table 1: Steps to develop, promote and implement a NAMA

Step 1 **Engage key stakeholders**	Engage key national stakeholders, promoters and implementers in a transparent consultation process: a) Ensure active stakeholder support and encourage their public endorsement of the NAMA b) Engage policy makers and secure the necessary support for carrying out implementation of the NAMA
Step 2 **Develop the NAMA proposal**	Develop a structured NAMA proposal, using one of the detailed formats available (see Annex B) based on the national strategy for energy efficient buildings, if such a strategy exists, and linked to other national priorities (energy, environment), describing and quantifying as accurately as possible: c) The array of direct and indirect benefits to different stakeholders d) Existing policies and actions targeting these benefits e) National (financial or regulatory) contribution f) A measurement, reporting and verification system or the preparedness to develop it g) An estimate of the expected greenhouse gas emissions reduction
Step 3 **Publish the NAMA**	Develop a NAMA proposal in the NAMA Registry format: h) Extract information from the structured NAMA proposal i) Make sure that key information from Step 2 is included Submit the proposal to the NAMA Registry, through the nation’s NAMA focal point (if established)
Step 4 **Finalize and promote the NAMA**	Promotion and finalization: j) Ensure that all supporting information has been published k) Circulate NAMA proposal to and meet with relevant donors l) Keep stakeholders engaged m) Further develop the proposal through interaction with donors

Table 1 should be considered a general checklist that must be elaborated specifically for any NAMA development process. The main message is that NAMA development is a process rather than an activity with a fixed start and end. Especially, it must be kept in mind that NAMAs do not represent a new type of activities. The checklist above is a brief on general good practice when developing new or revised approaches and policies in any given sector of activity. The NAMA concept adds an international angle to these processes, but it does not essentially alter them. Therefore, when studying the potential for NAMA development, the experience with policy development and formulation in related fields are very relevant. In fact, many of such development processes could have been labelled NAMA development. Therefore, the examples of policies and programmes for energy efficient buildings that are used in this publication are in effect examples of what is sought through the suggested NAMA development, even though it has not been labelled as such – illustrating that NAMAs are not alien to current planning and development processes; it is one and the same.

BENEFITS OF DEVELOPING NAMAS FOR ENERGY EFFICIENT HOUSING

While NAMAs generally refer to 'mitigation action', it is a common understanding that in most policies that have emissions reduction effects other benefits are the prime motivations for the development of the NAMA. Thus, most often the emissions reduction is a co-benefit to other more central development objectives of the NAMA host country.

By any standards, the economically feasible potential for increased use of energy efficient building technologies and materials can be immense. As already mentioned, almost 60% of the world's electricity is consumed in residential and commercial buildings. Depending on local circumstances, most energy efficiency investments employ commercially viable and available technology. Only due to different market barriers, these technologies have not reached the market penetration rate that it ought to reach from simple profitability considerations. The market penetration rate for different energy efficiency technologies varies widely among countries worldwide, mainly influenced by the setting of energy efficiency standards and the price of energy. Some countries that focus on this sector have achieved significant reductions of energy consumed per floor square meter, demonstrating what can be achieved with active promotion of energy efficiency in buildings – and thus also highlighting significant opportunities in countries that are yet to embark decisively on this path.

Programme and policy NAMAs for energy efficient buildings may be motivated by several objectives.

- A common motivation is the rapid growth in demand for electricity, mainly caused by a rapid growth in installation of technologies to improve thermal comfort (space heating, cooling and ventilation. Power generation capacity may be constrained and investment capital limited for larger scale power generation facilities. Reducing electricity demand, therefore, is a way to postpone such investment needs. More efficient appliances, central cooling systems and district cooling are relevant responses, as is cool air recovery in ventilation systems. Also passive technologies are relevant.
- Replacement of power generation capacity (future or existing) by reducing electricity demand may also reduce demand for imported fossil fuels or counter future fuel shortages and price increases and possibly reduce local particles, sulphur and NOx pollution from fossil fuel combustion.
- Local energy efficient buildings materials manufacturing and enhanced employment opportunities may also be a motivation for the promotion of energy efficient buildings, particularly in programmes for rehabilitation of existing buildings, possibly combined with increased product quality through standard setting.
- Support of energy efficient buildings may be a strategy to reduce effects of a reduction of energy subsidies.

Thus, there are many possible benefits of policies and programmes that increase the energy efficiency of buildings. Framing them as NAMAs may have the added benefit of access to additional sources of financing, or it may serve as a contribution to national emissions reduction commitments, if any. Unilateral NAMAs for energy efficient buildings may also be used to make the case for international support for other, more capital intensive or less profitable NAMAs. Thus, promoting energy efficient buildings through NAMAs may bring the action into a larger international context, which may hold added benefits in the form of access to financial resources.

Another benefit may relate to a more general NAMA development strategy. Many efficiency motivated NAMAs may come at no net cost – they are profitable so to say. Countries that implement policies that promote such efficiency gains may refrain from, or neglect, to label them 'NAMA'. It is, however, advisable to report such unilateral actions from the simple reason that when emissions reduction options do come at an extra cost and a NAMA host country wishes to attract international financing to overcome these costs, the national effort in other areas may be recognized by those financiers that may consider to contribute.

SINGAPORE'S GREEN BUILDING JOURNEY

Singapore is a small, densely populated urban city-state with limited natural resources. Its small land area, geographical location and other physical attributes makes it more challenging to access energy sources. It lacks the natural endowments to tap hydropower or geothermal energy and low wind speeds also preclude wind power. The only forms of renewable energy that are applicable to Singapore comprises waste-to-energy, solar energy and biofuels. However, these sources of renewable energy are yet to be cost-competitive with conventional fossil fuels. Hence, Singapore is an "alternative energy-disadvantaged" country reliant on fossil fuels to meet present energy needs. The combustion of fossil fuels in electricity generation is the major source of CO_2-emissions in Singapore, and the building sector a main consumer of electricity, along with a relatively small proportion of use of LPG (liquefied petroleum gas) and town gas mainly for cooking and heating of hot water.

By 2030, Singapore aims at having 80 per cent of its buildings certified green - that is, energy and water efficient, with a high quality and healthy indoor environment, integrated with green spaces and constructed from eco-friendly materials. This goal is set by the Inter-Ministerial Committee on Sustainable Development (IMCSD) which charts Singapore's national sustainability strategies. To achieve this goal, the Building and Construction Authority (BCA) of Singapore has set out specific initiatives to lead Singapore's building and construction industry in greening Singapore's densely built-up urban environment. With limited land space and few natural resources, greening buildings is vital to sustainability and at the same time one of the most effective ways for a city to reduce its carbon footprint.

In 2005, BCA launched the BCA Green Mark: a rating system to evaluate a building's environmental impact and recognise its sustainability performance, designed specifically for buildings in the tropics. Since its introduction, the Green Mark certification programme has undergone several revisions and has evolved to incorporate increasingly sophisticated methods of greening buildings. The standards it covers today include a greater variety of the building types and spaces; it has a higher emphasis on passive design and the use of sustainable construction materials; and it promotes development of performance-based designs and systems, amongst others. There is also greater focus on the needs and well-being of building occupants.

In 2006, following the Green Mark, BCA introduced the first Green Building Master Plan, which brought together financial incentives, legislation, industry training programmes and a public outreach campaign to place green buildings in the forefront of industry and consumer awareness.

The first Master Plan focused on greening new buildings, but in 2009 the second Green Building Master Plan was launched covering existing buildings and having the public sector take the lead, spurring the private sector through various incentive schemes and setting minimum performance standards for existing buildings. The second Master Plan also gave more prominence to research and development and greater emphasis on profiling Singapore as an international leader in green building capability. Amongst others, the BCA has established Centre for Sustainable Buildings as a collaboration between BCA and the United Nations Environment Programme and the annual International Green Building Conference is now hosted in Singapore.

On the basis of the successful implementation of the first and second Green Building Master Plan, BCA is embarking on its third Green Building Master Plan. The new vision is to become a global leader in green buildings, with special expertise in the tropics and sub-tropics. The new plan aims at guiding Singapore's building and construction industry in the development of "software", to match the "hardware" put in place earlier. This involves a paradigm shift in the consumption behaviour of building occupants, the development of industry knowledge, and the building of green building management expertise, thus having addressed all aspects of green buildings.

3

OVERVIEW OF POSSIBLE INTERVENTION AREAS AND TECHNOLOGIES

According to IEA, the building sector in Southeast Asia has the largest unrealised energy saving potential by 2035 in comparison to other sectors (see Figure 1). At the same time it is a rapidly developing region with growing economy and population, which will inevitably lead to the increase in the energy demand in a number of sectors, including buildings. According to IPCC, thermal energy use (i.e. energy for space heating, cooling and water heating) in the building sector in this region is going to at least triple by 2050 in relation to 2010 (Lucon, Urge-Vorsatz, and et.al. 2014). As can be seen in Figure 2 total building energy consumption in both residential and commercial sectors of the region is significantly increasing by 2050 even under rather ambitious IEA scenarios.

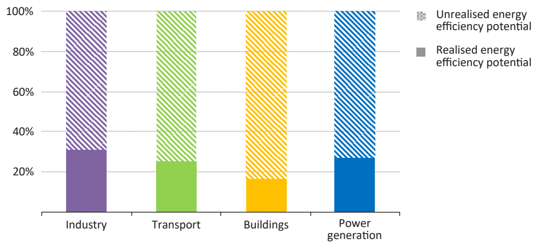


Figure 1. ASEAN energy efficiency gains and unrealised potential by sector in the New Policies Scenario, 2012-2035. Source: IEA (2013)

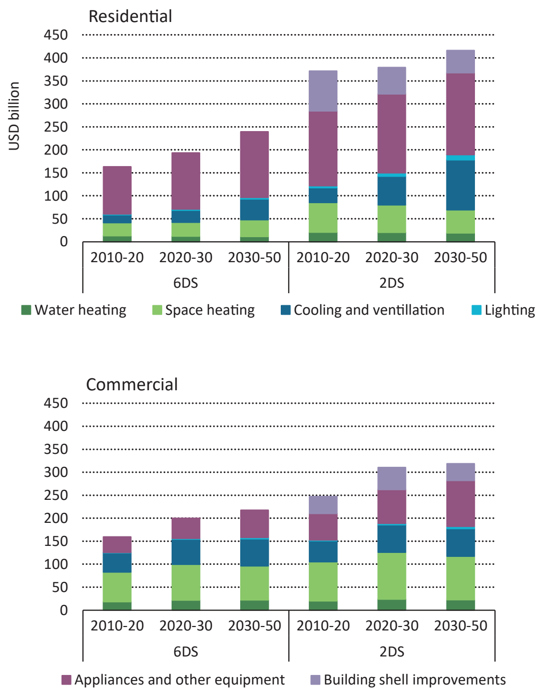


Figure 2. Building energy consumption by end-use in the ASEAN region. Source: IEA (2012)

Therefore, energy saving interventions in the building sector are crucial for Southeast Asia and utilisation of the NAMA mechanism can help to implement them. The following sections present key energy efficiency strategies, which can be applied in buildings, reducing energy use and related greenhouse gas emissions. It is structured according to the four groups of technology presented in Chapter 1:

1. thermal comfort (space heating, cooling and ventilation)
2. lighting
3. sanitation and hygiene (water heating, washing and drying, and dishwashing),and
4. appliances and equipment

THERMAL COMFORT: SPACE HEATING, COOLING AND VENTILATION

Thermal comfort includes space heating and cooling energy needs to maintain an acceptable indoor air temperature (Urge-Vorsatz, Petrichenko, et al. 2012).

Taking into account that energy demand for space heating is nearly absent in most of the locations in the region (Olz and Beerepoot 2010) and in those areas, where it exists, winters are quite mild, it is likely that comfortable indoor temperature during the cold period can be ensured through reduction of the heating load without the need for an active heating system. Cooling energy needs can also be significantly reduced through passive cooling techniques.

PASSIVE MEASURES

BUILDING DESIGN

The energy performance of a building is significantly influenced by its shape and orientation. In tropical climates orientation should aim at excluding direct exposure of the building to the sunlight and radiant heat at all times of the year while maximising access to cooling breezes (Department of Industry 2013).

ENVELOPE THERMAL PERFORMANCE STANDARD IN SINGAPORE

Since 1979, Singapore's Building Control Regulations had prescribed an envelope thermal performance standard know as Overall Thermal Transfer Value (OTTV). The OTTV standard applied only to air-conditioned non-residential buildings.

A major review of the OTTV formula was carried out in the early 2000 to provide a more accurate measure of the thermal performance of building envelope. The new formula is given the name 'Envelope Thermal Transfer Value' (ETTV) to differentiate it from the original OTTV formula. A similar review of the OTTV formula for roofs was also conducted and a new formula, known as 'Roof Thermal Transfer Value' (RTTV), replaces the Roof OTTV formula. The ETTV requirement does not apply to non-air-conditioned buildings such as residential buildings that are designed to be naturally ventilated. However, as it becomes increasingly common for residential buildings to be air-conditioned, the design of the building envelopes should be regulated in order to reduce heat gains in the interior spaces and minimise the need for air-conditioning. The ETTV concept was then extended in 2008 to cover residential buildings. As the air-conditioners in residential buildings are usually turned on in the night, the envelope thermal performance standard for residential buildings is given the name Residential Envelope Transmittance Value (RETV) so as to differentiate it from ETTV, which is meant for buildings that operate the air-conditioning system during the day.

Envelope Thermal Performance Standards in Singapore comprises of: -

- Envelope Thermal Transfer Value (ETTV) for air-conditioned non-residential buildings
- Roof Thermal Transfer Value (RTTV) for air-conditioned non-residential buildings (with skylight)
- Residential Envelope Transmittance Value (RETV) for residential buildings
- Roof insulation for air-conditioned non-residential buildings (without skylight) and residential buildings

THERMAL MASS

Thermal mass can be defined as the ability of building materials to store heat (thermal storage capacity). The main role of the thermal mass is to absorb heat, store it, and release it later, when it is needed (SEA Victoria 2005). Examples of thermal mass may be parts of the building structure (walls, floors, ceilings, stairs, etc), furniture, finishing materials and passive solar heat storage containers (Kosny 2001).

The effectiveness of thermal mass is the highest in places where there is a big difference in the maximum day temperature and minimum night temperature and, therefore, the greater this temperature difference is, the more thermal mass is needed in the building (SEA Victoria 2005).

In tropical climates the use of lightweight construction materials (e.g. timber) with low thermal mass is preferable, particularly on the building parts exposed to the sun. Lightweight materials combined with appropriate insulation will help to avoid overheating and reduce building's cooling load (Carins Regional Council 2011).

INSULATION

Insulation acts as a barrier to heat flow and is essential for minimising heat transfer through exterior elements (e.g. walls, windows, roof) (Department of Industry 2013).

Harvey (2010) provides the following types of insulation: glass fibre (fibreglass) batts, mineral fibre batts, cellulose, foam, wood, vacuum insulation panels. More broadly two types of insulation can be distinguished: bulk insulation and reflective insulation. In hot and humid climate reflective insulation installed under roof sheeting is highly effective as it does not trap heat inside the building. However bulk insulation is more effective at preventing loss of cool air from the building and so improves the efficiency of air-conditioning (Carins Regional Council 2011).

In hot and humid climate mild level of insulation is usually sufficient (Florides et al. 2002) and should be accompanied by adequate amount of shading in order to prevent the captured by insulation heat from accumulating inside the building ('oven' effect). In these climates the insulation of roofs and ceiling is usually the most important in order to reduce heat gain. It should be combined with sufficient roof space ventilation in order to reduce moisture content of the air. In order to prevent excessive condensation, which is typical in hot and humid climates, reflective foil sarking or foil-backed building blanket can be used. In climates with heating requirements, as well as in hot climates with extensive utilisation of air-conditioning, floor insulation can be used to reduce heat transfer with outdoors (Department of Industry 2013).

BUILDING ENVELOPE CRITERIA IN SINGAPORE'S BCA GREEN MARK CERTIFICATION

Under the Green Mark Certification criteria in Singapore, it is a prerequisite requirement to ensure building envelope design could meet its stipulated criteria.

For Residential Building Criteria:

- Building envelope design with Residential Envelope Transmittance Value (RETV) computed based on the methodology and guidelines stipulated in the Code on Envelope Thermal Performance for Buildings and the Green Mark Certification Standard.

Green Mark GoldPlus – RETV of 22 W/m² or lower
Green Mark Platinum – RETV of 20 W/m² or lower

For Non-Residential Building Criteria:-
Air-conditioned Buildings

- Building envelope design with Envelope Thermal Transfer Value (ETTV) computed based on methodology and guidelines in the Code on Envelope Thermal Performance or Buildings and the Green Mark Certification Standard.

Green Mark GoldPlus – RETV of 42 W/m² or lower
Green Mark Platinum – RETV of 40 W/m² or lower

In addition to the prerequisite requirements, the assessment framework has also included the building envelope design and thermal parameters for non-air-conditioned building area (excluding car park and common area) that will enhance the overall thermal performance of building envelope through minimising heat gain, improving indoor thermal comfort and encouraging natural ventilation or mechanical ventilation. For instance, minimum direct west facing façade through building design orientation, minimum west facing window openings, effective sun shading provision for windows on the west façade with minimum shading of 30%, better thermal transmittance (U-value) of thermal west facing walls and better thermal transmittance (U-value) of roof.

The introduction of these criteria has created a pushing factor for the building developers to consider the strategies to reduce the ETTV value through structural concept, façade system (e.g. curtain wall, cladding, patch fittings and membranes), heat transfer and day lighting and construction materials (e.g. concrete, steel, glass, metal cladding, stone cladding, fabric membrane, plastic and wood).

AIRTIGHTNESS

Air tightness is the resistance of the building envelope to inward or outward air leakage. Excessive air leakage increases energy consumption for both heating and cooling as well as occurrence of draughts in buildings (HRS Services Ltd 2010). Therefore, air tightness of the building envelope is very important in an energy efficient building, especially at connections between different elements, (e.g. windows, doors) (Strom, Joosten, and Boonstra 2005).

Feist, Peper, and Görg (2001) propose to improve air tightness through "the principle of a single airtight envelope". This can be achieved by applying different technologies for insulation and air leakage prevention, such as: internal plastering (lime plaster, lime-cement plaster, gypsum plaster, also reinforced loam plaster); plywood board, hardboard, particle board, bituminous reinforced felt and tear-proof reinforced building paper (Feist, Peper, and Görg 2001). Airtightness is the most beneficial for the climate conditions, where significant heating and/or cooling is needed, except for the naturally ventilated buildings located in tropical climates (Department of Industry 2013).

ADVANCED WINDOWS

Properly designed and manufactured windows play a crucial role for the building energy performance. Advanced energy efficient windows perform such functions as (1) daylighting, (2) solar heat gaining and (3) heat losses reduction. Daylighting allows for maximized utilization of natural light for lighting the room and decrease the operation time of bulbs and lamps in the building, therefore, reducing energy. The second function is a part of passive solar heating as it allows sun heat to enter the building directly, which is then captured and stored by thermal mass (this might be beneficial for the areas, where some heating is needed). Windows also should not cause overheating of the building through solar heat gain and, therefore, they might be accompanied by adaptable shading. The third function prevents the captured solar heat or air cooled through air-conditioning or ventilation from leaving the building.

In hot climate conditions "low-gain" or "spectrally selective" glazing may be beneficial to control solar heat gain (Apte, Arasteh, and Huang 2003). Toning of the glazing and reflective coatings (i.e. thin films of metal or metal oxide applied to standard glass) are known solutions to reduce the amount of heat gain through windows, which can be used in tropical climate. However, reflective coatings may create glare problems for neighboring properties and reduce the quantity of light admitted through the glass (Carins Regional Council 2011).

SHADING

Shading refers to any kind of protection of the solar transmitting surfaces of the building (usually glazing) from direct sunlight (Colt International Ltd 2003). Shading minimizes the incident solar radiation and prevents the building from overheating and, consequently, improves building energy performance (Kamal 2010). In high humidity climates and hot dry climates with warm winters it may be beneficial to use shades for windows, uninsulated and dark coloured walls, as well as outdoor living spaces throughout the year. However, shading requires a thorough design, as it may reduce incoming daylight and, therefore, increase the need for artificial lighting (Department of Industry 2013).

Shading can be natural (e.g. vegetation) or artificial (e.g. overhangs, louvers, awnings, internal blinds, controllable fins, etc). Natural shading presumes that passing of direct sunlight through the roof, walls and glazing is blocked by trees or other vegetation. Evergreen plants are recommended for hot humid and some hot dry climates (Department of Industry 2013). Vegetation can be planted not only near the building, but also directly on building's walls, which can further reduce energy demand for cooling (Urge-Vorsatz, Eyre, et al. 2012).

However, in a number of buildings (e.g. high-rise buildings, buildings located in the areas with high building density, etc.) natural shading may not be applicable. Moreover, in very hot climates it may be insufficient. In these cases artificial shading can be used.

Weston (2010) distinguishes between static and active shading devices. The latter can adapt to changing conditions, depending on lighting, time of day, and presence of the occupants in the building. Active shading usually takes the form of motorized metal fins and roll-down shades.

Light color of shading devices is usually more preferred in hot climates, as it enhances the reflection of heat and increases the potential for daylighting (Department of Industry 2013). In such climates the shading of roof surface may be beneficial for increasing thermal comfort and reducing cooling load. The roof may be covered, for example, with "concrete or sheet or plants or canvas or earthen pots etc" (Kamal 2010).

COOL ROOFS

A cool roof has a higher solar reflectivity of the surface and lower level of heat absorption than a conventional one. It is achieved by utilizing the light color of a roof surface and special highly reflective[1] and emissive[2] materials, which can reflect at least 60% of sunlight (this value for conventional dark-colored roofs is usually between 10 and 20%) and keep the temperature of the 'cool' roof 1.5-2 times lower in comparison to a conventional one (EPA 2007).

The main benefit of cool roofs is that it transfers less heat to the building, which is crucial in hot climates, thereby reducing cooling energy demand. Moreover, it helps to decrease a peak electricity use in commercial and public buildings, which occurs on weekday afternoons due to use of cooling, appliances and often lighting. Cool roofs can also improve human health, for example by reducing heat-related illnesses and deaths in buildings without air-conditioning during very hot periods (EPA 2007).

There are two main types of cool roofs: low-sloped and steep-sloped depending on roofing material. Traditionally, low-sloped roofs use built-up roofing or a membrane, and the primary cool roof options are coatings and single-ply membranes. The most common materials for steep-sloped roofs are asphalt shingles (EPA 2007).

Cool roofs can be a perfect solution for tropical and other climates, which do not require space heating, and can be less favorable for the areas, which could benefit from passive solar heating, as during winter buildings with cool roofs absorb less solar heat. However, this adverse winter effect is usually much lower than the amount of cooling energy saved during summer through the application of cool roofs (Wang 2008).

