NAMAs as a tool to deliver energy efficiency measures in buildings

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Abstract
The concept of Nationally Appropriate Mitigation Actions (NAMAs) has been proliferating in the policy agendas during past several years, especially in the light of the post-Kyoto climate negotiations. However, taking into account a rather broad scope of this concept and relatively short history (it has been introduced in Bali Action Plan in 2007), the understanding of the NAMA framework and its practical implementation remain limited even among experts and policy-makers. At the same time NAMA framework can offer developing countries a useful tool to capitalize on the opportunities for reducing greenhouse gas emissions and transforming their development towards sustainable pathways.

One of the sectors, which offer significant mitigation potential in developing countries, is the building sector; especially taking into account rapid urbanisation, increase in access to energy, population and economic growth in developing countries, which will drive up the energy consumption of this sector in the future.

This paper therefore aims at bringing clarity to the topic of NAMAs, suggesting a strategy of dealing with conceptual ambiguity and providing recommendations and guidelines for policy-makers on designing and implementing NAMAs aimed at improving energy efficiency in the building sector with a particular focus on tropical and sub-tropical climates.

The paper covers the following topics:

- generic background for the NAMA concept, it origin and founding principles
- potential areas for NAMA interventions, policy and technology
- technological measures in buildings in hot and humid climates
- development process for policy NAMAs that aim to improve energy efficiency in buildings.

The paper concludes on future prospects for policy NAMAs related to energy efficient buildings and the necessary actions that NAMA host countries need to take in order to efficiently utilize the NAMA for climate change mitigation.

Introduction
Improving energy efficiency in buildings sector is a global challenge. In 2010 buildings were responsible for 9.18 Gt of CO_2 emissions, which is more than 30 % of all energy-related CO_2 emissions worldwide (Lucon et al. 2014). Emissions form the building sector might exceed 15 Gt by 2030 (IPCC 2007). Meanwhile, the sector has significant energy-saving potential: up to one third of thermal energy use can be reduced in the global building sector through energy efficiency actions by 2050 in relation to 2005 (Urge-Vorsatz et al. 2013). It can be realized through technical, regulatory and awareness raising means in a cost-efficient manner (UNEP, 2007).

While the scale of cost-effective measures and potentials to deliver energy savings and regulatory instruments to support the technological innovation and introduction of existing technological advances have been known for decades, many of these energy efficiency possibilities have not been realized. A number of sector specific barriers, which are well described in the literature (Koeppel and Urge-Vorsatz 2007) and briefly covered later, hinder the technological innovation and policy ambitions. In order to overcome or limit the impact of these barriers, decision-makers enact a broad spectrum of policy instruments and programmes worldwide. There is a variety of policy instruments to promote energy efficiency in buildings (Urge-Vorsatz, Koeppel, and Mirasgedis; UNDP 2010). Up to date most governments have favoured economic instruments, such as subsidies, energy taxes, and tax reliefs schemes (International Energy Agency, IEA 2013; Noailly 2012).

Recently there has been an increased interest in promoting energy efficiency through market mechanisms focused on demand side, such as White Certificate Schemes and Green Investment schemes. However, they have been running only for a few years and in a limited number of countries (Building Performance Institute Europe (BPIE) 2010). While these schemes achieve energy saving goals in a number of countries, there is not enough evidence up till now that they can be effectively replicated in developing countries (Tyler, du Toit, and Burchell 2011). The NAMA framework presents the opportunity for developing countries not only to harness the vast mitigation potential within the sector, but also to benefit from a development of non-market approaches encouraging energy efficiency measures for other sectors.

In the light of above, NAMAs are to be recognized as a crucial framework, offering the possibility to address a combination of barriers and to access additional sources of financing, increasing political motivation for implementation of mitigation actions and contributing to the national low carbon development. However, little understanding exists on what constitutes an effective NAMA intervention and what are the main considerations behind it. Very little experience exists in NAMAs related to energy efficiency and even less information is available regarding NAMAs for energy efficiency in buildings.

This paper aims at bringing clarity to the regulatory NAMAs in the building sector and providing recommendations and guidelines for policy-makers for designing and implementing NAMAs aimed at improving energy efficiency in the building sector with a particular focus on hot and humid climates. It explores the power of non-market mechanisms in the apparent absence of sufficient market drivers for the desirable investments.

The analysis is based on the desktop review of the available data about existing NAMAs in the buildings sector and the experience from the UNEP Project 'NAMA Development for the Building Sector in Asia'[1] complimented with expert consultations.