BUILDING MATERIALS

In hot and humid climates besides the need for cooling, there is also a certain energy requirement for the air dehumidification, which can represent a significant fraction of the total cooling load. It is not possible to lower this requirement through the passive measures described above. A potential solution is materials that absorb moisture if they are placed at the internal surface of rooms. Such materials can maintain nearly constant relative humidity inside. If humidity levels in a building drops the moisture from the materials can be released back to the air through ventilation (Urge-Vorsatz, Eyre, et al. 2012).

[1] Solar reflectance, or albedo, is the percentage of solar energy reflected by a surface (EPA 2007).

[2] Thermal emissivity is a relative term, which shows the amount of heat a surface material radiates per unit area at a given temperature, in comparison with an absolute black body, i.e. how readily a surface gives up the heat (EPA 2007).

SINGAPORE'S BCA GREEN MARK CERTIFICATION PROGRAMME

BCA Green Mark Certification Programme was first launched in 2005 to promote the adoption of green building design and technologies that improve energy efficiency and reduce the negative impact of buildings on the environment. It is a green building rating system developed specifically for the tropical and sub-tropical region and managed by the **Building and Construction Authority of Singapore (BCA)**. The introduction of BCA Green Mark Certification Programme was a bold initiative to move Singapore's building and construction industry towards environmentally-friendly buildings by providing a standard benchmark and guideline for the industry to follow when constructing new buildings or retrofitting existing building. It was first targeted at **New Buildings/ New Development** (i.e. non-residential, residential and landed house), followed by **Existing Buildings/ Existing Development** (i.e. non-residential, residential and schools). The BCA Green Mark Certification criteria periodically undergo a comprehensive review via extensive industry consultations with key industry players and stakeholders to set clear directions and feasible pathways in a new Green Mark version. The BCA Green Mark scheme has evolved since its inception and the criteria for New Non-Residential and Residential Buildings are currently in its 4th version. Today, the BCA Green Mark scheme is also not just applied to new and existing individual buildings, but deployed to promote environmental sustainability **Beyond Buildings**. This includes parks, supporting infrastructures, districts, rapid transit systems, and even **Occupant-Centric Spaces within buildings** such as in supermarkets, restaurants, office interiors and data centres.

Under the assessment framework, the buildings are assessed on five criteria - **energy efficiency, water efficiency, environmental protection, indoor environmental quality and other green and innovative features** that improve building performance to meet their sustainable operations goals and to reduce adverse impacts of their buildings on the environment and occupant health over the entire building life cycle. The buildings are then awarded one of **four Green Mark ratings: Certified, Gold, GoldPLUS and Platinum**. Certified Green Mark buildings are required to be **re-assessed every three years** to maintain the Green Mark status.

With the support from various green building policies and incentives, the number of Green Mark projects has grown from a mere 17 projects in 2005 to more than 2,300 projects currently. This translates to 67.07 million m^2 of cumulative gross floor area (GFA) or 27% of the total GFA in Singapore as of January 2015.

ACTIVE THERMAL COMFORT SYSTEMS

Strategies described above can significantly improve building energy performance. However, depending on the climate conditions and opportunity to benefit from these strategies, they may not be sufficient for satisfying all energy needs and ensuring sufficient level of thermal comfort. In this case utilisation of active systems may be necessary. Depending on the climate conditions different active systems might be preferable.

COOLING

Evaporative Cooling

Evaporative cooling systems work through cooling the air during evaporation of the water or another liquid into the vapour. Such systems require certain energy input to run the fans, which supply and drive the air through the cooler to the indoor space of a building. The energy need of an evaporative cooling system is much lower than those of a conventional one. Combining such systems with photovoltaics (to supply electricity to the fans) will further lower greenhouse gas emissions from cooling. Potential cooling effect is greater in the regions with lower absolute humidity (Urge-Vorsatz, Eyre, et al. 2012). Therefore, in hot and humid climates it will be beneficial to combine evaporative cooling with dehumidification systems, for example a desiccant dehumidifier. Evaporative cooling systems coupled with adsorption pre-dehumidification can provide a less energy-intense alternative to a conventional cooling system in tropical climate (Camargo, Godoy, and Ebinuma 2005).

Desiccant Cooling

In a desiccant cooling system, the process air is dehumidified in an adsorption process by a desiccant material, and then cooled by evaporative cooling to the desired temperature. Solid desiccants may include silica gels, zeolites, synthetic zeolites, activated alumina, carbons, synthetic polymers, while liquid ones - triethylene glycol solutions of lithium chloride and lithium bromide solutions (S. A. Kalogirou and Florides 2012)

To reuse the desiccant, water vapor adsorbed is driven off through a regeneration process, which requires heating from a thermal energy source. The heating process can use electricity, waste heat, or renewable energy (Zheng, Ge, and Wang 2014).

A system that utilizes solar thermal energy is solar powered desiccant wheel evaporating cooling, which consists of two subsystems: a solar subsystem and a desiccant cooling subsystem. The solar collector's role is to absorb solar radiation and heat up the water which is utilized in air heater to heat up regeneration air. Hot air from outside enters into the desiccant cooling subsystem, where it is dehumidified and heated in a desiccant wheel and subsequently pre-cooled in the heat exchanger and further cooled in evaporative cooler, after which it is transferred into the building. Air from the indoor space is driven back into the system for regeneration (Ge, Dai, and Wang 2014).

Underground Earth Pipe Cooling

Another way to cool the air before supplying it to the building is through utilisation of the temperature difference between air and the ground. In order to do that warm outside air can be drawn through earth pipes placed under ground. The air is driven by fans, which requires electrical input and passes through an air exchanger, where heat removal takes place. The amount of the heat removed depends on the magnitude of the difference in temperature of the outside air and the underground. In hot climates the underground temperature may not be sufficiently low, however, these systems may be used to pre-cool the air in conjunction with other cooling systems, for example, radiant ceiling cooling (Urge-Vorsatz, Eyre, et al. 2012).

Water-cooled air conditioners

The most commonly used type of air conditioners is an air cooled system. In hot and humid conditions they can solve both cooling and dehumidifying tasks. However, the coefficient of performance of such a system drops significantly when the ambient temperature is very high (above 35°C). An alternative cooling medium for air conditioning can be water, which is recognised as a more energy efficient alternative (Chen, Lee, and Ylk 2008).

AIR CONDITIONING IN SINGAPORE

There are two types of cooling systems commonly used in non-residential buildings in tropical countries:-

In Singapore, the prerequisite requirements of water-cooled and air-cooled air-conditioners are shown in table below:

(a) Water-cooled air conditioners

Green Mark Rating	Peak Building Cooling Load (RT)	
	< 500	≥ 500
	Minimum Design System Efficiency DSE (kW/RT)	
Green Mark Certified	0.80	0.70
Green Mark Gold	0.80	0.70
Green Mark GoldPlus	0.70	0.65
Green Mark Platinum	0.70	0.65

(b) Air-cooled air conditioners

Green Mark Rating	Peak Building Cooling Load (RT)	
	< 500	≥ 500
	Minimum Design System Efficiency DSE (kW/RT)	
Green Mark Certified	0.90	0.80
Green Mark Gold	0.90	Not Applicable
Green Mark GoldPlus	0.85	
Green Mark Platinum	0.78	

Solar cooling

Solar cooling is an attractive option for southern countries of the Northern Hemisphere and for northern countries of the Southern Hemisphere. Solar cooling systems can include the following types (based on Kalogirou and Florides 2012):

- Solar sorption cooling systems, which work in a same way as desiccant ones using solar energy to regenerate drying desiccant
- Solar mechanical systems, which utilize solar power to drive a conventional air-conditioning system. For example, solar electricity from a PV can be supplied to an electric motor to drive a vapour compressor. Solar collector can supply solar thermal energy to a heat engine, which would drive a vapour compressor, producing a cooling effect.
- Solar-supplied heat pumps, which use electricity for operation provided by photovoltaics.

Heat pumps

Ground coupled heat pump (GCHP) system is considered one of the energy efficient solutions for space heating and cooling, predominantly in heating-dominated climates.

GCHP systems consist of the following important parts: ground heat exchanger, heat pump unit, and the air delivery system (ductwork). The heat exchanger includes a system of pipes and is placed under ground on the building's site. The heat exchanger uses the temperature difference between the air on the surface and the ground (which is usually rather constant throughout the year) to cool or heat the medium (e.g. water) in the pipes, which is then supplied and circulated around the building transferring the heat or cool to the indoor space (NREL 2014).

In hot and humid climates, where buildings have only cooling loads throughout the year, the performance of the heat pump might be limited (Lam and Wong 2005), as there is a tendency for accumulation of the heat rejected into the ground during the operation of the pump around ground heat exchanger. This leads to the increase in temperature of water entering the condenser of heat pump and depresses the performance of the system. One of the solutions for this problem is to couple the heat pump with a supplementary heat rejecter, for example, a cooling tower, a shallow pond or a nocturnal cooling radiator, which can take different forms (e.g. simple metal surface, a flat plate collector, etc.) (Man et al. 2011).

District cooling

District cooling can be defined as cooling that is commercially supplied to the building(s) through a cold/heat carrier medium against payment on the basis of a contract. District cooling usually involves a distribution network to serve the energy needs of several customers within a certain geographical area. Such a type of cooling can also include local production and distribution of cooling energy to meet cooling energy demand of a commercial or public institution (Euroheat & Power 2006).

A number of technologies can be used in district cooling systems (Euroheat & Power 2006):

- "Free cooling" uses the extraction of cold water from the natural local resources (e.g. lakes, ocean, sea, etc.), which is transferred to the distribution network via heat exchangers and delivered to the building enabling its cooling
- Absorption chillers use heat as primary energy, which may come from a number of the processes taking place locally: municipal waste incineration, industrial processes and power production
- Heat pumps can be connected to the district cooling system. Working in the 'cooling mode' they can circulate water from natural reserves (sea, late, river, etc.) or waste water to provide cooling for the local buildings
- District cooling systems usually include storage technologies. Typically they are based on ice or water solutions and allow for storing energy for cooling produced (and not used) over night for the utilisation during the following day.

Centrally-produced district cooling can have an efficiency 5 - 10 times higher than conventional local electrical cooling equipment (Logstor 2007).

WORLD'S LARGEST DISTRICT COOLING SYSTEM

Marina Bay is a 360-hectare extension to Singapore's downtown area, which pioneered the use of district cooling (DC) in the city.

There are currently three interconnected chilled water production plants operating in the area with total planned capacity of more than 330 MW, which provide cold air through efficient district cooling to 14 buildings, with a floor area of more than one million m².

Plants have demonstrated high efficiency with the system COP exceeding 5.0. There are plans to expand the DC network to five inter-connected plants with a total installed capacity of 900 MW, which will supply about eight million m² of floor space with energy-efficient cooling.

Source: Maehara (2014), ABB (2011)

VENTILATION

Ventilation in energy efficient buildings is very important for providing fresh air and reducing cooling loads. There are two main types of ventilation, which can be applied in an energy efficient building: natural and forced ventilation.

NATURAL VENTILATION IN TROPICAL COUNTRIES

In tropical climate, designing ventilation system in buildings becomes very challenging with its high humidity level and hot climate all around the year, torrential rainfall, very low diurnal variation, higher earth temperatures than average air temperatures as well as relatively low wind speeds. Solutions such as evaporative cooling, earth cooling, natural ventilation and purging and large thermal mass might not be able to assure effectiveness of ventilation system. Hence, multi-dimensionality of climate factors should be considered with solutions provided to the right context in tropical countries.

In order to encourage effective ventilation design to promote natural ventilation in buildings, Singapore has set a requirement of using ventilation simulation modelling and analysis to identify the most effective building design and layout under its Green Mark Platinum rating for residential building and non-air-conditioned non-residential building, including common areas like staircases and lobbies. In general, the buildings must meet minimum weighted average wind velocity of 0.6 m/s within the units.

Natural ventilation is possible due to pressure difference at the inlets and outlets of a building envelope and the difference between indoor and outdoor temperatures, as a result of wind velocity, whereas "forced ventilation is achieved by mechanical means, using fans to reach and control the appropriate air speed" (Energy Research Group, Central Institution for Energy Efficiency Education, and Architecture et Climat, Centre de Recherches en Architecture 2000). Natural ventilation usually takes place through opening windows and, therefore, causes heat and cooling losses; moreover, it does not always provide a sufficient amount of fresh air (NREL 2001). As energy efficient buildings often aim at high level of airtightness and minimization of energy losses, controlled ventilation systems with heat or cooling recovery from the ventilated air is preferable.

Feist, Peper, and Görg (2001) and Feist (2006) recommend forced ventilation with high efficient heat or cooling recovery for energy efficient buildings. In some countries this is already a legally enforced requirement. The main feature of this ventilation strategy is a heat exchanger. Warm or cold exhaust air flows from the room to the heat exchanger. At the same time colder or warmer fresh air enters the heat exchanger from outside the building. The energy captured on the plates (either cooling or heat) is transferred to the fresh air supplied to the room. Energy recovery ventilation consumes low amounts of energy (2-7 kWh/m² year) and reduces heat losses considerably, however, regular replacement of air-filters is required to ensure its high performance (Strom, Joosten, and Boonstra 2005).

Another option for energy efficient ventilation is the use of earth buried ducts. It uses the temperature difference between the outside air and the ground allowing for preheating (if heating is needed for a building) or pre-cooling the circulated air (Feist 2006). In hot and humid climates such systems often require coupling with dehumidifiers.

Other potential solutions for hot and humid climates can be a combination of thermal mass with night ventilation and selective use of air conditioning. Such a strategy can be beneficial for reducing the cooling load of the building (Tenorio 2007). Night ventilation uses the ambient air temperature difference between day and night, giving the opportunity to cool the building's thermal mass exposed to the outside air and the air located close to the thermal mass inside the building (Urge-Vorsatz, Eyre, et al. 2012). Cross-ventilation, which can be achieved through open design and/or use of fans, can be also used in hot and humid climates during the night (Department of Industry 2013).

WATER HEATING

Lower energy consumption for water heating and related GHG emissions reductions can be achieved through reducing the demand for hot water or heating it in more efficient ways. The actual demands should be assessed in collaboration with the main users, in households often women.

REDUCING HOT WATER DEMAND

There can be a number of ways to reduce hot water consumption, for example through:

- Choosing water efficient showers, toilets, taps and appliances (e.g. washing machines, dish washers, etc.).
- Minimising paving of outdoor areas as this increases heat radiation and water runoff from the site.
- Reusing water through waste water reuse, harvesting and filtering of rain water (Department of Industry 2013).

Installing water efficient shower heads can halve the hot water use in the building. Water and energy efficient washing machines and dishwashers can also significantly reduce the consumption of water and energy. Consumers' choices of more water efficient products can be informed by a labelling scheme (Department of Industry 2013).

ENSURING ENERGY EFFICIENCY

Heat pumps

As mentioned above, heat pumps can perform as energy efficient water heaters. For hot and humid climates, air-sourced and CO_2 heat pumps can operate with high performance. Heat pumps can also be designed in a way to use waste heat from air conditioners and refrigerators, which might be very advantageous for tropical climates with growing demand for space cooling (Department of Industry 2013).

Natural gas water heaters

Natural gas can offer a relatively low-emission solution, if the systems have a high level of efficiency. Gas consumption can be significantly reduced if the heaters are coupled with solar collectors, that preheat the water in the storage tank (Department of Industry 2013). The storage tank and connecting pipes should be well insulated to minimise heat losses.

Tankless water heaters

Another option can be tankless water heaters, which can be powered by both gas and electricity. These systems heat up water directly as it circulates in the pipes without storing in the tank. Gas-fired heaters usually provide higher flow rates than the electrical ones. In general, tankless heaters might be disadvantageous during high peak loads and may not be suitable for large households or intensive multiple uses, unless more than one heater are operating in parallel. Tankless water heaters can be also used as a booster for solar water heating (U.S. Department of Energy 2014).

Solar water heaters

Solar water heaters are "a special kind of heat exchangers that transform solar radiation energy to internal energy of the transport medium" (Tyagi et.al. 2012). Solar collectors usually consist of several modules with units of 2.5–10 m^2, which can replace conventional roofing material and perform the insulation function for the roof. A typical solar water heating system consists of an absorber, a heat-carrying pipe and a storage tank. The main function of the absorber is to capture the sunlight and transfer its heat to the fluid, which then supplies the heat to the water in the tank (Eicker 2001).

The two most common types of collectors are flat plate units and evacuated tubes. Evacuated tube collectors usually have lower efficiency in cold and cloudy weather in comparison to flat plate ones (S. Kalogirou 2009). For the best performance solar collectors should be mounted on the roof facing North (in Southern hemisphere) with the tilt angle approximately corresponding to the location's angle of latitude. When solar energy is not sufficient to cover a building's demand for hot water (e.g. cloudy weather, peak hours, etc.), solar collectors are often backed up with gas or electric boosters (Department of Industry 2013). In tropical climates, which usually have high availability of solar resources throughout the year solar water heating can be very efficient.

Another option for solar water heating can be a photovoltaic/thermal hybrid solar collector (or PV/T collector), which is a combination of photovoltaic (PV) panels and solar thermal components. It uses PV cells as a thermal absorber to convert electromagnetic radiation into electricity; solar thermal collector converts solar energy into heat and removes waste heat from the PV module. Therefore, such systems generate both electricity and heat from the same technology and roof surface, which can be used in the building for different end-uses (Dupeyrat et al. 2011). Extraction of the heat from the PV modules prevents them from overheating, which is typical for hot weather, and, thereby, maintaining its efficiency (Cartmell et al. 2004).

LIGHTING

Energy efficient lighting includes a combination of the optimal utilisation of daylighting with the energy efficient active lighting systems.

DAYLIGHTING

"Daylighting is the use of light from the sun and sky to complement or replace electric light" (O'Connor et al. 1997). Daylighting should be designed taking into account orientation of the building, shading strategies and glazing technologies to optimise the amount, intensity and spectrum of the daylight admitted into the building and at the same time to minimise heat gain during the cooling period, which is especially important for tropical climates (Department of Industry 2013). It is recommended that all glass surfaces should not be directly exposed to the sunlight, which can be ensured through shading and/or glazing technologies that reduce heat transfer (Carins Regional Council 2011).

Daylighting can help to reduce cooling loads, as the luminous efficacy (the ratio of light to heat) of natural light is 25–100% greater than that of electric light systems (Urge-Vorsatz, Eyre, et al. 2012). Therefore, if the heat gain is minimized, for example through advanced glazing, tuning or coating, the daylighting's contribution to indoor temperature increase is lower than that of the electrical lighting systems.

The effectiveness of natural light utilisation can be improved through application of light colours on walls, floors and horizontal surfaces inside the building, and by aligning internal surfaces to maximise light reflection from light sources (Carins Regional Council 2011).

The amount of sunlight received in the interior of the building can be enhanced by installations such as skylights, atriums, sun shelves, solar tubes, glass bricks, etc.

DAYLIGHTING AND ENERGY EFFICIENT ARTIFICIAL LAMPS

Energy use for artificial lighting can be reduced if daylighting in the building is enhanced. Abundant sunlight benefits the tropical countries a lot. Singapore encourages the use of daylighting and glare simulation analysis to optimise the use of effective daylighting integrated with automatic electric lighting control systems in both residential and non-residential buildings through the Green Mark certification scheme. Energy efficient artificial lighting is encouraged in order to minimise energy consumption from lighting usage while maintaining a proper lighting level.

In terms of current practices, the industry is mindful in selecting the types of lighting. LED lighting has been a good choice if it is a reputable and proven brand. Other energy efficient lighting has also been introduced to the market, such as induction lamp, it was being used in Changi Airport, Singapore and its energy saving could achieve up to 40%. Now, the induction lamps are being widely used in large compounds such as warehouse application and postal sorting bays. The induction lamp also has shorter payback period, which is 2-4 years as compared to LED lamps with 6-10 years.

ACTIVE LIGHTING SYSTEMS

The most common ways to reduce energy use of the active lighting systems are through installing energy efficient bulbs and introducing control strategies for electric light usage.

There are various types of the light bulbs available on the market with different efficiency levels. Table 3 presents the data on the main characteristics of different types of bulbs. Incandescent bulbs, which are still dominant in the majority of countries, have the lowest output and shortest lifetime. Therefore, the replacement of such lamps with more efficient alternatives will result in electricity savings. By replacing all inefficient incandescent lamps with compact fluorescent lamps (CFLs), Southeast Asia could save 16.52 TWh annually (UN Environment and GEF 2011).

Table 3. Parameters of different types of lighting

TYPE	LIFETIME, '000 HOURS	APPROX. WATT FOR SIMILAR LIGHT OUTPUT
Incandescent light bulbs	1-1.5	60
Halogen bulbs	1.5-2.5	40
Fluorescent tubes	8-10	14
Compact fluorescent lamps	5-8	14
Metal halide bulbs	7-12	10
LEDs	30-70	10

Source: Combination of different sources. Numbers only indicative

There is a number of strategies to control utilization of electric light in a building, based on the activities, time of the day, external conditions, etc. Most widely used strategies are summarized in Table 4.

Table 4. Light control strategies

LIGHT CONTROL STRATEGY	APPLICATION
Scheduling	turning the light on when needed, and turning it off when not needed; installing manual (in a wall switch) or automatic time clocks , occupancy and movement sensors
Daylighting	turning off the electric lighting or reducing its use if enough natural light is available (usually by means of photosensors' signals to the lighting control system)
Lumen maintenance	monitoring luminance levels of lamps and increasing delivered power over their life cycle (new lamps are operated at partial power, and deteriorated lamps - at full power)
Tuning	dimming lights to the lowest level that does not affect the performance in order to avoid overlighting
Adaptation compensation	reducing the visual difference (luminance variance) between the background and local (task) lighting
Peak demand limitation	detecting the building's peak energy draw and slowly reducing power to lighting systems with a minimal impact on occupants
Tasks lighting	distinguishing different levels of light intensity, according to the functions of space: an adequate level of background lighting and more intensive task lights
Solar lighting	utilizing solar energy to power various lighting devices, e.g. LED lights with polycrystalline silicon solar panels for ceiling and wall mounting, portable solar reading lights, portable solar lanterns and torches (Philips 2014)

Data sources: adapted from Eley, Tolen, and Benya (1992), Adelaide City Council (2011), Philips (2014)

COOKING

Almost half of the population in Southeast Asia still relies on traditional use of biomass for cooking. Energy efficiency improvements and technology choices for this type of end-use is crucial (IEA 2013) and should specifically be assessed in collaboration with household representatives, including women that commonly are responsible for cooking in families. For the successful implementation of any cooking technology in a particular area, local needs, food preferences, cooking habits, availability of local materials and social conditions must be taken into account.

Improved biomass cooking stoves

Biomass cooking stoves are devices, in which biomass (wood, agricultural residuals etc.) is used to produce heat for cooking. There are different types of such devices with very different levels of efficiency, health and environmental impacts.

More efficient types of stoves, which also rely on the solid biomass, have been developed and disseminated in different developing countries. The design of such stoves includes improvements in the combustion chamber, insulation materials, heat transfer ratios, stove geometry, and air flow, which results in fuel savings between 30% and 60%, reduction in indoor air pollution levels up to 90% compared to the open fires (Urge-Vorsatz, Eyre, et al. 2012).

One example for an improved cooking stove is the rocket stove. It can be built from local materials with light-weight insulation (e.g. ceramics, brick, clay or steal) and cylindrical or L-shaped combustion chamber to minimise heat losses. It has been disseminated in some countries of Africa and Asia. Another example is the improved biomass cooking stove Save 80. It is usually made of stainless steel and is quite common in Southeast Asia. It allows for saving up to 80 % of wood fuel in comparison to a three-stone stove. (Adria and Bethge 2013).

Gas cooking

Gas cooking stoves can use natural gas, propane, butane or other flammable gas to produce heat for cooking purposes. In this type of stoves gas is burnt and the produced heat is transferred to the food being cooking. Gas for the stoves can be also supplied from gas bottles in the buildings not connected to the gas pipes. In comparison to electric stoves devices using gas burners and natural convection for cooking are usually more efficient in terms of primary energy. Some models of the stoves place burners on top of a stainless steel or ceramic surface, while in others the burners can be under a glass ceramics. The efficiency of the former is typically higher (Adria and Bethge 2013).

Solar cooking

Solar cookers are devices that are used to prepare food by harnessing solar radiation. The technology is most appropriate in climates, where high solar radiation is available throughout the year (Adria and Bethge 2013). Modern solar cookers are highly efficient appliances as they do not require fuel input and can reach temperatures of 180 - 200°C, which is sufficient for preparation of the majority of dishes. They can be used outside of the home and, therefore, allow for eliminating the increase in indoor temperatures from cooking. Sun cookers also benefit from a long lifetime, as they do not incorporate moving parts or complex technologies, which could require maintenance or repair. Some models may include sun-track indicators, which ensure optimal alignment with the sun (Eartheasy 2014).

Electric and Induction cooking

There are different types of cooking units, which can be used in electric stoves, for example, iron, infrared, halogen or induction units. Most of the types emit heat to the cooking pots, which enables different means of cooking. Induction-based cooking units create a magnetic field, which induces a current in the ferromagnetic bottom of a pot specially designed for this way of cooking. Up to 90% of electricity supplied through the coils in the stove will be converted into heat energy through the cooking vessels. Many households are switching to induction for their cooking due to the safer and cooler cooking environment it provides. With recent improvements in the technology, induction cookers are now better than ever. Cheaper manufacturing from China has reduced the cost of induction cookers to levels that are affordable to every household and thus, it is also becoming more prevalent in emerging countries like India.

Source: www.green-energy-efficient-homes.com/energy-saving-induction-cooking.html

APPLIANCES AND EQUIPMENT

Appliances provide a variety of services in residential and commercial buildings. Their operation requires electrical energy supply. With the population growth and improvement of the living standards, higher income and wider electrification, the energy consumption for appliances is increasing exponentially in developing countries. As can be seen in Figure 2 appliances and equipment have a substantial contribution to the energy consumption growth by 2050 in the ASEAN region. One of the possible ways to mitigate this growth is to ensure a wide-scale utilisation of highly energy efficient appliances.

All main appliances used in residential and commercial buildings (refrigerators, freezers, dishwashers, washing machines, ovens, stoves, computers, etc.) can be energy efficient (WSU 2003).

Minimum energy performance standards (MEPS) have been introduced by a number of countries to ensure that the appliances present on the market have an adequate level of efficiency. In order to inform consumers' choice of products about their efficiency energy labels are often used. Energy labels can be mandatory or voluntary and have been adopted by a number of countries in the world.

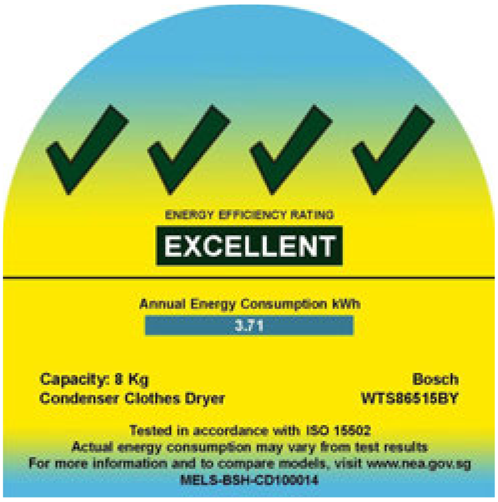
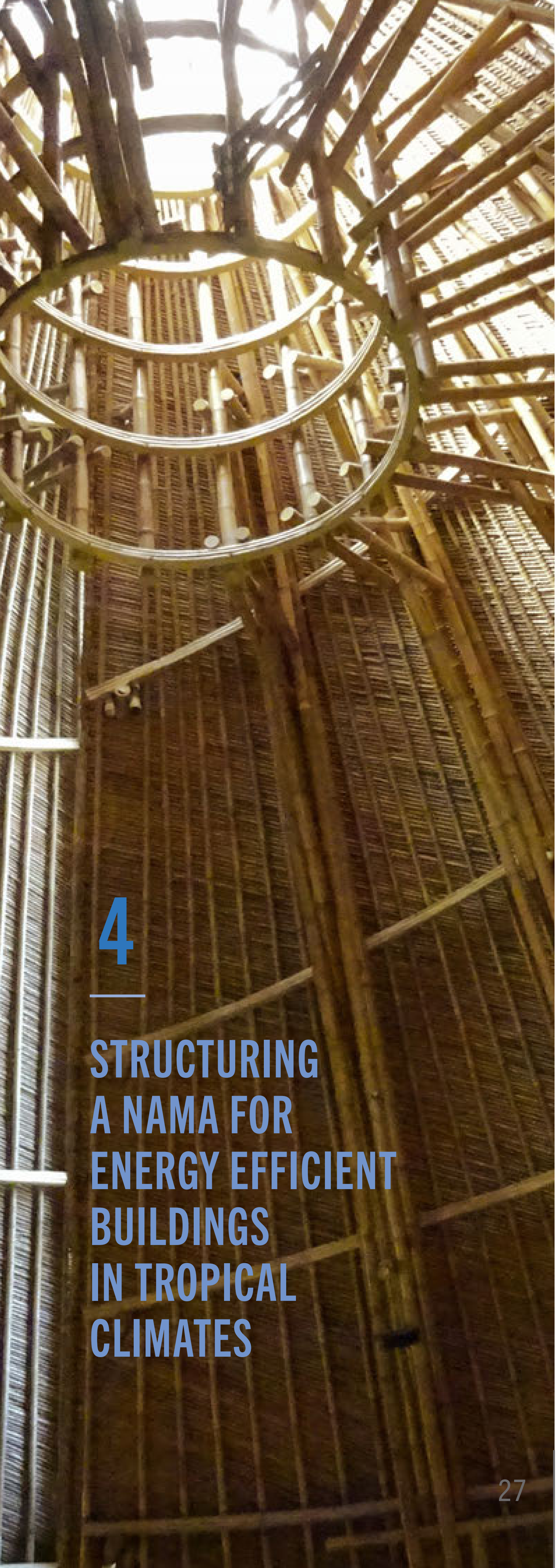


Figure 3. Energy label in Singapore

Energy labels are usually based on a certain rating system of products' energy performance. For example, Singapore has adopted a tick rating system, according to which most product types can receive between 1 and 5 ticks depending on their energy performance, with 5 ticks corresponding to the highest level of energy efficiency. The methodology for calculating a number of ticks a particular product is eligible for depends on the product type (see National Environmental Agency 2014). A number of ticks is displayed on the energy label, which is placed on the product to inform consumers during their purchase (see Figure 3). The key strategy for reducing energy consumption from appliances and equipment is to replace old and/or inefficient ones with the alternatives, which have higher energy performance. Additional features of certain types of appliances can help to reduce energy consumption of particular units. For example, utilisation of sleep modes and energy saving regimes in computers can reduce their energy use by turning off the unneeded capacity; automatic brightness control in display technologies in accordance with presence of users and/or ambient lighting can result in energy savings of up to 70%; in refrigerators additional energy savings can come from enhanced insulation, improved compressors, heat exchanger and controls (Urge-Vorsatz, Eyre, et al. 2012).



4

STRUCTURING A NAMA FOR ENERGY EFFICIENT BUILDINGS IN TROPICAL CLIMATES

Development of a comprehensive NAMA proposal requires a holistic approach to assessment of the national context and background, identifying existing challenges and barriers. This includes an assessment of market readiness; evaluation of the institutional context and analysis of stakeholders and stakeholder behaviour conducted prior to NAMA design. The context and background should include a description of the current level of and approach to energy efficiency in buildings. Relevant national policies, objectives, and laws is the foundation for this assessment, such as:

- energy efficiency policies;
- existing energy performance standards;
- product labeling requirements;
- the national climate change policy and targets;
- low-carbon development strategies, and
- any sector specific energy efficiency strategy.

This information serves as both a baseline (starting point of the NAMA) and a foundation for integrating the actions into national policy. Both are important considerations for NAMA financiers, but should be equally or even more important for NAMA developers: Without such anchoring the risk that the NAMA becomes a stand-alone action with no transformational qualities is significant. The barrier analysis provides the basis for defining the interventions; the activities that form the core of the NAMA, while considering and/or addressing any barriers that might have hindered development so far.

When framing the NAMA, existing barriers to a transition towards more energy efficient buildings should be identified and analysed. The barrier analysis provides the basis for defining the intervention; the activities that form the core of the NAMA. Table 5 classifies barriers according to four groups: institutional barriers, behavioural barriers, financial barriers and the absence of enabling environment as a barrier.

*Table 5. Barriers to energy efficiency transition in buildings**

INSTITUTIONAL BARRIERS	BEHAVIOURAL BARRIERS	FINANCIAL BARRIERS	TECHNOLOGICAL BARRIERS	ABSENCE OF ENABLING ENVIRONMENT
Lack of the framework for participation for a variety of stakeholders	Stakeholders' split incentives and conflicts	No acceptable collateral	Imperfect information regarding technology solutions available	Lack of market incentives
Lack of coordination and confusing mandates among administrative and regulatory entities	Rebound effect	Prohibitive interest rates	Patent protection and technology transfer	Limited access to technology
Regulatory gap	Lack of awareness, imperfect information, regarding regulatory changes and innovations	No access to insurance	Lack of understanding of how to adapt technology to regional conditions	Industry fragmentation
Lack of regulatory incentives	Life-style, cognitive and behavioral patterns	Limited access to construction finance		Poor feedback
Enforcement and compliance gap	Insufficient service quality	Lack of awareness in the banking sector		Economic informality
Stakeholders have insufficient knowledge about energy end-use and cost-effective approaches to energy saving.		High upfront cost and limited understanding of incremental costs estimation, due to complicated methodologies		
Lack of integration between national targets and local policy				
Insufficient data collection systems		Risk aversion		

Table adapted from IPCC 5, Buildings Chapter 9 (Hinostroza et al., 2007; WBCSD, 2007; Levine et al., 2007, Cheng, 2010), and Carbon Lock-In: Barriers to Deploying Climate Change Mitigation Technologies. (Brown M., J. Chandler, M. Lapsa, and B. Sovacool (2008b). Oak Ridge National Laboratory US. Available at: www.ornl.gov/sci/eere/PDFs/ORNLTM-2007–124_rev200801.pdf.

ASSESSMENT OF MARKET READINESS FOR ENERGY EFFICIENT BUILDINGS

The maturity of a market for adopting a given level of energy efficient technologies in buildings may be determined through four interrelated parameters:

1. Support Framework for energy efficient buildings: Government policies, regulations, and engagement programs have played central roles in any country moving towards higher levels of energy efficiency in the building sector. Such support framework includes energy efficient buildings targets (building code), financial incentives, loan programs, building mandates, and outreach campaigns. Support frameworks may also be negative in the form of policies that promote inefficient building, particularly energy subsidies.
2. National Conditions: The relevant national conditions include the general climate, energy efficient buildings penetration and market growth, energy demand trends, and the competitiveness of energy efficient buildings compared to other buildings (cost of energy, cost of construction, taxes etc.).
3. Financing: Financing takes into account national macroeconomic conditions, the accessibility and general level of development of the banking sector as well as financing practices and the cost of financing.
4. Business Climate: The business climate consists of elements of points 1 and 2 above as well as actual enforcement of efficiency standards for buildings, the judicial system, level of transparency and corruption in the sector, and the presence of associations that support energy efficient buildings.

The market assessment may be represented in simple graphics – the larger the area covered by the figure; the more ready the market (Figure 4). It will also illustrate which dimension would need attention in order to improve conditions for implementing a NAMA for energy efficient buildings.

Not all parameters are equally possible to influence, and most often it will be beneficial to address more than one parameter in order to improve the framework for promoting energy efficient buildings in the market.

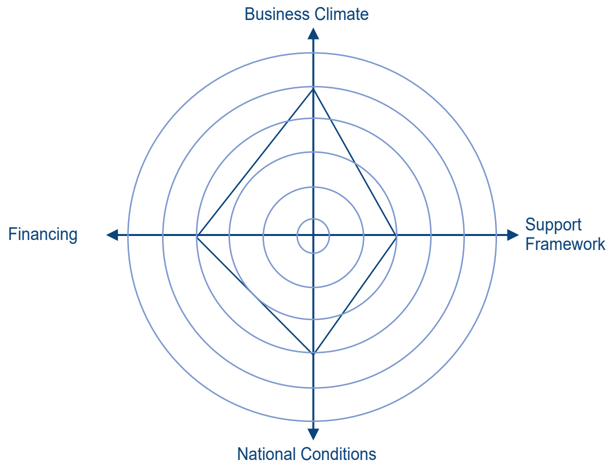


Figure 4. Assessment of market readiness

ASSESSMENT OF THE INSTITUTIONAL CONTEXT FOR THE BUILDING SECTOR

Institutional arrangements are unique to each country's political, cultural and socio-economic context and are ultimately associated with planning styles. NAMA development does not require the establishment of separate or parallel institutional arrangements – it is simply embedded in current structures. That said, some of the barriers that NAMAs may encounter are linked to institutions. As mitigation actions require multi-stakeholder involvement from planning to implementation, a thorough understanding of the relevant institutions involved in the NAMA, from development to implementation, is essential. The institutional context is a key component in development and implementation of a NAMA.

NAMA host countries may consider revising their current national institutional arrangements for climate change in such a way that they tackle climate change more effectively. Mainstreaming climate change into institutions and planning processes would also support NAMA development in the sense that parallel structures are avoided, while taking into consideration planning styles, leadership, inclusiveness, participatory processes and ownership. For instance, sector-governing bodies' empowerment, leadership and ownership with regard to mitigation actions are claimed to be crucial factors of success.

Although the building sector is under expansive regulation it is also a sector driven by significant private entrepreneurship, often by large and powerful corporations, but also a myriad of small and medium enterprises and small craft workshops. In many NAMA host countries regulation and enforcement structures are therefore facing significant challenges, mainly due to lack of resources, but also because of development dilemmas posed by on the one side demands for fast development and on the other a conscious and well-planned development. To the extent possible, therefore, institutions and regulatory authorities should consider frameworks that are 'self-regulating', where incentives are aligned with the desired development. The institutional aspect of climate-change governance from a sectoral perspective contains two barriers: duality of roles in management and coordination, and weak inter-sectoral coordination. These barriers can often be overcome if the roles of the regulator and that of the operator are separated – which is common good practice.

Without supporting policies and legislation to incentivise investment in energy efficient buildings, as well as State-led actions to remove the most significant non-financial barriers, rapid technological scaling-up is unlikely to occur. Decision-makers have to identify, ex-ante, mitigation potentials, development impacts, suitable private sector incentives and sources and mechanisms of support – and indeed areas of taxation in order to divert practices away from unsustainable conduct. Therefore, the primary responsibility for developing mitigation strategies and actions lies with national government, which also has the responsibility for defining the roles of different institutions and organizations in terms of identifying, developing, implementing, monitoring and enforcing NAMAs. The government also sets the framework for the participation of other stakeholders, such as the private sector, sub-national authorities, etc., in implementing mitigation actions. The establishment of a coordination agency to harmonize actions and enhance cooperation between various stakeholders is important for mainstreaming of NAMA activities into national policies and fostering implementation.

So far the most common approach adopted by Parties in handling climate-related activities is to nominate a climate-change focal point and to designate one responsible entity or ministry. In many cases, the Ministry of Environment is responsible for policy-making and implementation, budget allocations and international negotiations at the same time. This may be a natural anchoring, but often it also poses challenges in relation to achieving priority of actions within the responsible line ministries and, importantly, also the ministry of finance. Although a NAMA focal point may well be anchored in the Ministry of Environment, the actual development of the NAMA should materialize in the line ministry, i.e. in the case of buildings in the equivalent of a ministry for buildings and construction. However, other line ministries may have roles as well, e.g. the Ministry of Water Resources, the Ministry of Energy, the Ministry of Transportation and not least the Ministry of Finance. All the competent national institutions should be involved in the NAMA development in order to make sure that the NAMA is mainstreamed into the existing system and framework. Further entities involved in activities encompassed by the NAMA may be civil institutions, interest organizations, and of course private business. In order to navigate among all these stakeholders and institutions a national coordinating committee should steer the process and make sure that all relevant stakeholders are included in the process.

EXAMPLE FROM INDONESIA OF INSTITUTIONAL ARRANGEMENTS FOR CLIMATE CHANGE MITIGATION

The Government of Indonesia intends to achieve its national greenhouse gas emission reduction target by means of NAMAs. Indonesia's national framework for climate change mitigation establishes the foundation for NAMA development and implementation, ensuring institutional fit and coordination. The government believes that the NAMAs require institutional reform and regulatory adjustments in order to establish an effective regulatory regime for overall climate change mitigation.[1] Indonesia's NAMA framework contains three elements: actions, governance and mechanisms. It is a good example of a significant effort to ensure coordination and mainstreaming of NAMAs into national policies, coordinated by a single inter-ministerial agency while responsibilities for implementation remain with the line ministries. The coordination of regulatory activities, stakeholder participation and financial mechanisms are supported by institutional arrangements.

Regulatory framework

Indonesia's extensive regulatory framework for addressing climate change mitigation was initiated in 2007 with the National Action Plan for climate change. It was further developed into the National Action Plan of GHG Emissions Reductions (NAP-GHG), which is a guideline for government agencies, communities and businesses for efforts to reduce GHG emissions. The NAP-GHG is a principal tool for institutions in planning, implementing, monitoring and evaluating GHG emissions. The National Mitigation Action Plan on GHG Emissions Reduction (RAN-GRK) is built on NAP-GHG and is a document open to adjustments and development, that provides the foundation for various national institutions and local governments for the implementation of mitigation actions (REF RAN-GRK, 2011). RAN-GRK provides an overview of the national potential for mitigation actions, and encourages the design of programmes and actions to reduce GHG emissions. RAN-GRK aims to provide guidance for concrete actions needed to reach the 26-41% emissions reduction target by 2020.

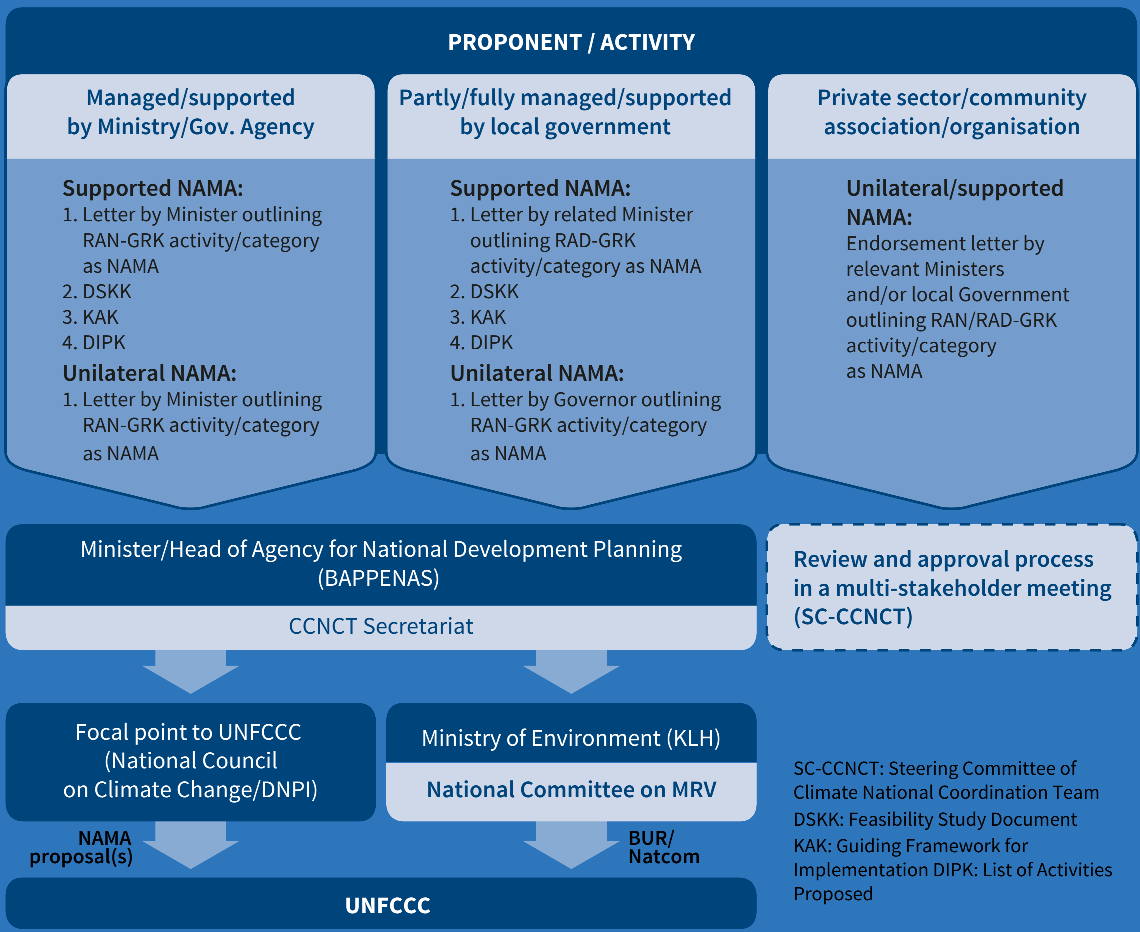
Institutional arrangements

The government of Indonesia has already been taking steps towards reforming and rearranging its institutions to respond to the mitigation challenge. In Indonesia, mitigation activities have been led from the national Planning Ministry (BAPPENAS), which has helped to ensure integration into traditional development planning. There is a strong political commitment to mainstream climate change into national policy and developmental priorities, and commitment to safeguard multilevel cooperation.

In 2008, Indonesia created a new institution to serve as the primary body for policy coordination on climate change with a Presidential Decree (No. 48/2008) for the establishment of National Council on Climate Change (NCCC). Codified by the Presidential Regulations this council is chaired by the President, with Coordinating Ministers for Economic Affairs and for Peoples' Welfare serving as vice-chairs, and with sixteen cabinet ministers and the Head of Meteorology, Climatology and Geophysics as council members. Clearly defined roles and responsibilities of agencies and stakeholders guide the policy-making, implementation and enforcement. The NCCC acts as the national focal point on climate change and submits NAMAs to the UNFCCC as illustrated below.

[1] http://unfccc.int/resource/docs/2014/sbi/eng/inf01.pdf

National Submission Procedure tor NAMAs



There are multi-step procedures in place to ensure review and appraisal by the variety of agencies on different levels, and the quality of submission. The respective proponents submit potential NAMAs to the respective line ministries, which reviews and forwards to the Steering Committee of Climate Change National Coordination Team (SC-CCNCT) and BAPPENAS for review and appraisal. SC-CCNCT and BAPPENAS ensures consultations with relevant stakeholders. Afterwards, the National Focal to UNFCCC (NCCC), the National Committee on MRV and the Ministry of Environment review the proposal and submit it to the UNFCCC.

Within the NCCC's responsibilities lies engagement in international negotiations and communication between UNFCCC Secretariat and relevant governmental authorities, but it has no legal recognition or executive functions. The NCCC includes operating secretariat, sectorial working groups consisting of permanent full time staff, and policy development and implementation monitoring office.

Two other ministries, BAPPENAS and the Ministry of Environment, are in charge of coordination with the overall developmental goals as well as Measurement, Reporting and Verification (MRV) in the context of climate change mitigation actions. Every line ministry is responsible for collecting data and drawing up a greenhouse gas inventory within their jurisdiction in support of data aggregation performed by the Ministry of Environment.

The Ministry of Finance is responsible for identifying fiscal policies, financial incentives mechanisms and budgetary allocations for addressing climate change. Among its duties is directing domestic and foreign investors in prioritization of investments in mitigation and adaptation in relation to climate change. One of the key functions of the Ministry is to coordinate the activities of climate-change financing in the PIP (Indonesian Investment Agency) programs.

Enforcement and implementation at the regional level

In Indonesia the provincial government is responsible for making mitigation action plans for the provinces, in line with their local development priorities and plans, including the respective capability and capacity of each regional area. RAD-GRK provides guidance for development and monitoring plans. The tasks of RAD-GRK are to align local development priorities with national climate change mitigation efforts and also to serve as a basis for the upcoming development of monitoring indicators. The line ministries and provincial governments are in charge of mitigation actions implementation within their own domains. They are responsible for collecting information on implementation and reporting to BAPPENAS annually. Ministry of Internal Affairs provides support to BAPPENAS ensuring integration of climate change mitigation actions into the plans and programmes of the provincial governments.

ASSESSMENT OF STAKEHOLDERS' BEHAVIOUR

One key precondition for developing a successful NAMA for energy efficient buildings is knowing the way in which building owners, users and other stakeholders in different circumstances are likely to react to the energy efficiency measures introduced. In the building sector, probably more than in other sectors, there are numerous stakeholders with opposing interests – many of which are the fundamental barriers for energy efficiency improvements. The bullet points below capture some, but not all types of conflicting interests depending on roles in planning, developing, financing, constructing, owning, managing and occupying buildings – all of which must be taken into account in the implementation of energy efficiency measures in the building sector. Stakeholders' conflicts of interest, interactions and distribution of authority impact the adoption of energy efficiency measures in buildings and create barriers to energy renovation as well as construction of energy efficient buildings, even in the face of improved building codes. The conflict of interest and split incentives among these groups of stakeholders lead to difficulties in implementing energy efficiency measures.

- **Different levels of government.** National regulation, such as building codes and norms, affects all stakeholders, but local government is often powerful enough to influence, both positively and negatively, the adoption of energy-saving technologies according to such codes (Pinkse and Dommisse, 2009; Comodi et al., 2012). The scope can be limited by regional and local regulation, and the local government often owns the land where buildings are sited, or it has the power to decide about the construction. Consequently, its power over decision-making processes is often high (Albino and Berardi, 2012).
- **The Developer-Owner.** A construction process may involve several stakeholders depending on the purpose of the future building. It may be developed for a future owner and occupier, but a construction company without owners and/or occupiers identified from the outset may also develop it. The building may be rented out by the developer and, upon achieving a certain level of occupancy; the building may be sold to a building owner and manager. No matter which model, the developers have a crucial role in determining a building's future energy performance, since they make decisions about building design, including orientation, equipment, and construction materials. Funds are not commonly allocated to energy efficiency measures, either due to shortage of financial resources, or in order to maximize profits as the price of buildings are commonly benchmarked against simple square meter prices of other buildings. If the future owner is known at the outset, operational costs affiliated with occupying the building may – but might also not – be considered during development. If the future owner is also the future occupant, it may be more likely, depending on how operational costs are entertained. This is a concern not only in private real estate development, but also for public sector buildings that may be owned by one public sector entity, but occupied by another. Even if operational costs are considered in the development of the building, owners might be sceptical regarding promised energy savings and the prospects for saving cost. These economic conflicts of interest are probably the most challenging barriers.
- **The Owner-Occupant.** The owners have a large impact on what energy efficiency improvements are included and to what extent they are implemented. However, real estate holding periods biased to favour short-term investments. The owner pays for upfront capital costs, but energy savings from efficiency upgrades benefit the occupant. Undertake energy efficiency, renewable energy, and water efficiency projects require large up-front payments by the owners. The situation in which the owner pays for upfront capital costs, but energy savings from efficiency upgrades accrue to the occupant is often referred to as "split-incentives". Occupants are temporarily beneficiaries of energy saving measures and sharing the costs of long term energy efficiency projects in the buildings is financially unattractive to them. The occupant collects the benefits from the solutions that deliver short-term saving, such as more efficient lightning. However, they might be reluctant to invest in such solutions. It might intensify the negative response if the electricity tariff is relatively low.
- **The Owner-to-Building Manager.** The owner might reject energy efficiency options proposed by the buildings manager and allocate funds to other urgent issues. For managers that are not interested in increasing their workload and dedicating time to get familiar with new technologies the perverse incentive can contribute to a laissez-faire attitude that impedes efficiency.
- **The Owner-Financier.** Small energy efficiency lenders are met with a number of obstacles while seeking financing for energy efficiency measures. The perception prevails of high transaction costs, risk aversion, competition with other investments, lack of awareness regarding costs and benefits and availability of energy efficient technologies, and there may be lack of marketing and awareness for incentives. Financiers are dealing with the lack of regulatory support and reporting on the investment hurdles.
- **The Occupant-to-Building Manager.** The goal of the building manager is to provide service to the occupant that satisfies their comfort needs. For instance, increasing or decreasing temperature, intensifying the ventilation increases building energy consumption and stifles the overall building energy efficiency.

Research suggests that for successful adoption of energy efficiency measures and technologies, it is necessary to favour more integrated relationships between stakeholders in the building sector, to improve conditions for market demand of energy-saving technologies and create enabling regulatory environment in the building sector to support energy efficiency innovations {Berardi:2013de}. Most of these incentives are of an economic nature.

POSSIBLE MEASURES TO ADDRESS CONSUMER BEHAVIOUR CHALLENGES

Generally, tenants should be encouraged to take a more active role in improving energy efficiency of the occupied buildings. Measures for addressing stakeholder's conflicts may include the following:

- Awareness raising and education for sustainable planning, investment and utilization in buildings
- Use of an integrated mixture of instruments encompassing fiscal, behavioural and technology change encouraging consideration for efficiency measure among all stakeholders
- For appliances it should be suggested that inefficient appliances are taxed and the revenue used to support the efficient ones.
- Developer savings guarantee via a performance contract
- Employment of owner arranged financing model
- ESCO model
- Ensure the lease contract that rewards the landlord for providing capital, and holds the tenant accountable for its energy use (allow an owner to allocate upfront capital costs to the occupant, require ongoing quality control of systems and equipment, and mandate information exchanges between landlord and tenant) (Berardi 2013).

THE REBOUND EFFECT

Occupant (or end-user) behaviour is an important factor influencing the amount energy consumed in buildings. It has been observed by a number of empirical observations, that energy efficiency measures make energy services cheaper, and therefore might encourage increased consumption of those services (Sorrell et al. 2009). For instance, a study of households in the Netherlands has demonstrated that building characteristics determine 42% of the variation in energy use for water and space heating, while more than 50% of the variation is attributed to user practices (Guerra Santin et al. 2009).

This phenomenon is known as the "rebound effect". The rebound effect can be widely defined as the increase in energy consumption in services for which improvements in energy efficiency reduce the costs (Guerra Santin 2012). The rebound effect is a behavioural phenomenon or a systemic response to a measure taken to reduce environmental impacts that more or less offsets the effect of the measure (Hertwich 2005).

Rebound effects can happen on several levels — either directly as a result of lower cost to the end user, indirectly through spending on other goods and services or at a macroeconomic level by driving consumption through increased productivity. Whereas a direct rebound effect drives an increase in demand from the same energy consumer for the same energy type or energy service following an energy efficiency improvement, there are a number of indirect effects that also arise following improvement in energy efficiency (Maxwell et al. 2011). Improved efficiency decreases services cost, thus the available income could be spent on purchasing other energy-using goods and services. This income effect on energy use through demand for other goods and services is the indirect rebound effect, and it may include the energy used in both consumption and production of the new purchase (Gillingham et al. 2013).

Since Khazzoom (1980) first described the rebound effect in estimation of energy savings based on the mandated efficiency standards for household appliances in the US, the scale and significance of rebound effects have been debated continually (Greening et al. 2000). The magnitude of rebound effects are debated and based on a relatively small number of empirical studies with modelling and data limitations. Rebound effects are difficult to quantify (Marszal et al. 2011) and hard to attribute to isolated effects of specific energy efficiency measures in the building. However, the existence of rebound effects is well recognized and taking its existence into account is important to achieve significant emissions reductions (UN Environment 2002). There is clear evidence for direct rebound effects for household energy efficiency for space heating and cooling, lighting and major appliances (Greening et al. 2000; Sorrell 2007). Empirical evidence indicates that the direct rebound effect will dominate in the near term, the only time period for which reliable studies exist and will not exceed the 50% (Gillingham et al. 2013). There is no clear evidence of the long-term rebound effect.

Despite increasing attention to the rebound effect in academic literature and policy debate, it is grossly disregarded in energy balances of energy efficient buildings (Bourrelle 2014). This might be because of the controversy surrounding the evidence of the effect and the magnitude of it for the buildings sector. Also the fact that it works counter to the energy efficiency agenda and that it further complicates the already existing conflicts of interest among stakeholders as listed above may play a role. The evidence base for rebound effects is still limited and is even scarcer in the case of developing economies.

Rebound effects are very dependent on the incomes of energy users. This is because energy accounts for a greater proportion of expenditure in lower income households. For this reason, the indirect rebound effect may be larger for low-income groups and households in developing countries (Sorrell, 2007). The magnitude of rebound effects are quite likely much larger in low-income countries, or among low-income consumers in wealthy countries (Ouyang et al. 2010). A limited number of studies that exist for developing countries estimate that the rebound effect for energy efficient buildings is more than 30% in developing countries (DFID 2014; Roy 2000; Spalding-Fecher et al. 2002). This means that about 30% of the efficiency gained through technical improvements of building and appliances divert into increased consumption for higher comfort. The increasing amount of household appliances and floor area should also be understood as a result of other processes in the society, which have been described as drivers behind consumption, including changing social norms and expectations following from new technical possibilities (Røpke 1999).

The rebound effect existence might to a certain degree discourage the potential decision-makers (governments, developers, owners, occupants etc.) of introducing household energy efficiency measures in actual projects. Nevertheless, failure to take account of the rebounds effects will contribute to shortfalls in achievement of energy and climate policy goals. Its micro- and macroeconomic implications can in part explain why governmental energy efficiency programmes failed to reduce total energy needs in our societies (Bourrelle 2014). Accounting for rebound effects may be key in evaluating the overall benefits of energy efficiency measures.

It is crucial to understand how a change in energy efficiency will affect energy consumption prior to introducing energy efficiency measures. Depending on the magnitude of the rebound effect it may be the single most important factor to be considered in order to determine the effectiveness of energy efficiency measures. The full effect of the rebound may not necessarily need to be reduced depending on other (welfare) policy priorities beyond energy consumption levels. The research and empirical evidence are limited outside OECD countries (Roy, 2000; Ouyang et al., 2010) and further research is required here. Meanwhile, policymakers will need to have access to detailed modelling that estimates the savings potential in each sector, including the degree of rebound. Efficiency targets then might have to be adjusted to take into account rebound effects.

Possible measures for addressing rebound effects

Measures for mitigating the rebound effect may include the following:

- Recognising and accounting for rebound effects in the design and evaluation of policy;
- Use of an integrated mixture of instruments encompassing fiscal, behavioural and technology;
- Sustainable lifestyles and behaviour change in consumers;
- Awareness raising and education for leveraging behaviour change in business

IMPLEMENTATION GAP

Weak enforcement and compliance are the biggest obstacles to reaping full benefits of any energy efficiency policy, including a NAMA. A lack of implementation or poor application is often a result of insufficient assessment of the national context. An enforcement strategy should be included into NAMA development and has to pay explicit attention to factors such as the right incentives of various sectoral stakeholders, the level of cooperation and coordination between national institutions, multiplicity of national authorities and the extent to which targeted stakeholders will comprehend regulatory requirements and comply despite potential costs of compliance. Active willingness to cooperate throughout the chain of command is key to enforcement. Focusing on a highly developed regulatory framework, while omitting the necessary emphasis on sufficient capacity for enforcing regulation is not uncommon, particularly in donor aided actions where enforcement structures are believed to be the responsibility of national authorities. Failure to address non-compliance, however, may render NAMAs useless and potentially have long-term consequences through the erosion of credibility of the national policy mechanism itself – and energy efficiency measures as a policy tool as well. The rate of compliance with any policy measure is of a key significance for the evaluation of programme effectiveness and value, and therefore it is paramount to include in the initial stages of NAMA development.

Possible actions to promote regulatory compliance

A key determinant of government effectiveness is achievement by regulatory systems of policy objectives and targets (OECD 2000), Measures to support desired compliance outcomes should begin at the policy design stage. Policy should be designed with the adequate implementation mechanisms and possibilities to make the policy workable in practice, which means that governments have to ensure that the necessary information is provided to the target group, technical capacities facilities and mechanisms are carefully considered. Actions to address non-compliance and to promote the enforcement of regulation may include the following actions:

- Non-compliance due to lack of regulatory knowledge or comprehension by the targeted stakeholders should be addresses through communication with the target group. It is important to make sure that stakeholders are adequately informed it about their rights and duties, since requirements might be too complex to know of and to understand. New rules, regulations and regulations applied need to be explained and communicated in an adequate manner.
- Non-ability to comply by the targeted stakeholders can be also addressed through provision of necessary information and other support or mechanisms in order to avoid failures of administrative capacity and bureaucratic burden.
- Non-compliance due to the unwillingness of the targeted stakeholders to comply with regulations with reference to the cost of compliance, and in cases when newly introduced policy contradicts market incentives and behavioural practices needs to be addressed. It can be achieved through the use of a variety of embedded policy instruments (taxes, prohibitions and subsidies for instance) to influence the behaviour of the target group, backed up with a variety of enforcement activities (such as regular audits and penalties).
- Intended monitoring activities should be planned at the policy development stages. Formal rules that are not monitored are unlikely to induce compliance. Audits and inspections reduce the likelihood of future non-compliance and also can serve as means of assistance with regulatory comprehension.
- In response to compliance and enforcement failures regulators invoke voluntary compliance schemes. Different types of regulations might be designed to maximize the possibility of voluntary compliance, for example most often they combine such measures as performance standards, rewards and incentives for voluntary compliance.

ELEMENTS OF A NAMA PROPOSAL

Building the above central messages into a NAMA requires careful consideration. Particularly the rebound effect, enforcement and compliance structures are crucial for the performance of an energy efficiency NAMA for the building sector; - but obviously also the split incentives between different stakeholder groups. The stakeholder analysis and the assessments of institutional and market readiness are essential to describe these factors as well. In order to do this, the last three steps described in Table 1 provides some guidance.

The NAMA process encompasses a number of consecutive activities: developing the NAMA proposal, submitting it to The NAMA Registry, implementing the NAMA action plan, monitoring progress and reporting its impacts. While various stakeholders in implementation of the NAMA carry these out, the same NAMA developer in the development process will address them all. Therefore, a transparent consultation process and strong stakeholder engagement are essential for the successful completion of the NAMA proposal.

There are different templates for the description of a NAMA and different donor organisations, which may be supporting a NAMAs, have their own formats. The NAMA Registry format for the presentation of NAMAs includes basic guidance on how to submit information to the NAMA Registry, and may be used as a generic format for the provision of the minimum information requirements, which resulted from the international negotiations under the UNFCCC. But for the national process the NAMA Registry template is probably not sufficient – it was not developed for that purpose. Also financiers that might be involved are likely to require more thorough information. Although submission to the NAMA Registry is voluntary, it is recommended to use the NAMA Registry to increase the international visibility of the NAMA.

The overview presented below is generic and does not follow a template format. It includes the relevant elements to present a NAMA for support, based on current experience, and different NAMA templates that have been developed by several organisations. See Annex C for a format used by UNEP Risoe – the NINo (NAMA Information Note).

The NAMA proposal provides detailed information on the planned mitigation activities, how they will be implemented and monitored. Projects seeking international support would need to include justification for why international support is necessary to support the implementation. Table 6 provides a summary of the main information elements of a NAMA proposal.

Table 6: Overview of a generic proposal for a NAMA for energy efficient buildings

NAMA PROPOSAL	WHAT SHOULD BE INCLUDED?
Context, background, barriers and proposed solutions	• Situation and need for a national strategy for energy efficiency in buildings, linked to national energy, environmental or other strategies • Information on the policy context, current (baseline) situation, institutional context and stakeholders • Description of existing barriers to energy efficiency in buildings • Proposed solutions
Scope and objectives	• Description of the scope of the NAMA, its goals and main objectives
Components and timing	• Components should be developed in the context of the identified barriers • Plans and timing for implementing the main activities • Key legislation that will be proposed, and the responsible parties for proposing and approving the legislation
Expected impacts	• Including estimated emissions reductions and other positive or negative impacts
Costs and support needs	• Description of the implementation cost of the NAMA, including identification of finance sources and support needs, including non-financial support required, such as capacity building • Budget items, per year and for the duration of the NAMA, including anticipated revenues (cash and in-kind support) and expenses
Measuring, reporting and verifying framework	• Description of the framework for measuring • Key indicators to measure progress in implementation • Key indicators to assess impacts, sustainable development, and greenhouse gas emissions reductions - Methodology for estimating impacts - Systems and procedures for collecting and storing data- • Roles and responsibilities for data collection, analysis and reporting • Reporting format and verifying procedures should conform to the government's and funders' requirements
Implementation plan	• Details on the planned implementation of the activities: • Institutional framework, roles and responsibilities of various stakeholders • Time frame • Risk management
Financing plan	• Describes the funding scheme, which may include domestic funds or a combination of domestic and international funds • References the budget for costs and support needs
Responsible parties	• NAMA focal point • Person and organization with overall responsibility for the NAMA • Key institutions and contacts

NAMA SCOPE AND OBJECTIVES

The scope and objectives of the NAMA include a definition of the types of buildings targeted (public/residential/commercial/industrial as well as new/existing) and technologies envisaged to be employed (ref. Chapter 3). If there are geographical limitations in the coverage of the NAMA, this is also where such limitations are introduced (national or sub-national). The most common objective of a NAMA for energy efficiency in buildings is obviously a reduction in energy consumption – which may be motivated by many different purposes. A NAMA, however, is a 'mitigation action' and it would be expected that scope and objectives would also refer to high level policy objectives related to the national climate change and development path, thus contributing to both national energy efficiency targets and greenhouse gas emissions reduction targets.

A national strategy for improvement in the energy efficiency of buildings may include other goals and objectives not directly related to climate change mitigation and energy savings, such as reducing demand for increasing electricity generation capacity. There may also be social considerations related to improvement of building standards such as achieving higher community consciousness.

The template provided for sharing information on NAMAs in the NAMA Registry includes a section on contributions of the NAMA towards sustainable development priorities of the host country. This should also link to wider national goals, like a national energy strategy and/or housing strategy.

NAMA COMPONENTS AND TIMING

The main components of a NAMA will typically be related to one or more barriers that in the current scenario are keeping the desired development from happening. Such barriers may be as simple as 'the price of energy' or 'the lack of enforcement of existing regulation' in the form of minimum energy performance standards, but in all likelihood there are also more complex barriers related to the split incentives among different groups of stakeholders as described above. The NAMA components section describes not only which are the means to achieve the objectives, but also how their effect is secured and the timing of the interventions. Also the institutional anchoring and which are the prime responsible actors for implementation must be identified.

It is important that there is coherence among the initiatives and/or instruments that are incorporated in the NAMA. It is equally important that all necessary instruments are included – e.g. not only a regulation but also means to secure its enforcement.

EXPECTED IMPACTS

NAMAs should result in transformational changes by shifting the market towards a low-carbon pathway on a permanent basis. That fundamentally means that interventions generally are without an end date. Exceptions to this rule are short term programmes that for instance would have as their objective to phase out the most inefficient installations. Relevant for buildings in that context could be a scrapping programme for inefficient split unit air conditioners. Such programmes could have an end date to encourage a quick retirement of below-standard equipment. Assessment of impacts of permanent changes in a sector may be difficult to quantify over time, but may rather be established as a quantified impact per year. Such impact estimates should present the expected emissions reductions, but also impacts on other parameters that have been identified as objectives of the NAMA, possibly identified as economic, social and environmental benefits:

- Economic: The implementation of a national strategy for energy efficient buildings can reduce electricity bills for consumers. Implementation can lower the growth rate of electricity demand, thus resulting in cost savings associated with avoided additional electricity generation capacity as well as government savings on fossil fuel subsidies, if any. Other benefits could be increased technology uptake or technology transfer as well as potential attraction of foreign investors
- Environmental: Reduced demand for electricity compared to the business as usual case, and, hence, reduced electricity generation, is expected to result in lower levels of air pollution (sulphur dioxide, nitrous oxide and particles). Lower electricity production could also have benefits such as reduced use of water and other natural resources.
- Social: Reducing electricity demand in buildings and thus the cost of energy in households will result in welfare gains especially for the lower income population. Positive health effects from reduced air pollution are equally a positive side effect from a general reduction in demand for electricity generation. A NAMA for energy efficient buildings could also contribute to job creation and economic development by establishing demand for new services such as e.g. retrofitting. Capacity building would be a natural accompanying activity as well.

Baseline data gap

The NAMA proposal should include an assessment of the expected impacts on a qualitative and/or quantitative basis compared to a scenario without the action envisaged, i.e. the 'baseline'. One challenge that may be posed by the institutional context, however, is a baseline data barrier. The overwhelming majority of national institutions involved in NAMA development and implementation are facing the first roadblock in the form of an absence of an adequate data collection system and the lack of necessary data for establishing baselines. Insufficient data thus hinders a transparent national quantification of the energy efficiency potential. The process of data collection, aggregation and systematization requires significant human capital investment and capacity. The calculation of baselines requires significant data and poses information demands. Data collection, baseline methodology selection and baseline calculations will result in a consequential delay in planning and implementation and may in the worst of cases obstruct the NAMA development altogether. It is also a common assumption that the lack of data is a key hurdle stopping investors from getting involved due to insufficient proof of actual energy savings or emissions reductions.

FINANCING PLAN

The financing plan for the NAMA is central and includes several elements as described in Chapter 6. It should distinguish between public expenditures in the form of capital investment and recurrent spending as well as expected private sector financial involvement. The financial plan is not an exercise in listing cost items in order to arrive at a total for which a grant application can be submitted to potential donors. Instead, most NAMA financing models and plans will be integrated with current national budgets for operation of frameworks in the targeted sector. For the building sector, which is dominated by private investment, the financing plan may in fact not focus on support for technology choices, but rather on establishment of enforcement structures or models for overcoming split incentives. For more details on financing, see Chapter 6.

Countries may also seek support other than financing. For example, Mexico identified the need for capacity building support activities to raise awareness of local banks, and to train the implementing national agency on procurement processes. The NAMA Registry of the UNFCCC also includes a section in which countries can invite donor financing for this kind of technical assistance. However, the central financing is not for possible technical assistance; it is for the actual implementation of mitigation actions.

IMPLEMENTATION PLAN

The implementation plan will provide detailed information on the roles and responsibilities of different actors and stakeholders who will be involved in the implementation of the NAMA. It will also describe the institutional processes needed to implement and operate the NAMA. Obviously, the implementation plan will present a timeline and milestones, commonly in the form of central elements in the NAMA, e.g. regulatory elements and the timing of their introduction. Figure 5 illustrates a NAMA implementation plan for the building sector in Singapore and it has been recommended as an exemplary framework model for Southeast Asia region, such as Indonesia, Thailand, the Philippines and Viet Nam. The plan identifies the central stakeholders and the timing and nature of their involvement. In the Singapore context, stakeholder engagement in early stage of policy planning is the key of successful framework. Whilst consulting and gathering feedback from key stakeholders, in particular those with direct impact from the intended policy, is essential to identify barriers and obstacles, the engagement will also indirectly garner the supports and endorsement from the stakeholders and thus, lead to an effective implementation outcome.

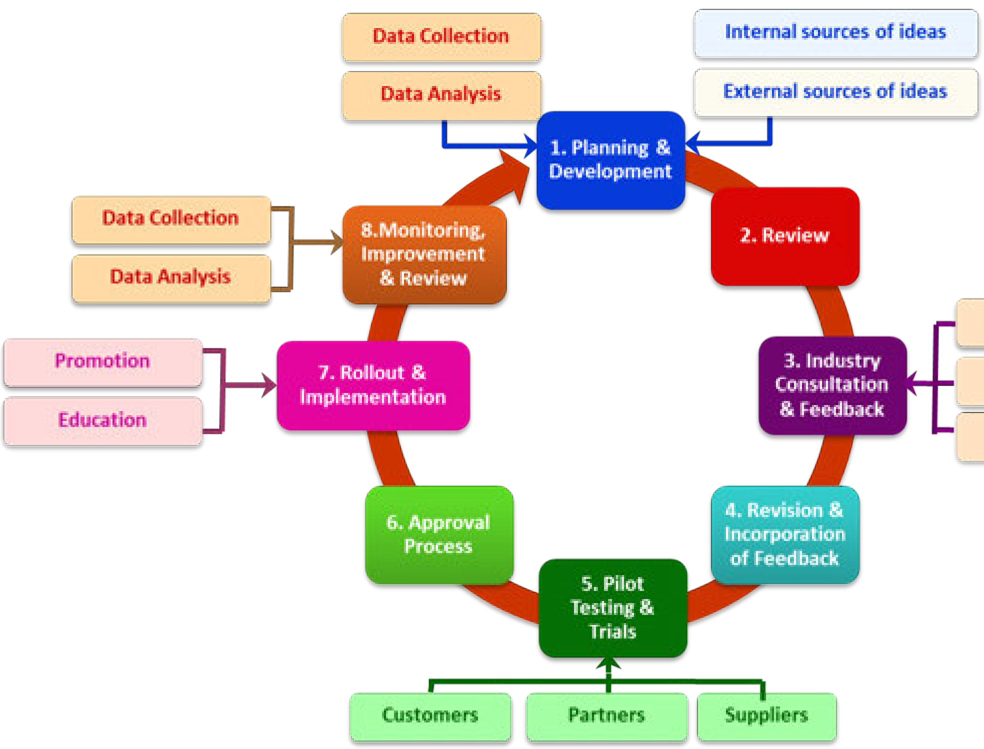
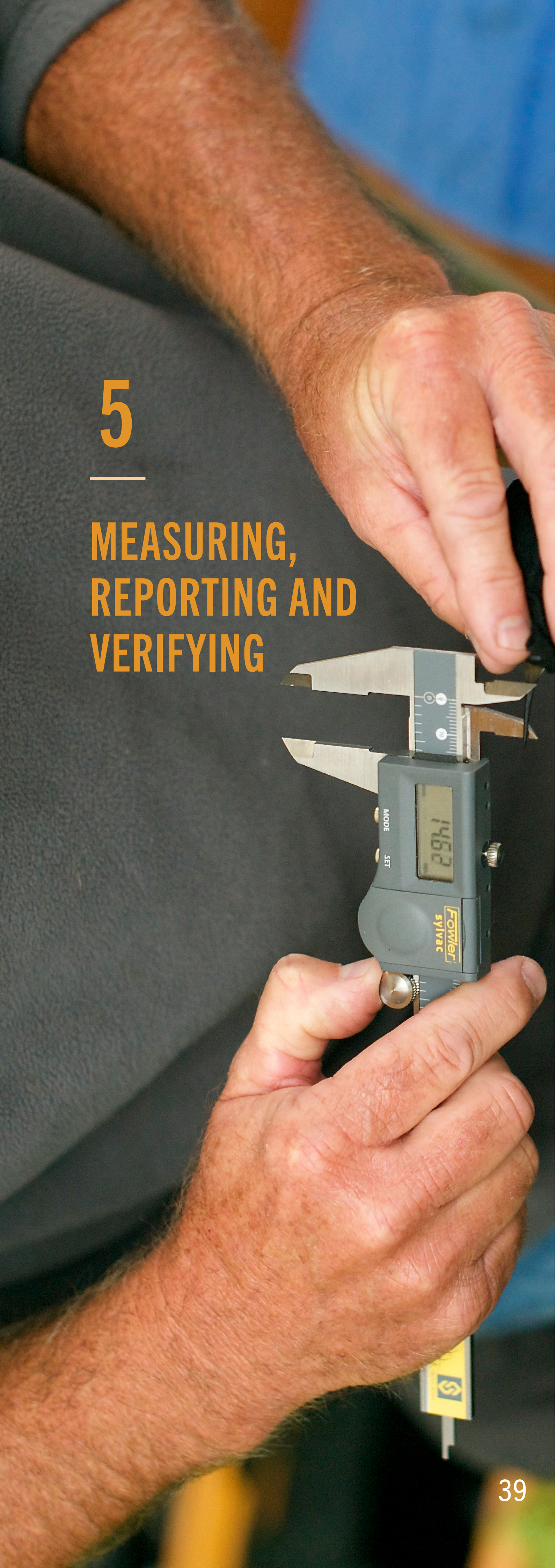


Figure 5. NAMA implementation plan



5

MEASURING, REPORTING AND VERIFYING

This chapter provides guidance on measurement methodologies, reporting and verification processes and procedures. It briefly explains the measuring, reporting and verifying framework for NAMAs, and then explains the aspects of developing a measurement methodology for energy efficient buildings NAMAs.

FRAMEWORK FOR DEVELOPING COUNTRY NAMAS

This section explains in simple terms the complete measuring, reporting and verifying framework for developing country mitigation actions. In order to understand this framework, it can be divided into two tiers: the measuring, reporting and verifying of the voluntary national mitigation actions of developing countries under the Convention, which can be called the national tier, and the measuring, reporting and verifying of the specific individual NAMAs (implemented by the countries as part of their voluntary national mitigation obligations), which can be called the NAMA tier. The NAMA tier supports the national tier (UNEP DTU Partnership 2013).

NATIONAL TIER

The measuring, reporting and verifying of the voluntary national mitigation actions of the developing countries will be conducted at the international level, under the UNFCCC. This tier covers the measuring, reporting and verifying of all the national mitigation efforts and the national greenhouse gas inventory. It includes: measuring parameters to prepare the national greenhouse gas inventory; reporting of information on the national greenhouse gas inventory and the impacts of NAMAs implemented by the country, including on greenhouse gas emissions reductions below BAU; and assessment of the information reported in the BURs through International Consultation and Analysis (akin to the verifying step of measuring, reporting and verifying).

NAMA TIER

The NAMA tier addresses the measurement, reporting and verification of individual NAMAs. This tier supports the national tier, and provides the necessary information on NAMAs for countries to prepare their Biennial Update Reports for the UNFCCC. Unilateral and supported NAMAs will be subject to measuring, reporting and verifying, according to the NAMA tier. The NAMA tier will be established by the country, based on the general guidance recommended by the Conference of the Parties at its 19th session (FCCC/SBSTA/2013/L.28). The guidelines are generic, and allow for significant national interpretation for the development of a domestic measuring, reporting and verifying system. This provides generic guiding principles and/or good practices, which countries could use to establish institutional arrangements, and modalities and procedures for undertaking measurement, reporting and verifying of NAMAs. Modalities and procedures will include: guidance for developing measurement plans for individual NAMAs, reporting requirements, and process and procedures for undertaking verification of the reported information. NAMA developers are expected to use the guidance on measurement plan to develop a measurement methodology for the NAMA, and to use the reporting requirements to report the measured information.

Measuring, reporting and verifying of internationally supported NAMAs will be influenced by the requirements of the entity providing support. Internationally supported NAMAs will also be subject to international measurement, reporting, and verification, in accordance with guidelines developed for International Consultation and Analysis, adopted at the 17th session of the Conference of the Parties (UNEP DTU Partnership 2013).

The measurement requirements for NAMAs described in this chapter are based on UNFCCC defined guidelines for the Biennial Update Report (regarding information to be provided on planned and implemented NAMAs), and on the approaches used for measurement by various internationally supported climate change mitigation financiers, such as the Global Environment Facility and investors in Clean Development Mechanism projects.

Given the wide range of activities possible under NAMAs, the level of accuracy with which the impacts, especially greenhouse gas impacts, can be measured at a given cost is expected to vary significantly. Also, the level of accuracy required by financial and other stakeholders may vary. Thus, the approach to measurement and verification could vary from a simple approach to a very accurate and sophisticated approach. For example, in case of energy efficient buildings a simple approach for estimating energy savings and GHG estimations could be based on developing energy use benchmarks for 20% most efficient buildings for estimating the baseline emissions. A more sophisticated approach and accurate approach would be to create a control group of similar buildings and monitoring their energy consumption regularly. The trade-off between cost/level of effort and precision, which ultimately will be influenced by the current availability of data and opportunities for initiating additional data collection, will also influence the approach to measuring and verifying.

METHODOLOGY FOR MEASURING, REPORTING AND VERIFYING

MEASUREMENT METHODOLOGIES AND PROCEDURES

Measurement methodologies and procedures define how to monitor the expected impacts (including greenhouse gas related impacts, transformational impacts and sustainable development benefits), the progress (both the status of activities and outputs), and the support given to the NAMA. The measurement methodology includes:

- The geographical scope;
- The impact boundaries of the activity on greenhouse gas emissions, as well as sustainable development benefits;
- The baselines for key development benefits and greenhouse gas emissions;
- The indicators to measure the impacts;
- The data required to measure/estimate the indicators;
- A data collection system including clear responsibilities for data required to estimate the indicators; and,
- Establishing procedures to ensure reliability of data collected and estimates.

WHAT TO MEASURE IN A NAMA

To understand what kinds of measurements are required, the guidelines for Biennial Update Reports, as adopted at the 17th session of the Conference of Parties, outline the following types of information that countries are expected to report on NAMAs (planned and implemented) to the UNFCCC[1]:

- Information on planned NAMAs: progress indicators to track the implementation of the NAMAs; methodologies and assumptions related to estimation of greenhouse gas emissions reduction.[2]
- Information on NAMAs under implementation, or implemented: progress of NAMAs under implementation, including the underlying steps taken and further steps envisaged; results achieved, outputs (metrics depending on type of action), and impacts in terms of greenhouse gas emissions reduction.

This is the minimum required information that should be measured for NAMAs. The two broad categories of measurement requirements listed are «progress» indicators and «impacts» indicators of NAMAs, including greenhouse gas impacts. Countries are also required to provide the methodology and assumptions made in estimating greenhouse gas impacts.

[1] Annex III to decision 2/CP.17.

[2] It will also include information on the objectives, and a description of NAMAs, including information on the emissions sources covered in the NAMA (sectors and gases) and quantitative goals; steps envisaged to implement the NAMA; barriers, and related financial, technical and capacity needs, including a description of the support needed.

TYPES OF INDICATORS

An indicator is a specific, observable and measurable characteristic that can be used to show progress or measure impacts of A NAMA. There should be at least one indicator for each outcome. The indicator should be focused, clear and specific. The change measured by the indicator should represent progress that the NAMA is expected to bring about in the system. Indicators should be defined precisely to avoid variations in interpretation regarding whether the target has been achieved or not. An indicator should be precise and unambiguous in describing clearly and exactly what is measured. The indicator description should also include clear description of the data required. The indicators should aim to be specific, measurable, accurate, realistic and time-bound ("SMART"), while bearing in mind the trade-off between price and precision.[3] The indicators should be chosen to ensure that they are comprehensive (to track the progress and impact of implementation), relevant to the purpose and cost effective.

Progress indicators track the implementation status of NAMA activities (see Table 7). The expected deliverables for each of the activities described in the national strategy/NAMAs for energy efficient buildings are a good basis for identifying progress indicators, as are the indicators and milestones to measure progress on each of the elements of the implementation plan. Progress indicators may relate directly to impact indicators if the impact is assessed on the basis of reaching certain milestones. For example, if the NAMA is to develop and encourage the use of energy efficiency standards for new construction, one of the indicators could be the percentage of new buildings that meet the minimum standards established by the energy efficiency building standard. The data collected for the indicator also assesses the impact of the energy standard, and hence indirectly the GHG emission impacts.

[3] In some cases, it may not be possible to have quantitative indicators and, thus, qualitative indicators may be used to measure progress or impacts. In the case of qualitative indicators, the term 'measureable' does not imply measuring exact quantities, but measuring the perceived impacts. For example, quality of construction of energy efficient buildings could be qualitative indicator for perception of consumers; this could be measured through surveys.

Table 7. Examples of progress indicators

<table>
<tr><th colspan="12">GOAL</th></tr>
<tr><td colspan="12">Increase the penetration of energy efficient building design and construction in new buildings</td></tr>
<tr><th colspan="12">OBJECTIVES</th></tr>
<tr><td colspan="4">Strengthen the Regulatory system for building energy efficiency standards</td><td colspan="4">Promote construction of energy efficient buildings through fiscal incentives</td><td colspan="4">Increase technical capacity in the country to support the construction of energy efficient buildings</td></tr>
<tr><th colspan="12">ACTIVITIES</th></tr>
<tr><td colspan="3">Development of standards and regulations for energy efficient Buildings</td><td colspan="3">Training of planners, architects, energy advisors, and other key stakeholders</td><td colspan="3">Financing scheme for incentivizing energy efficient buildings</td><td colspan="3">Awareness creation among consumers on benefits of energy efficient buildings</td></tr>
<tr><th colspan="12">PROGRESS INDICATORS</th></tr>
<tr><td colspan="3">sq m of floor space of energy efficient buildings constructed that meet the established standards</td><td colspan="3"># of training programmes conducted for planners, architects, energy advisors and other key stakeholders</td><td colspan="3">Finance disbursement for loans to buy apartments and space in energy efficient building</td><td colspan="3"># of outreach programmes (radio, television, etc) carried out and # of people reached to increase awareness on energy efficiency standards for buildings and their energy saving benefits</td></tr>
</table>

The progress indicators in the table are a mix of indicators to track progress on outputs and activities. For example, indicators of awareness raising track the activities implemented to increase the awareness, whereas, the finance disbursement indicator tracks the output of activity to provide concessional finance for energy efficient buildings. Generally, progress indicators track the inputs (to implement activities, normally the financial resources and technical resources), activities and outputs.

Impact indicators refer to the impact of outputs of NAMAs (see Table 8). These are referred to as outcomes in the logical framework analysis, and relate to the reduction of greenhouse gas emissions, as well as other objectives served by the activity, in accordance with national sustainable developmental goals. The measurement methodology must include indicators for all objectives served by the NAMA, including transformational changes that shift the economy towards a low-carbon development pathway.

Table 8. Examples of impact indicators

<table>
<tr><th colspan="6">GOAL</th></tr>
<tr><td colspan="6">Increase the penetration of energy efficient building design and construction in new buildings</td></tr>
<tr><th colspan="6">OBJECTIVES</th></tr>
<tr><td colspan="3">Strengthen the Regulatory system for building energy efficiency standards</td><td colspan="3">Promote construction of energy efficient buildings through fiscal incentives</td></tr>
<tr><th colspan="6">IMPACTS</th></tr>
<tr><td>Climate: lower greenhouse gas emissions (compared to business as usual)</td><td>Economic: savings in fuel import bill</td><td colspan="2">Institutional: increased capacity to support construction of energy efficiency standards</td><td>Environmental: air pollution reduced from avoided fossil-fuel based electricity generation and transport of fossil fuels</td><td>Social: green jobs created</td></tr>
<tr><th colspan="6">IMPACT INDICATORS</th></tr>
<tr><td>tCO2e reduced</td><td>Annual savings of fossil-fuel energy (amount) attributable to energy efficient buildings</td><td colspan="2">Technical capacity among planners, architects, energy advisors, as well as, availability of materials to implement options for energy efficiency improvements In buildings</td><td>Amount of air pollutants reduced from electricity generation and transportation of fossil fuel</td><td>Number of jobs created</td></tr>
</table>

The impact indicators track outcomes or impact of outputs. In this sense some of the progress indicators could either be used to estimate the impact indicators or the two might use the same data. For example, data for estimating indicators of «sq m floor space under energy efficiency building» could also be used for estimating the GHG impacts. The impact indicators also help track the transformational change in the system. For example, the indicator for technical capacity and availability of material helps show the shift in the construction sector.

The potential benefits identified in the strategy/ NAMA for EE Buildings are a good starting point for identifying and deciding which indicators are useful to measure, report and verify the impacts of an energy efficient buildings NAMA on a regular basis. Impacts can be indicated either quantitatively (e.g. annual saving of fossil fuel from implementing energy efficiency measures), or qualitatively (e.g. perception of residential/commercial property that building incorporating energy efficiency measures actually leads to energy savings).

IMPLEMENTING THE MEASUREMENT, REPORTING AND VERIFICATION PROCESSES

A measuring, reporting and verifying scheme includes institutional arrangements to oversee the implementation of the process, procedures and guidelines, including a clear definition of the responsibilities of the different actors. In the case of a domestic MRV system has been established, the MRV will be in accordance with the guidelines and procedures of the domestic MRV system for unilateral NAMAs. In the case of internationally supported NAMAs, the country could use the domestic MRV system guidelines and procedures and may need to be agreed upon with the entity providing international support.

The institution that oversees the measuring, reporting and verifying system will be responsible for developing and providing guidance on measurement methodology and reporting, and, for defining the process for verification. Developers and implementers of NAMAs will be responsible for developing the measurement methodology and for reporting in accordance with the guidelines.

REPORTING

Reporting entails regular communication from the entity implementing a NAMA to different entities, such as the designated authority that manages the measuring, reporting and verifying system or the entity providing international support. The parties agree upon the content and format of the reporting templates. Purposes of reporting may include:

- Providing information to the relevant national entity for inclusion in the Biennial Update Report, for the NAMA Registry (which in the case of unilateral NAMAs would be for recognition), for national policy mainstreaming, for impacts on sustainable development and for co-benefits; and,
- Fulfilling requirements per agreement with the entity providing support as per its requirement in a mutually agreed upon protocol, especially regarding greenhouse gas emissions reduction impacts.

The monitoring report for Clean Development Mechanism projects is an example of a reporting template. There are no standard guidelines for reporting for NAMAs at present, so the following principles of reporting can be used to prepare and submit information: feasibility, relevance, completeness, transparency, consistency, accuracy and cost effectiveness.

Reporting frequency for internationally supported NAMAs would be as per the agreement with the international financier. For instance, this could be an annual report on the progress of implementing the NAMA.

VERIFYING

Verifying confirms that what has been measured and reported (progress in implementation and impacts) is complete, accurate, and transparently presented, so that a third party would arrive at the same conclusions based on the reported information. What is to be verified (the progress in implementation, greenhouse gas emissions reduction impacts, impact of sustainable development benefits, or a combination of these three aspects), and how the information is verified, will depend partly on the domestic and international entities providing support and partly on other national reporting requirements, if any. Below are two approaches that could be used to determine the verification procedure of a NAMA for energy efficiency in buildings:

- The Clean Development Mechanism style of verification: Requires detailed analysis by a specific entity that is designated to verify the emissions reductions based on data collected in predefined procedures, with or without employing specified metering and estimations of indicators for greenhouse gas emissions, as reported by Clean Development Mechanism project implementers through the monitoring report. This is followed by an on-site visit from the verifier to undertake a sample-based analysis of the measured data to ensure accuracy and reliability.
- International Consultation and Analysis: This is equivalent to the verifying step for the Biennial Update Reports to the UNFCCC. The information in the report, including on NAMAs, is subject to analysis by an international team of experts to ensure that reporting is done as per the guidelines, and that it is complete, consistent and transparent. The analysis and the report will be discussed by Parties to the UNFCCC in order to understand the progress and identify the challenges that the host country is facing in implementing the NAMA.

NAMAs may have a wider scope and be policy-focused rather than project-focused, so the International Consultation and Analysis approach is most likely to be followed for verifying both unilateral and supported NAMAs. The reports submitted by the entities implementing a NAMA are expected to be thoroughly analysed to ensure completeness, transparency, and consistency. In the case of internationally supported NAMAs, depending on the requirements for precision of greenhouse gas emissions estimates, and the financing provided, verification of the greenhouse gas emissions reductions could be more stringent. It may use the approach based on sampling, used by Programmes of Activities under the Clean Development Mechanism. It would be natural to seek inspiration here to design a verification system that corresponds to the required balance between precision and cost.

A third party could also perform a detailed review of the NAMA impacts, specifically the emissions reductions, based on the measurement methods and procedures. This is similar to the approach used for the evaluation of policies and programmes implemented by governments, where specifically designated governmental departments (ones that are separate from the departments responsible for implementing the programmes or policies) undertake evaluation to assess the effectiveness of implementation in achieving the objectives of policies and programmes. Indonesia is in the process of developing its domestic MRV system and they have proposed accredited auditors undertake the verification. Though it is not yet decided whether this will be based purely on a desk review or would involve a more CDM like investigation.

SPECIFIC PROCESS REQUIREMENTS FOR MEASUREMENT, REPORTING AND VERIFICATION SUPPORT

Developed countries are required to report information on support provided to developing countries through biennial reports and National Communications. Thus, entities providing financing will require information on utilization of funds, as well as types of activities supported by their financial contribution, to enable them to meet their reporting obligations to the UNFCCC. This information will be used to assess the provision of climate finance by developed countries, to improve transparency of the support provided and the assessment of global efforts to reach the goal of USD 100 billion of climate change related funding per year by 2020. Developing countries are also required to provide information on support received and utilized in the Biennial Update Reports. Such reporting would also highlight the funding received and utilized by recipient countries against the funding provided by developed countries, which may include costs of international administration and international consultants. Thus, entities implementing NAMAs will be required to provide information to the appropriate national authorities to enable host countries to meet their reporting obligations to the UNFCCC.

NAMA financiers, whether national or international, will require effective systems for allocating and tracking financial resources for the implementation of NAMAs, to ensure that funds are used effectively and for the purposes intended. Entities implementing internationally supported NAMAs should adhere to international fiduciary standards. For example, national implementing entities applying for funds from the Adaption Fund must meet the fiduciary standards established by this fund. Similar requirements will emerge for NAMAs. In addition to fiduciary standards, monitoring of the support provided will also be subject to an agreement between the NAMA host country and the financier for the reporting through the appropriate national authority, ultimately also being subject to verification procedures.

ESTIMATING THE IMPACT OF A EE BUILDING NAMA AND PROCEDURES FOR COLLECTING DATA

As per the UNFCCC guidelines for the Biennial Update Report (Decision 2/CP.17), both the greenhouse gas emissions and sustainable development impacts need to be assessed and reported. The estimated greenhouse gas emissions reduction is the expected amount of carbon dioxide equivalent (tCO_2e) that will be reduced as a direct or indirect result of the activities implemented under the NAMA to achieve the NAMA objectives. These should be estimated quantitatively and compared to a business as usual scenario. These estimates are based on measured indicators for outcomes of the activities implemented under the NAMA. For example, data for estimating indicators of «sq m floor space under energy efficiency building» could also be used for estimating the GHG impacts. For the purpose of transparency and completeness, the direct and the indirect greenhouse gas emissions reductions should be distinguished and separately reported.

Direct greenhouse gas emissions reductions are directly attributable to the activities implemented through the NAMAs. These effects are mediated through an intermediate actor. The subsidy programme coupled with quality certification of EE Buildings and awareness programmes are likely to increase the demand for purchase of apartments/homes with EE characteristics. Thus the direct impact is limited to the amount of resources allocated in the NAMA for subsidization.

Indirect greenhouse gas emissions impacts are related to the activities of the NAMA without having a direct causal link. These indirect impacts result from impacts of NAMA activities on the behaviour of people who are responsible for making decisions on the purchase of residential/commercial property. These impacts also include impacts beyond the NAMA implementation time frame. The following activities are likely to have indirect, impact along with direct impacts:

- Regulations to set quality standards and enforcement of these standards
- Strengthening capacities for monitoring and enforcing quality
- Accreditation of architects and builders of energy efficiency buildings
- Involving commercial banks in providing loans
- Awareness raising activities

The quality enforcement systems have improved the perception of quality among consumers and thus the acceptability of the product. This coupled with demonstration of benefits and returns on investment can increase the acceptability of the energy efficient buildings among consumers. Further, creating an accreditation system for architects and construction companies also improves the experience and acceptability of the product by lowering risks of gains from EE design not being realized in energy bills. This affect is strengthened by awareness raising. Another indirect impact could be a general improvement in perception of energy efficient design of buildings thus having an indirect impact on other building construction in general. Involvement of commercial finance providers enhances their capacity to understand the gains of energy efficient construction, development of financing models for financing such products and thus increase availability of finance for other products. Some of these impacts cannot be directly measured, but could be assessed in either qualitative way to express the expected impacts.

The diagram in Figure 6 gives a good basis of designing a data measurement system.

INDICATORS	Define key performance indicators
• Input, activity, output and outcome • Indicators should be tailored to the policy or action, based on the type of policy or action, the requirements of stakeholders, the availability of existing data, and the cost of collecting new data	
PARAMETERS	Define parameters for ex-post assessment
• Parameters required to estimate baseline emissions using the emissions estimation method(s) for each source and sink. Parameters are the variables (e.g., activity data, emission factors) that make up the emissions estimation equations or algorithm	
DEFINE	Define monitoring period for the policy
• The policy monitoring period is the time period over which the policy or action is monitored. • At a minimum, the policy monitoring period should include the policy implementation period. But note the effects on GHG emissions may go on long after the policy has finished	
CREATE	Create a monitoring plan
• Measurement or data collection methods, sources of data (either existing or additional data needed}, monitoring frequency, whether the data are measured, modelled, calculated or estimated; uncertainties, sampling procedures, documentation, OA/QC	
MONITOR	Monitor parameters over time
• Performance indicators are likely to provide useful information on the validity of the assumptions made in the exante assessment of the policy	

Figure 6. Elements of a data measurement system

The following section provides further details on the calculation of the emissions reductions from use of EE Buildings. From a donor's perspective, conservative approaches are more appealing than overly optimistic assessments. However, in contrast to the Clean Development Mechanism, the NAMA provides a greater degree of flexibility in the calculation of impacts and the use of indicators. This also could yield significant variations in the level of accuracy in greenhouse gas emissions reduction estimates from the measured outcome of activities, depending on the estimation model employed. In cases where high accuracy could be achievable, but at a high cost, use of conservative estimations, benchmarks, and average factors are likely to be acceptable to the financiers.

- The timeframe for estimating emissions reductions is related to the period over which impacts of implementing the NAMA are realized. The shortest time frame is the NAMA implementation period, when activities included in the NAMA are implemented. However, in most cases, and in conformity with the objectives of transformational change, impacts will be realized well after the implementation of the NAMA. For example, the impacts of a programme to demonstrate energy savings from energy efficient buildings would occur well beyond the programme, which may last for a period of only 3 or 4 years. Thus, the choice of timeframe should also reflect the planning horizon of the national initiative.
- It may be beneficial to link the NAMA to internationally discussed timeframes for achieving significant deviation from baseline emissions. In negotiations under the Conference of the Parties the target year 2020 has often been used to demonstrate deviations from business-as-usual GHG emissions. It is expected that most of the reductions in greenhouse gas emissions will occur beyond the completion of activities of the NAMAs. Therefore, calculations should state the reductions during and beyond the implementation phase, at least until 2020. For supported NAMAs, the duration of the financial involvement of a third party may set another target date for achievements under the NAMA.

Beyond these achievements strictly related to emissions reduction, most NAMAs are expected to accomplish sustainable and transformational development in the targeted sector. Sustainable and transformational impacts: NAMAs should result in a long-term, permanent transformation of a sector towards a lower greenhouse gas emissions pathway. To secure long-term transformation, NAMA design should ensure sustainability of impacts beyond the implementation period. A NAMA is one way to transition rapidly to a system in which the energy efficient construction no longer have to be supported but becomes a competitive option. For example, a NAMA could include a requirement to periodically assess the consumer perception of energy efficient building construction in terms of financial savings and integrate this assessment with the policy and regulatory framework for supporting the initiative.

CALCULATION OF GREENHOUSE GAS IMPACTS

This section describes in brief different sources that can be used for collecting data and is developed based on methodologies from the following guidelines

- Common Carbon Metric : Protocol for Measuring energy use and reporting GHG emissions from Building operations
- Large Scale CDM Methodology AM0090 for EE measures in existing and new buildings
- Small scale methodology AMS II.E (measures in buildings), AMS II.k (cogeneration in buildings), AMS II.N, AMS II.Q, and AMS II.R.
- Mexican Energy efficient housing NAMA & UNEP SBCI report on Mexico
- M&V protocol for net zero energy buildings

The starting point for estimating the GHG emissions of a building, like any other, is identifying the key sources of GHG emissions. There are two major sources of emissions stemming from the use of buildings:

- Energy consumption from operations of the building (pumping, ventilation, elevators, etc.) and energy consumed by the occupants for lighting, electric appliances and heating/cooling. Emissions from energy consumption could be from energy generation on site (e.g. onsite generators) or could be generated outside the building (e.g. grid electricity) or could be embedded in services purchased from outside (e.g. purchase of heat/steam/cooling).
- Leakage of GHGs from equipment used for operation of buildings such as the refrigerants used in equipment for cooling (refrigerators, air conditioners, chiller plants etc.)

The emissions from buildings also result from the construction of a building as well as demolition of a building. The construction related emissions include, both, direct and indirect, emissions. Direct emissions related to energy used in construction phase. The indirect emissions include emissions from production of construction material as well as emissions from equipment in the building. The section focusses on emissions from the use phase of buildings.

The emissions from energy use in buildings are related to four key factors: the design of the building envelope that determines the lighting and heating/cooling requirements (see Chapter 3); the demand for lighting and heating/cooling; the use of appliances for meeting the requirements of lighting, heating/cooling, cooking and other building operations; and source of energy used. The energy use in a building operation reflects the design efficiency of a building.

The design features only indicate the minimization of lighting requirements and heating/cooling requirements. But the use of energy inside, especially for residential buildings, depends on the preferences of the individuals. How much lighting do they perceive as necessary? how much heating or cooling is deemed necessary? These preferences are in general governed by socio-economic conditions of the users. Thus the socio-economic conditions become a key governing factor of energy use. The aspect is relevant in categorization of buildings.

ESTIMATING GHG EMISSIONS

Figure 7 below gives the basic steps of estimating the GHG emissions. The basic elements require measurement of the activity (typically power consumption) and the emission factor for the activity (the grid emission factor or the emission factor for onsite power generation).

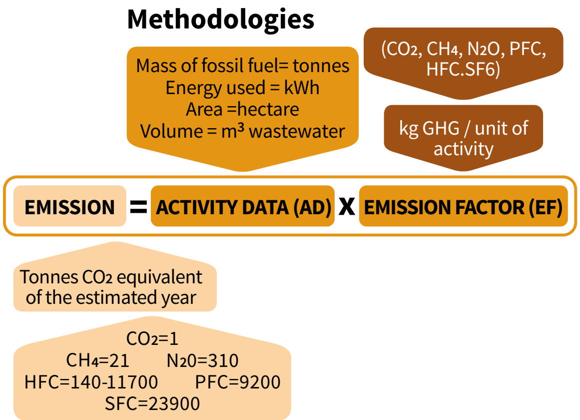


Figure 7. Basic steps of estimating GHG emissions

The source of energy consumption can be defined as direct energy consumption on site and service purchased to meet the heating/cooling demand of the building. This includes

- Electricity used for lighting, heating/cooling;
- Fossil fuel used on site for either generating electricity or for meeting heating and cooling demand;
- Heat/chilled water procured to meet the heating/cooling demand; and
- Leakage of refrigerants used in appliance in the building.

The emissions use related to electricity should be estimated for electricity purchased from either grid or a source that is not directly operated by the building owners. The electricity generated from own source is captured under the fossil fuel consumption on-site. The emissions from electricity could be estimated using the following equation:

$$E_{EC} = \sum_j EC_j * EF_j * (1 + TDL_j)$$

Where,

- E_{EC} = GHG emissions from electricity consumption in the reporting time period (tCO_2e)
- EC_j = Electricity consumption in reporting period (MWh) from jth source (either grid or a power plant that supplies to the building)
- EF_j = Emission factor for electricity source j (tCO_2e/MWh)
- TDL_j = Transmission and distribution losses of supply procured from source j (expressed as a fraction)

If electricity is procured from renewable energy source, the emission factor (EF) is considered zero.

One may use the Tool for estimating project and baseline emissions from use of electricity. This is available at http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf.

GHG emissions from use of fossil fuels can be estimated using the following formulae:

$$E_{FC} = \sum_j FC_j * COEF_j$$

Where,

- E_{FC} = GHG emissions from fossil fuel consumption in the reporting time period (tCO_2e)
- FC_j = Fossil fuel type j consumed in reporting period (tonne or m^3 of fuel consumed)
- $COEF_j$ = GHG emission coefficient for fuel type j (tCO_2e/tonne or m^3 of fuel consumed)

Generally default values of fuel types are available, especially in the GHG Inventory of the country or from IPCC GHG inventory guidelines. The coefficient may also be estimated as follows:

$$COEF = w_C \times \rho \times {}^{44}/_{12}$$

COEF = CO_2 emission coefficient of fuel (tCO_2/mass or volume unit)

W_C = Mass fraction of carbon in fuel (tC/mass unit of the fuel)

ρ = Density of fuel (mass unit/volume unit of the fuel)

(if the fuel is measured in mass unit then use 1 for density)

The COEF could also be estimated using the net calorific value of fuel as follows:

$$COEF = NCV \times EF_{CO2}$$

NCV = Average net calorific value of fossil fuel (GJ/mass or volume unit)

EF_{CO2} = CO_2 emission factor of fossil fuel (GJ/mass or volume unit)

Estimation of emissions (E_{WC}) from use of heat/chilled water from outside can be estimated as follows:

$$E_{WC} = \frac{m \times \Delta t \times C_m \times EF}{1 - \eta}$$

EF = Emission factor for production of chilled/hot water (tCO_2/GJ)

η = Average technical distribution losses of the chilled/hot water system (fraction)

m = Annual chilled/hot water consumption (in kg)

Δt = Average temperature difference between the outlet and inlet of the heat exchanger used for the cooling/heating

C_m = Specific heat capacity of the chilled/hot water (GJ/(kg•K))

Emission factor for the chilled water/heat will be based on information from the supplier of the service on fuel type used, the efficiency of the system, and the emission factor of the fuel type.

Emissions from the use of refrigerants are based on the amount of refrigerant used to replace the refrigerants in reporting period (Q_R) and its global warming potential (GWP):

$$E_R = Q \times GWP$$

One may consult «Common Carbon Matrix Protocol» for more options in estimating the emissions from use of refrigerants.

SETTING THE BASELINE

Setting the baseline for measuring the GHG impacts of the NAMA is the starting point for estimating the GHG impacts of implementing NAMAs. As mentioned earlier the objective of energy efficiency improvement of buildings is to design and construct buildings that reduce the demand for energy for lighting and cooling/heating. Given the nature of the sector benchmark approach or control group is the best way of establishing the baseline.

A key challenge in building sectors is that the energy consumption depends on the type of building, building use and the climate zone the building is located in. Thus it is important to categorize buildings according to use, type of building, and climatic zone.

Define an indicator: Defining an indicator is an important first step towards monitoring progress. For estimation of total impact indicator is not that important, but indicator helps in understanding the changes over time and also assessing how is a given geographic region performing against a set norm or comparison of different regions. The obvious indicator for GHG impacts is GHG emissions per unit. But a GHG based indicator can mask the actual energy efficiency improvements, as for most countries reducing energy demand is a key policy imperative. Further, reduction in energy consumption is a useful factor in assessing the sustainable benefits in terms of savings in energy system investments (which could be used for other socio-economic benefits) and environment benefits where this energy could have come from fossil fuels.

The indicator generally used GHG emissions and energy use per gross floor area (GFA) of the building. Another factor that is relevant is number of occupants of the building and thus it is also useful to create an index in terms of GHG/energy consumption per occupant. If the occupancy per GFA has a small variation across the buildings, the two indicators will show a high correlation.

Benchmark approach - This is termed as static baseline, as the baseline value is fixed at the start of the intervention. Benchmark approach is based on measuring the actual energy consumption in a sample of existing buildings. The benchmark could be either set as average consumption of the sample or could be set as the top 80 or 90% of the performance level. In establishing the benchmark it is important to know the sources of emissions will be measured, thus measurements for establishing the benchmark should be same as the measurements that would be undertaken on the buildings covered by the intervention. The challenge with the benchmark approach is that it doesn't capture the trend improvements anticipated in the future and may thus overestimate the impact. For example, energy efficiency improvements in appliances used for lighting and heating/cooling would result in energy consumption reduction over time. Also, it is likely that lighting and heating/cooling demand increases with time, in which case the energy consumption would increase.

Control group approach - This is termed the dynamic approach to the baseline and is established for each reporting period based on a control group sample which is not impacted by the interventions. The control group approach allows for capturing the changes in demand behaviour as well as changes in the efficiency of appliances used. The control group sample of houses should have the characteristics that are similar to the buildings that are impacted by the intervention. For example, methodology AM0091 specifies that buildings included in the control group should be «located in a region with annual heating degree days (HDD) and cooling degree days (CDD) in the range from 80% to 120%». To ensure a more robust baseline, the control group could be based on selecting the top 10 or 20% performing buildings. The control group is subject to the same level of measurements as the buildings covered under the intervention. Normally in defining control group, the sample size could be set bigger than the required as buildings in the control group that undergo renovations/changes that are beyond normal should be removed from the control group. Normal could be defined as changes/renovation that are substantially different from average changes/renovation observed in the control group.

Modelling Approach - Simulations models could be used to establish a dynamic baseline. A number of usable models exist all of which in general need the following information: weather and climatic conditions around the year; building characteristics (location, geometry, construction materials used, construction features (walls, windows, shadings, etc)); operation characteristics of the building (characteristics as quantities, capacities and operating characteristics of primary equipment (e.g. chillers and boilers), secondary equipment (e.g. air handling units, terminal boxes), fan sizes and types, motor sizes and efficiencies); interior loading and occupancy as well as residential appliance characteristics in case of residential buildings etc.). The use of models also allows the possibility of integrating any mandated building characteristics that may not have been implemented in the existing buildings. Also, the modelling approach allows for a dynamic baseline based on monitoring of key parameters that could see endogenous improvements over time.

Key to using the modelling is calibration of the models to ensure that the results of the model are representative of the energy use in the buildings. Further, as with the benchmark, the model should be calibrated separately for each category of building. The data required for modelling approach is more extensive but allows for disaggregating and observing trends in various factors that influence the energy use.

MONITORING NAMA SCENARIO

Monitoring of the parameters for assessing the energy consumption of buildings requires measurement of same data that is measured for establishing the baseline. The equations provided in section above can be used to estimate the GHG emissions in the NAMA scenario. As mentioned earlier given the nature of the sector, the monitoring of energy consumption would be through sample based surveys. The samples should be randomly selected and be representative of the different categories of buildings identified as part of the intervention.

Computer simulations too could be used to estimate the energy consumption and GHG emissions of the building under the NAMA scenario. In this case too data needs to be collected for various characteristics of the building. Some of the data (building characteristics) would need to be collected once, if a fixed sample is used for monitoring impact of intervention, and occupancy characteristics will have to be regularly updated. The frequency of collecting data should ideally be annual, but if there are no significant changes, then the measurements frequency could be lesser.

For tracking progress over the longer term in the building sector, the collection of data should be connected to the authorization and certification of the buildings. This will enable decentralization of data collection and lower the total cost. Such a system could provide data on energy efficiency features incorporated in the building envelope for all new constructions and renovations. Such a data base could help develop the indicator of average energy efficiency of different building groups and use it as a mechanism to track the transformation of the sector.

Further, the above system could be complemented with a regular sample based survey of buildings to assess their actual energy consumption. Such a survey could be integrated with the regular data collection programmes that countries already have. Institutions that undertake such data collection normally has the expertise of designing and undertaking sample surveys. For example, in India government carries out every five years national sample survey, that collects a number of information on household consumption including energy. Such an existing exercise would be useful to undertake data collection for assessing the impacts of energy efficiency codes for buildings.

EXAMPLE OF MRV SYSTEM FOR MEXICO'S NAMA ON ENERGY EFFICIENT HOUSING[1]

Mexico's Sustainable Housing NAMA is one of the first NAMAs for mitigating emissions in the residential sector by incentivizing construction of energy efficient housing units. The objective of the NAMA is to move the construction industry in building housing units to achieve the mandated energy efficiency level. The specification of energy efficiency standards also includes efficient equipment specifications. For example CASA I the standard includes solar water heaters and efficient A/C units in the specifications.

The Measurement of GHG impacts is based on measuring energy consumption of a representative sample of homes and compare its GHG emissions with emissions of a reference home. The sample size is designed to estimate the emissions of the reference homes within a 90% level of confidence. Table 9 presents the parameters to be measured for estimating the GHG impacts:

Table 9. Parameters for measurement

PARAMETER	UNIT	FREQUENCY OF COLLECTION	SOURCE	COLLECTED BY
Electricity consumption	kWh	Bi-monthly, aggregated annually	Electricity meter of the electricity provider	Electricity Distribution company
Gas consumption	litres	Annually	Gas meter to be installed or simulations	DIT
Water consumption	litres	Aggregated annually	Water supply company	DIT
Occupancy	persons	Annually	Survey	Survey

As these are residential buildings, it is anticipated that there is no heating/cooling provided through common systems installed on the premises. Further, all the energy supply is through electricity and gas. The measurement system will also collect the following information at the time of home registration:

- Water heater, type and capacity
- Solar system, type and capacity
- Refrigerator, type and capacity
- Major appliances, type and capacity
- Lighting, type and capacity
- Estimated Savings from design features.

This data is used to establish the norm for each of the homes sold under NAMA and ensure compliance with the requirements. This information is also relevant for calibrating models.

The homes are categorized in three categories: single, connected, and vertical. Seven bioclimatic zones have been identified in Mexico. So baseline is established for 21 categories of homes. Baseline is established through a sample survey to establish GHG per gross floor area and energy consumption per gross floor area. Further, the baseline will be updated every 3 to 4 years to capture the changes in energy use pattern.

The assumption in the methodology is that GHG emissions from loss of refrigerants are expected to be the same or lower in energy efficient homes.

Further, the baseline also includes cooking energy use as part of the GHG emissions. The cooking energy use is not influenced by the design of the building but it is also difficult to subtract this energy use, if energy source for cooking is also used for other energy needs.

[1] This section is based on information in the publication «Supported NAMA for Sustainable Housing in Mexico - Mitigation Actions and Financing Packages», published by Conavi.

6

FINANCING A NAMA FOR ENERGY EFFICIENT BUILDINGS

The financing aspects of a NAMA are central to NAMA design and should be considered at the earliest stages of NAMA development. Only few, if any, NAMAs will not have any relationship with other activities and budget lines of the national budget, and thus NAMA financing cannot be thought of in isolation – it must integrate with current policies and current budgets. Contrary to many development projects based on international funding the exercise is not a listing of cost items in order to arrive at a demand for external (grant) funding.

The reduction of emissions is only rarely a separate purpose of investments, and climate finance therefore not a separate type of financing. It is an objective that countries and policy makers take into consideration for national development alongside a number of other development parameters and priorities. Policies implemented by governments in support of national sustainable development objectives are commonly accompanied by government funding. Here, investment motivation exists at at least four levels: 1) the NAMA as a motivation factor for assessing the impact of existing policy/ies on GHG emissions; 2) the NAMA as a policy correction to address both national sustainable development goals and climate change, and assess the financial implication of supporting the policy; 3) the NAMA as motivation for the public sector to devote additional finance for a given policy, and 4) this particular policy's ability to motivate private – or other public – entities to invest. While (part of) such government funding may originate also from international support, this should not be the starting point.

NAMAs are generally being defined within the context of general development planning or, ideally, Low Emission Development Strategies (UNEP RISØ 2011).[1] Many elements of general development planning inherently include initiatives that in themselves have emissions reduction effects – or their implementation modalities may be shifted towards a lower level of emissions. Emissions reduction, therefore, will commonly be regarded a co-benefit related to other prime objectives like reduction of traffic congestion, reducing health hazards in landfills, preventing hazardous emissions from old power plants, improving security of supply, providing energy access, substituting imports, reducing subsidies, pursuing targeted industrial development or a host of other motivations. Emissions reduction integrated with such motivations may come at no cost – in which case host countries for such policies may refrain from, or neglect, to label them 'NAMA'. This may well be the case e.g. for building codes, which may be imposing profitable improvements to building practices. Even if such actions are profitable it is still advisable to report such unilateral actions from the simple reason that when emissions reduction options do come at an extra cost and a NAMA host country wishes to attract international financing to overcome these costs, the national effort in other areas may be recognized by those financiers that may consider to contribute.

[1] See Low Carbon Development Strategies - A Primer on Framing Nationally Appropriate Mitigation Actions (NAMAs) in Developing Countries, UNEP RISØ 2011

There may be factors that hinder even profitable actions from happening. Many of these may originate in conflicts of economic interest among different stakeholders or in difficulties in raising up-front investment financing for high-investment-low-operational cost technology alternatives. Financing can be structured to overcome such financial barriers or to counter conflicts of interest. Such financing may need to be accompanied by regulatory initiatives to become efficient.

CALCULATING INCREMENTAL COSTS

INCREMENTAL COSTS?

A city develops a new residential area. The construction standard prescribes energy consumption of 170 kwh/m²/year. Such buildings may be built at 2000 USD/m². Raising the standard to 100 kwh/m² instead will raise the construction price significantly (maybe 20%). These are incremental investment costs. The actual incremental cost includes the cost of operating the buildings as well. It is most likely that the energy efficient building will save (significantly) more in operational costs than the extra cost of meeting a higher standard so that in the end the higher capital cost solution comes out the most profitable one. But lower operations costs, particularly in the building sector, do not easily convert into investment capital – which is why the world is full of low cost, low quality, low efficiency buildings that are expensive to run during their often limited operational life. Meeting this challenge would be a major achievement of NAMA finance.

If a NAMA is in need of international support it would essentially be additional to resources raised within the NAMA host country itself from motivations of meeting national sustainable development goals. International financing for NAMA implementation may cover 'incremental costs' above a business as usual scenario. The Global Environment Facility (GEF) has interpreted this as 'additional costs associated with transforming a project with national benefits into one with additional global greenhouse gas mitigation benefits. However, arriving at a figure for a shortfall of finance is not straightforward – should the investment for instance result in significant savings in other parts of the economy, it may be a subject in discussions about the actual financing shortfall.

But even in the same sector, it may be a challenge to calculate incremental costs. For Instance, the choice could be central air conditioning instead of conventional split unit air conditioning installed by individual households in each their apartment. The lifetime cost difference between the two options is the incremental cost. Unfortunately, such calculations are never that simple and a number of decisions about what to include in the calculation and what not to include may obscure the picture. A third approach would be to structure the national finance and the financing model and financial instruments as efficiently as possible, respecting national principal constraints, and devise a structure for the lowest cost option for filling the financing gap. This may or may not be the incremental cost. Particularly, the later returns on investment in high-capital-low-operational cost equipment such as energy efficient air conditioners cannot be disregarded. It is also obvious, that the less efficient the financing model, the higher would be the incremental cost. Most likely the final determination of incremental costs, if relevant at all, may be negotiated with any prospective financier.

STRUCTURING NAMA FINANCE FOR ENERGY EFFICIENT BUILDINGS

Although NAMAs are supposed to establish a deviation from a baseline or business as usual, the integration with general development policies may complicate such differentiation. Some NAMAs may therefore in a sense represent business as usual scenarios – or rather 'development as planned' scenarios. In terms of NAMA financing this is fundamentally an issue between the NAMA proponent and the financiers, including international financiers, of the action. A deviation from the baseline, however that is defined, may be essential for (international) funding motivated by emissions reduction, but it is not essential for other sources of finance. National public financing will be motivated by immediate public good objectives – private sector financing would be driven by motives of profit.

It is increasingly expected that NAMAs must lead to 'transformational' changes. A common interpretation of transformation is to permanently change one state of affairs into another. Such changes relate to permanent operational activities, i.e. it is not the asset investment alone, but the way in which it is used. This is particularly true for buildings.

Decomposing the types of buildings and especially the types of financing instruments that are relevant is necessary. By far the largest share of financing goes into construction. This financing is typically raised through banks and bond markets. Public and private developers of buildings alike are depending on these markets to access capital. The public sector may have additional avenues for raising capital, but the instruments available are practically the same.

NEW BUILDINGS

Building and construction finance is a traditional discipline with established practices and principles. These practices and principles may not be conducive to greening the building stock due to the aforementioned conflicts of interests among different stakeholders. If the market does not value low cost of operation, the financing of investments in support of such greening may be difficult to raise, simply because the business case may be difficult to make: If owners can rent out inefficient square meters at the same price as efficient ones it is obviously not good business to spend more investment capital for the same income. Thus the consideration in traditional finance.

Building codes that require higher levels of efficiency is a common response by the public sector. Building codes work in some contexts and not in other – particularly not in contexts where enforcement is weak. If it has no negative consequences to build against the code there is no incentive to comply, and the financing sector will continue a practice of lending also to construction of non-compliant buildings. If, however, there is a risk affiliated with constructions violating the code the financial sector may become the de facto enforcer of the building code. Buildings require electricity and water to operate and these services are typically delivered by public sector entities. Hence the connection of these essential services is in the hands of the regulatory authorities. Policies that prohibit the connection on non-compliant buildings have been attempted in China, but without significant effect due to circumvention at lower administrative levels. However, if a sufficient number of cases are established, where buildings are left idle due to non-compliance with the building code, the financing sector will change its perception of risk and require code compliance as a precondition for participating in the financing. In this way, the financing sector's traditional risk assessment and avoidance approach can be turned into working for the environment and not against it.

There may be other, more complicated avenues to achieve the same effect. Obviously, following a building code requiring higher levels of efficiency in most cases comes at a cost. This is a cost that generally makes construction more expensive and therefore forces the owner to rent out a square meter at a higher price compared to existing buildings. Possibly even the tenant will be reluctant, because of lack of trust that the less operational costs that he will have to entertain will off-set the extra rent. While the financing risk has been eliminated, the market risk has suddenly increased – at least in a transitional period where consumers are sceptical of the cost reductions. To make things look like business as usual an 'energy service company' concept can be adapted to new constructions[2]. Depending on the starting point, and omitting the possible increase in costs of design (which is small compared to the total cost), the basic construction of more energy efficient buildings is not decisively influenced by increased energy efficiency demands. Only a smaller proportion of the capital costs go into systems and materials that improve the efficiency. Imposing a dual ownership in construction, where the basic construction is undertaken by the developer and the 'energy efficiency package' is the responsibility of an energy service company, will ensure that part of the construction consortium will have as its main interest the cost of operating the building. Charges to consumers may be at conventional high levels, while the energy service company is benefiting from the lower consumption for heating, cooling and lighting. The energy service company will 'return' the infrastructure to the consumers after a predefined number of years that allows it to recover the cost of the investment in the increased efficiency. While this may be easily understood its implementation and judicial implications may be challenging. The financing model is relatively simple, but also here the trust of the financing sector is crucial and not easily won.

If the lack of trust in the financing sector becomes prohibitive to progress there are ways in which the public sector can be conducive. Such conduciveness may be in the form of different kinds of support, either to the financing sector, to the developers or to the consumers. Such instruments are presented later.

[2] see 'City-based Carbon Budgets', UNEP DTU working Paper, S. E. Lütken, forthcoming

EXISTING BUILDINGS

Improving the efficiency of existing buildings becomes increasingly important in economies where the ratio of the existing building stock compared to the upcoming one is significant or where the life expectancy of the existing building stock is significant – in other words, where there is a large and lasting building stock already in existence. Such building mass is suffering in full from the conflicting economic interests between owners and tenants, the latter often being without any means of influence to improve the efficiency of a building, and equally often without the interest in doing so as well. Improving existing buildings requires retrofitting. Some retrofits are easy, such as split unit air conditioners, while others are difficult or practically impossible, like windows in a multi-storey apartment building. But even the difficult ones have alternatives. Walls can be insulated from the inside with high-efficiency insulation panels and windows can be added an extra layer of glass on the inside (which is a very common measure in old European buildings where changing windows requires special windows manufacture).

The challenge with such investments is that they are permanent and tenants that are not certain to stay long enough to recover the investments through savings are unlikely to invest. There are no quick fixes to this conflict of interest, but ease of access to financing of such retrofitting may help incentivizing it. A simple grant for retiring inefficient air conditioners or tax exemption for insulation materials are options that reduce the payback time and thus improve the business case for a proportion of tenants. Energy service companies may involve themselves for total building refurbishment projects, but for those projects it is probably a precondition that the building is not a case of mixed ownership with both tenants and owners of individual apartments. For such large scale renovation projects bonds and large scale banking become essential financing models, while the smaller scale individual initiatives requires another small-scale model with banks, which are often not geared to handle small-scale loans for building improvements. For such individual loan-taking, which may be relevant at least for part of the owners of houses and apartments, a government guarantee scheme may reduce significantly the banks' due diligence burden, the cost of which may otherwise well exceed the income on the loan. A guarantee may both increase lending willingness and possibly also reduce the interest rate. In case the latter does not materialize and is considered a prerequisite to get activity going, the government may also consider offering, on top of the guarantee, a subsidy on the interest.

PRIVATE BUILDINGS

There are several ways in which buildings can be categorized, but the most basic one – apart from the above distinction between new and existing buildings – is based on the private and public ownership respectively. The building code will normally apply equally to any building regardless of ownership, but the way in which financing can be influenced by the public sector regulator obviously differs considerably. Private buildings are subject to taxation. The structure of taxation of real estate is varying considerably from country to country and is employing a range of different principles. It may be rent of land in countries without private ownership of land; it may be property taxes based on fixed values or concurrent valuation of property; it may be consumption taxes; approval taxes; financing taxes – and any combination of the said. Any such cash flows based on taxes or levies charged by the regulator may be subjected to revision. Such revisions may be linked with climate change objectives. For instance, taxes may be raised on a regular basis, but tax holidays may be offered if building owners undertake to invest in energy efficient technology. Increased taxes may also be circulated back into the sector in order to support grant programmes that are targeted at the adoption of certain energy efficiency measures. Such tax initiatives can be directed at new and old buildings alike.

As mentioned elsewhere the introduction of ESCO concepts for existing as well as new buildings is in essence also a financing initiative that allows the return on efficient technology to accumulate in a corporate structure whose business it is to reduce energy consumption.

PUBLIC BUILDINGS

Although public buildings are in the ownership of public institutions it does not necessarily mean that the regulator has easier access to influence cash flows and priority of investment in energy efficiency measures. Building ownership may be delinked from occupancy, which again may be delinked from actual payments of services like energy supply. Therefore, the split incentives among different stakeholders in the value chain of building design, construction, ownership and occupancy, is just as relevant within the public sector itself. It is just as necessary to align outlays and returns in the public sector as it is in the private. Otherwise, perverse incentives will dominate decision making. If a building is owned by the central government, occupied by the local school, and utilities paid by the hosting municipality, there are no easy way to construct incentives to improve energy efficiency of neither new or old buildings. But also here ESCOs may be relevant instruments. Such entities would need to be engaged by the authority that is currently entertaining the costs affiliated with energy consumption. Hence, if this entity is the municipality, it would be the municipality that engages the ESCO. However, such agreements with third parties to make energy efficiency installations on the property must be made in agreement with the owner of that particular property. If the owner is the national government, then the national government must be in agreement. Even though the value of the building is likely to increase as a result of the investment an agreement with the owner may come at a cost, i.e. the potential gains from the energy savings may need to be shared with the owner. Should this be the case, it must be kept in mind that the sharing is of a profit, not of a cost.

BARRIERS

It is clear from the above that even though energy efficiency investments, including in buildings, are often profitable and thus come at no incremental cost they still face financial barriers. Costs and benefits commonly accrue in differing groups of stakeholders, i.e. one group will entertain the cost, while another group gains the profit. The challenge is therefore not to make the finance cover an additional cost, but to make sure that costs and benefits accrue to the same stakeholder(s). If the public sector needs to step in and bridge a financing gap – which is the case in a couple of the above examples – it should also be considered how such outlays can be recovered. One optional source is marginal reduction of subsidies on energy (electricity), if such indeed exist. Another one is taxes, which may be engineered in a multitude of ways. Therefore, in many cases, the flipside of an incentives scheme will be a harder regulatory initiative that aims at recovering the cost of convincing consumers to earn a profit.

IDENTIFYING FINANCIAL AND ECONOMIC INSTRUMENTS AND VEHICLES

The above examples on new and existing buildings illustrate that the means of action in terms of financing incentives are determined entirely by the situation. An important realization from the above is that even in situations where investments are profitable, financing instruments may still be necessary in order to overcome built-in barriers in the structure of the sector. The financing plan for a NAMA presents financial instruments and vehicles for its implementation. It contains the entire financing of the action. That means that not only are the financing instruments described that shall motivate the targeted sector, i.e. the building sector, to incorporate more energy efficiency measures; also the means to finance these instruments must be described. For internationally supported NAMAs this also means that not only the part for which international third party financing is invited should be presented; also the national financing and its sources should be identified.

In most cases the plan involves private sector financing – often in the simplest form through private purchase of equipment and appliances in accordance with issued regulation. In these cases, as illustrated above, the private sector's access to financing should be considered and, if necessary, incorporated in the plan. In most cases, the financing structure will have to be adjusted according to negotiations with financial stakeholders, be it nationally in the ministry of finance or other central stakeholders, or internationally. Financiers should be regarded as important advisers as to how to maximize financial resources or reduce costs of financing. Consultations with financiers should be initiated at an early stage in the development of the NAMA, rather than waiting until the full NAMA proposal has been developed.

Table 10 presents examples of financial and economic instruments that could be used by a government to raise domestic financing for NAMAs that target energy efficient buildings.

Table 10. Government instruments

INSTRUMENTS
Grants
Purchase of assets
Fixed payment for services
Additional payment, subsidies (e.g. feed-in tariffs)
Removing subsidies
Tax
Tax credit/reduction/exemption
Variable or accelerated depreciation
Guarantee schemes
Loan schemes
Technology standards (forcing investment)

source: Inspired by UNEP RISØ (2011) (Low Carbon Development Strategies)

The instruments in Table 10 are traditional instruments available to a ministry of finance to structure the economy and as such familiar territory. Employing, or intent to employing, such instruments and mechanisms in support of a NAMA is essential to attracting international financing from both public and private sources for transformational NAMAs. This has to do with the nature of transformation as mentioned above, being mainly related to the operation, and thus the recurrent spending for a given action/activity. See further in the end of this chapter.

IDENTIFYING SOURCES OF FINANCING

The financial engineering of NAMAs may be guided by 'the right order of leveraging' as suggested by the UNFCCC NAMA Guidance (adopted from Lütken (2014)), illustrated in Figure 8. The leveraging model emphasizes the importance of the domestic financial participation, identifying which financing elements can be met domestically, and which require international financing so as to demonstrate how this will contribute to the activity.

Domestic and international financing may include both public and private sources as illustrated. The public sources, both national and international, should generally be structured in a way that leverages private investment. In the case of energy efficient buildings, the purchase of the equipment will first and foremost be undertaken by the private sector (either as developers, construction companies or owners of buildings), whereas the financial support (and/or regulation as mentioned) required to promote the desired purchase of energy efficient materials or equipment must origin in a public budget. The refinancing of such expenditure is part of the financial engineering of the NAMA and may include national taxes and levies, reduction of subsidies, international concessional lending or in the rare case, a grant from an international donor. However, as NAMAs are to foster transformational changes they implicitly assume a permanent shift in the financing model employed in a sector. Such shifts will be achieved by activating long term financing arrangements that often would involve national public recurrent spending budgets signalling permanent shifts in financing priorities – alternatively permanent regulation in support of the more energy efficient buildings can be used.

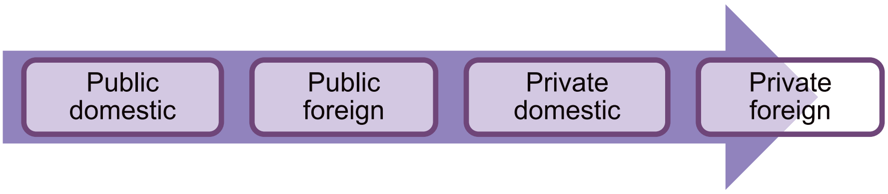


Figure 8. The order of leveraging

DOMESTIC FINANCING

Domestic financing includes budgetary support from public institutions as well as private sector investment43. The following stakeholders may play a key role in mobilizing domestic financing for energy efficient buildings NAMAs:

- Government, such as national energy agency or Ministry of Finance;
- Power utilities or independent power producers;
- Energy service companies (ESCOs);
- Suppliers of energy efficient buildings products and services;
- Banks and other financial service institutions;
- Electricity (and water) consumers.

Many of these stakeholders can contribute to the design and choice of policies, economic instruments, and financial vehicles (such as taxes, loans, grants, rebates or capital investments) that can be used to channel domestic financing toward specific NAMA components.

Domestic public financing is essential for attracting international financiers as illustrated in Figure 8, and in setting framework conditions that make private investment attractive. Depending on the host country's circumstances and abilities, a strong domestic financial contribution, or will to regulate, will increase the attractiveness of the NAMA for international participation. Domestic financing may be directed towards 'no regrets' actions that are cost neutral or that yield a net profit. The latter would be obvious targets for private sector investment. Conversely, if there is no national contribution, or no national preparedness to restructure the financing to achieve transformational changes in a sector, the attraction for international funding may be limited. For instance, it may be difficult to convince international financiers to compete with national fossil fuel subsidies.

INTERNATIONAL FUNDING

International funding for NAMAs has focused on supporting readiness activities, such as institutional capacity building and preparation of concept notes, through either bilateral or multilateral programmes. Dedicated initiatives and sources for financing NAMA implementation exist, such as The NAMA Facility and the Green Climate Fund. However, most existing bilateral and multilateral funds offer funding to countries for mitigation activities without explicitly targeting or mentioning NAMAs. 'Innovative financing' is sought, but most products offered are traditional loans, guarantees and occasionally one time grants. Orchestrating a full financial package is uncommon. Most development finance institutions continue to provide technical and/or financial support for mitigation measures in various sectors, some of which do have a dedicated 'NAMA financing window.

PRIVATE SECTOR FINANCING

Energy efficient buildings can be attractive investment opportunities for both domestic and foreign private companies, if they are profitable – or made profitable through public sector intervention. Private sector intervention requires a financial structuring that allows a return on the investment. Sometimes this requires additional regulatory support as mentioned in relation to enforcing building codes. For example, ESCOs enter into contracts that allow them to invest in energy efficient equipment, and finance it through the savings on the energy bill. Such contracts are sizeable and, therefore, challenging for the domestic household market, but may function well with the public sector or large commercial customers. The private sector only invests if the risk/return ratio is acceptable; its involvement in energy service companies may require public sector intervention that reduces risks and barriers, or increases returns.

ESCOs build on the idea of reducing the cost of energy, the common assumption being that an existing operation can be made more energy efficient. Thus, ESCOs would be an applicable concept for renovating existing buildings, and is increasingly being used in many (developed) markets for the improvement of the existing building stock. Few, if any, models exist for the introduction of ESCOs in new buildings. The ideas seen[3] mostly concern the setting of a standard and consider, if an ESCO model can help achieving the target for new builds. The earlier mentioned example, where the ESCO is imposed into the ownership structure of a new building, is a concept that still needs testing in practice.

[3] see e.g. http://www.eci.ox.ac.uk/research/energy/downloads/bmt-report3.pdf

The private sector, especially the technology providers, can also contribute to non-market activities, such as awareness raising and marketing campaigns, to increase the use of systems and technology for energy efficient buildings. To identify opportunities for private financing and involvement, international and local private sector stakeholders should be consulted during the NAMA development process through dialogues or workshops. Such dialogues will help to identify potential barriers to private sector investment and involvement, which can then be addressed by targeted public sector interventions as part of the NAMA and thus help leverage private sector finance.

OTHER SOURCES OF FINANCING

Bilateral financial institutions have extensive and long-standing experience in supporting traditional mitigation projects, and are increasingly engaging in the international support of NAMAs. A review of pilot and relevant activities of four bilateral financial institutions highlighted the measuring, reporting and verifying process, funding channels, engaging the private sector, and explores opportunities to utilise market mechanisms. "One of the key insights is that NAMAs should be mainstreamed into national development strategies to make the proposed actions 'nationally appropriate,' engaging planning, finance and line ministries, together with environment ministries. In addition, efforts should be intensified to produce financially viable and sustainable NAMA proposals, which can withstand the due diligence of financial institutions".

MEETING INTERNATIONAL FINANCIERS' REQUIREMENTS

The type of information that international financiers may expect from a NAMA developer depends significantly on the identity of the financier. Although different financiers will require different types of information some central issues include:

- A well designed proposal that transparently incorporate adequate domestic stakeholder consultations in order to ensure alignment with national development interests;
- A draft financing plan that incorporates existing national financial flows, both recurrent spending and investment budgets;
- A realistic plan of implementation, including realistic expectations for other financial stakeholders, in particular the private sector. A realistic scope for implementation is equally a prerequisite. For example, the NAMA may focus on a region, and/or be phased in order to secure sufficient implementation resources;
- A NAMA developer with a relevant mandate and appropriate technical and financial capabilities to see the implementation of the NAMA through.

Most of the financing for a NAMA, in all likelihood, is not motivated by emissions reduction. NAMAs are aligned with national development policies and these policies are already requiring financing from different sources that finance the initiatives for their fundamental purpose, typically the delivery of a public sector service. The NAMA financing cannot be conflicting with the interests of financiers already involved. Rather, their interest must be aligned. Thus, investment motivations may be divided between greenhouse gas related criteria, shown in Table 11, and non-greenhouse gas related criteria, in Table 12. Although the criteria seem to relate to different financial stakeholders, they should be regarded less separately than the table may indicate.

Table 11. Greenhouse gas related investment motivations

GREENHOUSE GAS RELATED CRITERIA	APPLICATION TO NAMAS FOR ENERGY EFFICIENT BUILDINGS
Cost effectiveness of emissions reductions	The net cost of improved building standards compared to the potential savings from lower operating costs ; possibly compensating for rebound effects
Direct and indirect mitigation potential	Direct and indirect emissions reductions expected from improved building practices or by retrofitting certain types of equipment (tCO_2e).
Mitigative capacity	Refers to a country's ability to reduce greenhouse gas emissions in the longer term. In the context of energy efficient buildings strategies, enabling activities to build institutional structures for measuring, reporting and verifying, for example, improve a country's ability to achieve long-term emissions reductions, also beyond the immediate target sector.
Long-term transformational potential and replicability	Transformational change is achieved through targeted strategic policy interventions which go beyond, for example, the mere replacement of electric water heaters. It may include regulatory changes or awareness building activities aimed at making the programme sustainable in the long term.

Table 12. Non-greenhouse gas related investment motivations

NON-GREENHOUSE GAS RELATED CRITERIA	APPLICATION TO NAMAS FOR ENERGY EFFICIENT BUILDINGS
Sustainable development benefits	The achievement of sustainable development through the NAMA will enhance the country's ownership, and will be considered a guarantee of the NAMA continuity in the long term.
Ownership and domestic funding (including co-financing)	National ownership can be demonstrated through the involvement of high-level decision makers during the stakeholders' consultative process, and through domestic (public) funding for specific NAMA components.
Robust measuring, reporting and verifying systems	As measuring, reporting and verifying of NAMAs is necessary to assess the emissions reductions achieved by the NAMA's activities and the use of support provided to such activities, the financier may have specific expectations in that regard.
Alignment with national priorities	Demonstrates how the NAMA will contribute to the achievement of development or environmental objectives, and specifies if, and how, the NAMA is embedded into existing governmental strategies.

Even though it would be expected that the NAMA developer has developed a realistic financing scenario, the NAMA proponent should refrain from being too specific on the request for financing when presenting the initial proposal to any financier. It should be left to a dialogue with financiers how financing may be applied most efficiently, including the deployment of different instruments – and their refinancing. Different instruments have different cost profiles and may directly influence the cost of the NAMA.

In that regard, the NAMA Registry deserves a final remark. The NAMA Registry requires such information about financing requirements for internationally supported NAMAs (see text box 3). But due to the fact that the financing of the NAMA will ultimately be developed together with one or more financiers, and that the financing requirement fundamentally depends on the financing model and instruments employed, it is difficult to present more than the above mentioned realistic financing scenario without particular specificity on the budget for third party financing. Thus, as mentioned in the beginning of this chapter, the financing belongs in the beginning of the NAMA development process, but it also remains an integrated part of the NAMA development process all the way to the end.

THE ROLE OF THE NAMA REGISTRY IN FINANCING

The ***NAMA Registry*** is serving dual purposes of: presenting NAMAs for recognition; and, providing a platform where NAMA host countries and NAMA financiers can meet. The Registry provides templates for submission of NAMA proposals. Although recommended, it is not mandatory to fill all the information fields. Additional criteria that reflect the interests of international financiers should also be considered when selecting the NAMA, and designing the NAMA proposal.

Some international funding requirements can be deducted from the information requested for the submission to the ***NAMA Registry*** . It is less certain, however, if the ***NAMA Registry*** will eventually be a useful platform for directing financing to NAMAs. It is more likely to serve the purpose of announcing financing agreements established through other channels, such as The NAMA Facility.

7

CONCLUSIONS

Reducing consumption of electricity or other sources of energy for the operation of buildings is a cost effective way for many countries to mitigate greenhouse gas emissions. Many countries have adopted such efficiency objectives in their NDCs. In many cases the improvement of the energy performance of buildings is profitable. The financing approach could thus be straightforward through savings in energy consumption. However, energy efficient buildings face not only a traditional investment barrier for 'high-investment-low-operation cost equipment, but also significant conflicts of economic interest among central stakeholders. Therefore, additional third party financing may still be valuable if an attractive revenue model can be established.

To a significant extent the improvement of energy efficiency in the building sector is a challenge of split incentives and the will to enforce regulation. It is not a technical challenge. To choose the right mixture of instruments and sources of finance requires an open dialogue with the central stakeholders, i.e. the developers and first and foremost the national financing institutions, and insisting that initiatives have to be taken. Obviously, there are dilemmas related to enforcement, because a new building that is constructed in violation of a building code represents a significant capital investment that strict enforcement could render a stranded asset. On the other hand, if regulators scare away from such enforcement measures they have already lost the battle and building codes and standards will achieve little in terms of improving the energy efficiency of buildings. Ultimately, in the longer run it is in nobody's interest to build unsustainably – and in everybody's interest that resources are not wasted on energy for buildings that could do with much less consumption.

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REFERENCES & ANNEXES

ANNEX A: SOME EXISTING PROGRAMMES FOR NAMA READINESS ACTIVITIES

LEAD ORGANIZATIONS	INITIATIVE	SOURCES OF FINANCIAL SUPPORT
UNEP DTU Partnership	ADMIRE – Adaptation & Mitigation Readiness	Danish Energy Agency, Danish International Development Assistance DANIDA
Energy Research Centre of the Netherlands (ECN) and Ecofys	Mitigation Momentum[a]	German Ministry of Environment
Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)	International Partnership on Mitigation and Measuring, Reporting and Verifying[b]	German Ministry of Environment
Center for Clean Air Policy (CCAP)	Mitigation Action Implementation Network[c]	German Ministry of Environment; The Netherlands; and, Environment Canada, with additional support from World Bank Institute's Carbon Finance-Assist programme and other donors
Japan International Cooperation Agency (JICA)	Training and Dialogue Programs on Capacity Development for NAMA/ MRV[d]	Ministry of Foreign Affairs, Japan
Global Environment Facility (GEF)	GEF Climate Change Priority	GEF
United Nations Development Programme	Low Emission Capacity Building Programme[e]	Australia; European Commission; and, German Ministry of Environment
United Nations Environment Programme	en.lighten initiative	Australian Agency for International Development; and, GEF
United Nations Environment Programme	Facilitating Implementation and Readiness for Mitigation[f]	Denmark

[a] www.mitigationmomentum.org/

[b] www.bmu-klimaschutzinitiative.de/en/projects?p=1&d=840

[c] http://ccap.org/programs/mitigation-action-implementation-network-main/

[d] www.jica.go.jp/english/our_work/types_of_assistance/tech/acceptance/training/about/lineup.htmlwww.jica.go.jp/english/our_work/types_of_ assistance/tech/acceptance/training/about/c8h0vm000066m3ps-att/environmental2013.pdf

[e] http://lowemissiondevelopment.org/

[f] www.lowcarbondev-support.org/

ANNEX B: NAMA TEMPLATE / QUESTIONNAIRE FOR POLICY MAKERS

SECTION 1: NAMA OVERVIEW

BASIC INFORMATION

1.1.1. Title of NAMA :	
1.1.2. Country:	
1.1.4. Proponent (name, contact details, legal status) ***Name of the person(s)/organisation responsible for the analysis and identification of measures for the NAMA proposal. If a working group is responsible, please name the members of the working group.***	1.1.5. The Proponent's interest in the NAMA development and implementation *any economic, political or personal interest in any aspect of the NAMA*
1.1.6. Sector/Subsector: ***Sector/subsector in which NAMA takes place***	1.1.7. Targeted Greenhouse Gas (tick) : CO_2 CH_4 N_2O HFCs PFCs SF_6 NF_3
1.1.8. Private sector interest in the development of the NAMA: ***Current private sector involvement in the sector and the opportunities created by the NAMA for increased involvement***	
1.1.9. The appropriate public authority under who's auspices the NAMA would be implemented: ***Entity/ies in charge of regulating the sector in which the NAMA is proposed***	1.1.10. National NAMA Approver: ***Mention name of national NAMA Approver if one has already been designated in your country (if not, leave blank)***
1.1.11. Status of Endorsement by appropriate National Authority: ***Endorsement is not required at the time of application, but formal endorsement must be provided before the application can be approved for funding***	

OVERVIEW OF THE KEY ASPECTS OF THE NAMA

The table below presents a summary of the information described in SECTION 2.

1.2.1 Brief description of the objectives of the proposed NAMA and summary of measures to be included in the NAMA	Describe the purpose of the NAMA by describing the current situation and the situation after NAMA implementation. Refer to technologies which would be implemented under the NAMA. Describe the objectives of the proposed NAMA in a clear manner. Briefly describe the measures that will be implemented as part of the NAMA. Explain what sources of emissions will be addressed by the proposed NAMA and how the proposed measures in the NAMA will impact GHG emissions. Refer to the GHG NAMA boundary.
1.2.2 Relevance to the national sustainable development plan(s) or national strategies and/or to the sectoral mitigation goals	Explain why the NAMA is relevant for national development plan/strategies and sectoral plans/strategies. In doing so, please provide information on the following: Describe the national sustainable development context and objectives. Refer to relevant existing national sustainable development plan/strategies. Describe the sectoral context (sector in which NAMA would be implemented) by referring to relevant existing sectoral plan/strategies. Describe sectoral mitigation goals, if any. Explain how the NAMA contributes to attaining the national sustainable development objectives and sectoral mitigation goals.
1.2.3 Brief description of relevant existing mitigation initiatives and their synergies with the proposed NAMA	Describe briefly any national and international (with international support) mitigation initiatives under implementation in the country that are relevant for the NAMA. For each of them, explain what are the link and synergies between the initiative and the NAMA. For each of them explain how coordination will be ensured with the NAMA.
1.2.4 Brief description of the transformational impact, including its sustainability	Provide a summary of the information detailed in point 5.5.

SECTION 2: NAMA DETAILS

INTRODUCTION	
2.1.1 Description of the general context of the country, including overview of national development and climate change policies	**(2 pages)** Describe the general social, economic and environmental context of the country relevant for the NAMA. Describe the national development strategies and list the national priorities and objectives relevant for the NAMA. Describe the national context related to climate change, and in particular the mitigation aspects: Describe briefly total national GHG emissions and key sources of emissions. Also describe available information on projections of national GHG emissions and key areas where growth is expected. Describe briefly the existing national climate change (mitigation) policies/strategies/plans and specify the national emissions reductions objectives. Describe briefly the national institutional context existing in the country to manage the climate change issue, in particular for GHG mitigation. The information should provide references to key national development planning or strategy documents.
2.1.2 Detailed description of the current situation in the sector/sub-sector, including the relevant existing legal, regulatory and institutional framework, where NAMA would be implemented	**(2-3 pages)** Describe the contribution and importance of the sector (where the NAMA would be implemented) in the country to national economic growth, and also its contributions to social (human development) and the environment, highlighting how this sector is related to the national development priorities, and objectives and challenges mentioned in 3.1. Explain the strategy and plans for development of the sector in which the NAMA would be implemented, as well as key objectives for the sector. Refer to national and/or any sector-specific strategy/development plans. Describe the GHG emissions for the sector in which the NAMA would be implemented and key sources of GHG emissions. Further, provide an assessment of projected growth in GHG emissions. Present any national/sectoral strategy or approaches to addressing GHG emissions from the sector if available. Describe the current legal/policy framework, the existing institutional framework and the existing regulatory framework, as well any policies directly or indirectly relevant for GHG emissions.
2.1.3. Description of scope and objectives of NAMA to address the current situation	**(1-2 pages)** Starting from the current situation described in 2.1.2, describe in detail the general and specific objectives of the NAMA, including the main source of GHG emissions that would be reduced. Describe the scope of the NAMA by describing where in the country the NAMA will be implemented (national, sectoral, local level) and quantify the approximate emissions reduction from the NAMA (national, sectoral, local level). Describe how the NAMA relates to the existing legal/policy/regulatory framework and the existing institutional framework.
IDENTIFICATION OF BARRIERS AND IMPLEMENTATION OPTIONS	
2.2.1 Known barriers (financial, legal, regulatory, institutional, capacity, technology, etc.) that may impede achievement of the NAMA objectives	**(1-2 pages)** Explain the barriers that impede the achievement of the NAMA objectives. For instance: Economic and financial Market failures Policy and legal Regulatory Institutional and organisational capacity Human capacity Social and cultural
2.2.2 Identification of possible options to address the barriers	**(1 page)** Describe the proposed solutions (measures) to remove the barriers through the NAMA. For each solution (measure), describe the expected output from implementing the measure. *Note that since the financial barriers are normally one of the main barriers, describing the solution through a financial analysis (although basic) with a comparison of costs (compared to other classic solutions that might be implemented in place of the NAMA) may be useful. For example, if it is proposed to develop a „Green mortgage program“ with extended credit to low-income households, it should be explained how this would work, at which rate, etc.*

DESCRIPTION OF THE NAMA ACTION PLAN	
2.3.1 Description of detailed activities to implement the mitigation measures included in the NAMA	**(2 pages)** Based on the measures identified in 2.3.2, describe the key output that will be achieved for each measure. Describe in detail the key activities to be implemented to achieve the respective output for each of the identified measure. Describe how the outputs will contribute to the NAMA objectives beyond the limits of the mitigation measures, and how these objectives will promote the desired impacts.
2.3.2 Implementation arrangements: roles and responsibilities of different entities and stakeholders involved in implementation of NAMA, including institutional arrangements	**(2 pages)** Describe the role of the private sector in the NAMA Describe the actors in the implementation of NAMA. Describe their role and their responsibilities.
ESTIMATE OF NATIONAL SUSTAINABLE DEVELOPMENT BENEFITS AND GHG IMPACTS	
2.4.1 Baseline Scenario: narrative description of baseline situation in absence of planned NAMA measures	**(1-2 pages)** Describe the scenario that would occur in the absence of the NAMA. The baseline section should cover the following information: Description of existing situation in the sector/sub-sector in which the NAMA is being implemented. Provide information on the key parameters influencing the GHG emission sources that are to be addressed by the NAMA. Provide projections of these key parameters. For example, if the NAMA is to implement Solar Home Systems, the emissions are from the use of energy for electricity. The section should provide information on the scenario for population change, the sources of electricity, the level of growth in electricity availability etc. If there are current mitigation policies in place, describe the impact of the implementation of these policies on the GHG emission sources related to the NAMA.
2.4.2 NAMA Scenario: narrative description of situation with the implementation of NAMA measures	**(1-2 pages)** *Describe the scenario that would occur with the implementation of the NAMA. Describe, based on the activities identified above in section 2.5.1, how NAMA implementation will influence the key parameters identified in section 6.1.*
2.4.3 Description of the benefits in terms of development (social, economic, and environmental)	**(1 page)** Describe the development benefits obtained from NAMA implementation: Social benefits: human benefits (health, education, etc.) Economic benefits: jobs created, any costs reduced, national economic benefits, etc. Environmental benefits (other than GHG reductions): positive impacts on forests, land degradation, biodiversity protection, any other natural resources, reducing pollution, etc.
2.4.4 Estimate of GHG emission reductions resulting from implementation of NAMA measures, including description of methodology to estimate GHG emissions impact	**(2 pages)** Calculate/estimate the GHG emissions related to the baseline scenario. Explain how the calculation/estimate has been made by explaining the methodology used, the hypothesis made, the formula used, etc. Calculate/estimate the GHG emissions related to the NAMA scenario. Explain how the calculation/estimate has been made by explaining the methodology used, the hypothesis made, the formula used, etc. Calculate the potential of GHG emissions reductions by comparing the baseline and the NAMA scenario. The information should be quantitative and should be linked to the description of the baseline and NAMA scenarios in the sections above.
2.4.5 Description of the transformational impact of NAMA, including its sustainability	**(1 page)** Describe how the planned measures will have a long-term impact on the way different stakeholders make choices, and particularly how will the implementation of the NAMA change the private sector's choice of lower emission alternatives. Describe how the NAMA will influence permanent policies for low emission development. Explain how the measures suggested in the NAMA will be sustained beyond the implementation of the NAMA. For example, if funding is requested for a standard setting and testing lab, how will the activities of this lab continue beyond the NAMA implementation? Focus on operation rather than investment

FINANCIAL RESOURCES	
2.5.1 Current public operational and investment budget in the sector	**(1 page)** Describe the operational cost and investment items in the targeted sector and give an estimate of the current public budget for these financial flows. Describe how the estimate is made and which assumptions are used Describe the current private investments in the sector and give an estimate of the size of these investments. Describe how the assessment is made. These assessments are challenging and may be with significant uncertainties. Please make sure that the numbers refer to the level at which the NAMA is suggested. For instance, if the NAMA is suggested for a municipal intervention, cost estimates should be at the same administrative level.
2.5.2 Funding from domestic sources (public, private, investments, etc.)	**(1 page)** Describe the expected financial participation by different financing entities listed in the table Entity annual operational budget investment government municipality local private investor foreign private investor local bank loan development bank loan guarantees donor grants Reference is made to the implementation and operation of the NAMA, not the cost of developing the NAMA. In the NAMA, while assessing domestic financial contributions, it should be kept in mind that, in the absence of the NAMA, the government would have implemented other measures (related to the baseline scenario) to achieve the national sustainable development objectives using domestic financial resources. See point 2.6.1 above. Also, investments would have been made in the baseline scenario either by the private sector or through loans from domestic financial institutions.
2.5.3 Risks affiliated with investments under the NAMA	**(1 page)** Describe the risks that may threaten cash flows and delay or hinder investments for the implementation and successful operation of the NAMA.
MEASURING, REPORTING AND VERIFICATION	
2.6.1 Description of key parameters to assess progress of implementation of the NAMA	Define the parameters/indicators that may be used to measure the progress of the NAMA implementation. Indicators should be identified for each of the outputs of the NAMA. Indicators can be by proxy, e.g. number of energy efficient buildings sold, etc. In case of qualitative parameters, define the qualitative scale that will be used.
2.6.2 Current data collection in the targeted sector	Describe how data for the different parameters are currently collected and who are involved in this process. If data is currently not collected, suggest procedures and responsible entities for collecting and compiling data to assess the efficiency of the NAMA. Suggest a frequency for measurement.
NON-FINANCIAL SUPPORT REQUIRED	
2.7.1 Description of the technical and the capacity-building needs	**(1 page)** Describe in detail the technical support needed from the ADMIRE programme. This section should provide information on the nature and scope of the technical assistance that shall bring the NAMA from proposal to implementation. Suggest roles of the ADMIRE team and how it complements the efforts by the proponent. This section implicitly describes the proponents' understanding of the development process and likely obstacles and barriers to the development and how these may be addressed. Please also provide a paragraph on how this enables capacity development in the country to sustain the change beyond NAMA implementation. This would be connected to the barriers identified in earlier sections.
2.7.2 Timeline	**(1 page)** Give an estimate of a timeline for the development of the NAMA, listing major tasks and milestones. Identify at least 3 milestones for stop/go decisions whether to continue the development of the NAMA or whether the chances for achieving the initial objectives have eroded.

ANNEX C:
SOME NAMA FUNDING ORGANIZATIONS

INTERNATIONAL CLIMATE INITIATIVE (IKI)

Sponsors/investors: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Germany, and Energy and Climate Fund (EKF)

Fund size: EUR 120 million (annually)

Target: Energy (and others) for national/sectoral goal, strategy, national/sectoral policy or programme

Type of support: Projects, such as developing NAMAs, gaining access to funding for implementation, and implementing ambitious components of NAMAs

Accessible by: Individual project developers

Example of project finance: Mitigation Momentum NAMAs

More information: *www.international-climate-initiative.com/en/*

Contact: Annual call for proposals: *programmbuero@programmbuero-klima.de*

THE NAMA FACILITY

Sponsors/investors: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Germany, and Department of Energy & Climate Change (DECC), UK

Fund size: EUR 70 million

Target: NAMA support projects

Type of support: NAMA support projects (grants)

Accessible by: Partner governments, individual project developers

More information and templates: *www.international-climate-initiative.com/en/issues/nama-facility/*

www.gov.uk/government/publications/information-about-the-nationally-appropriate-mitigation-actions-nama-facility

Contact: *contact@NAMA-Facility.org*

GLOBAL CLIMATE PARTNERSHIP FUND (GCPF)

Sponsors/investors: KfW Entwicklungsbank, International Finance Corporation (IFC), Ministry of Foreign Affairs, Denmark, and Deutsche Bank

Fund size: USD 235 million

Target: Energy (efficiency and renewables) for emerging and developing countries

Type of support: Technical, financial (senior and mezzanine debt, limited equity)

Accessible by: Financial institutions, project developers, sponsors, and technology providers

More information: *http://gcpf.lu/ and http://gcpf.lu/investment-portfolio-62.html*

Contact: *info@gcpf.lu*

GLOBAL ENERGY EFFICIENCY AND RENEWABLE ENERGY FUND (GEEREF)

Sponsors/investors: European Union, Germany, Norway, European Investment Bank Group (European Investment Bank and the European Investment Fund)

Fund size: EUR 112 million

Target: Energy (efficiency and renewables) for developing countries in Asia, Latin America & Africa

Type of support: Technical, financial (equity, channels financing to regional funds)

Accessible by: Regional funds, private equity funds

More information: *http://geeref.com/*

Contact: *geeref@eib.org*

THE GREEN CLIMATE FUND (ANTICIPATED OPENING IN 2014)

Sponsors/investors: (The World Bank is interim Trustee)

Fund size: (Anticipated, USD 100 billion)

Target: Mitigation, and adaptation to climate change in developing countries

More information: *http://gcfund.net/home.html*

Contact: Interim Secretariat, isecretariat@gcfund.net

KFW DEVELOPMENT & CLIMATE FINANCE

Sponsor/investor: KfW, Germany

Target: Any

Type of support: Financial (grants, concessional loans, structured financing)

Accessible by: National governments

Contact: *info@kfw-Entwicklungsbank.de*

UN environment

GUIDEBOOK

FOR THE DEVELOPMENT OF NATIONALLY APPROPRIATE MITIGATION ACTIONS (NAMAS)

A primer on energy efficient buildings in tropical and subtropical climates