The rest of this paper is structured as follows. The next section introduces concepts and presents generic background for NAMA. It is followed by description of the methodological approach. Later the results are presented and discussed briefly. Finally, recommendations and strategies for NAMA design and implementation are suggested.

1. In order to support four countries in the SEA region (Indonesia, the Philippines, Thailand and Viet Nam) to develop mitigation actions for the building sector UNEP is conducting a four-year project "NAMA Development for the Building Sector in Asia. Framework Policies for Climate Change Mitigation" (2013–2017). UNEP provides assistance aiming at recognition of the vast mitigation potential within the buildings sector in the region, identification and recommendations for potential actions to be developed as NAMAs. Project support targets national policy development, including codes, standards, and labelling; application of technologies to improve energy efficiency; development of fiscal and market incentives for energy efficiency; identification of potential retrofit of existing buildings; mitigation action incorporation in National Climate Strategies; identification of key stakeholders in the building sector to build support for achieving national goals.

NAMAs for energy efficiency in buildings

ORIGIN AND ADVANCEMENT OF THE NAMA CONCEPT

Nationally Appropriate Mitigation Actions (NAMAs) are becoming a key tool for developing countries to shape and stimulate their emission reductions approaches while contributing to transition towards low carbon development pathways. After the Bali Action Plan introduced the concept of NAMAs in 2007 (UNFCCC, 2007), NAMAs have manifested as a central concept for mitigation efforts. This new mechanism of climate policy is established in the context of national appropriateness and sustainable development priorities (UNFCCC 2008). NAMAs are expected to foster transformational change, enable and manage the environmental, social and economic dimensions of development demands (Hinostroza et al. 2014). At the same time NAMAs establish opportunities for developing countries to address their increasing emissions. In order for mitigation measures to achieve the desired outcomes, local circumstances and developmental needs have to be recognized (UNFCCC 2008; Hinostroza et al. 2014).

The concept of NAMAs and its operational definition are broad, vague and open to interpretation by the sovereign entities. Due to this NAMA has been regarded as immature, poorly understood and as having restrained power to shape policy (Tyler et al. 2013). According to UNFCCC, NAMAs are to be defined in two different contexts, at the national and individual level, meaning that NAMAs at the national level are expected to achieve deviation from business as usual emissions (Hinostroza et al. 2014). Most common definitions refer to NAMAs broadly as a set of policies and actions that countries undertake as a part of commitment to reduce GHG emissions. The UNFCCC currently argues for a "bottom-up" approach to designing NAMAs, encouraging developing countries to define for themselves what constitutes NAMAs and what actions should be taken under this framework (Cameron et al. 2013; Overseas Environmental Cooperation Center & OECC 2014). Due to the ambiguity of connotations, respective institutions should respond to country realities and political conditions.

There are three unspecific categories of NAMAs: policy NAMA (has no expiration date), programme NAMA (set of activities within a limited timeframe) and a project based NAMA (Lütken et. all, 2013). Policy-based NAMAs are specific measures that are incorporated in wider regulatory and economy measures and targets implemented by a government in order to promote or deter technology options, impact economic activity or alter behaviour. Programme NAMAs include policy activities that have a planned phase out period. Project NAMAs are actions undertaken in private or public sector, aiming at finite GHG emission reductions within project timeframe and remain within certain boundaries. The relevance of a specific NAMA intervention needs to be evaluated as per impact on GHG reductions and co-benefits delivered. This is to be assessed in the national context, in terms of its relative contribution. This paper focuses predominantly on the policy NAMAs as the tool that can ensure a transformative change towards higher levels of energy efficiency in buildings.

It is crucial to recognize that, NAMAs in the building sector – or any other sector – are not referring to new types of activities. They refer (most often) to policies or programmes, the form and principles of which are known and, thus, commonly have precedents if not in the host country, then in other countries or contexts. Respective countries define the appropriateness and the context of potential actions, thus there are no guidelines of what constitute appropriate mitigation action. However, NAMAs add an international dimension to such policies and programmes by lending an emissions reduction angle to policies that normally are motivated by either energy efficiency or quality of the building mass. The international recognition of national mitigation actions carries within prospects for access to other sources of finance, technology and technical assistance through the international climate change agreement architectures. Engaging in NAMA development and implementation has a potential to aid national mitigation efforts by creating additional opportunities and strengthening national capacities. A comprehensive approach to NAMA mechanisms has a potential to address a number of barriers hindering the wide-scale improvement of energy efficiency in buildings. However, due to the novelty and ambiguity of the mechanism, there is a need for enhanced comprehension regarding its potential benefits and drawbacks.

ROLE OF NAMAS FOR ENERGY EFFICIENCY IN BUILDINGS SECTOR

The building sector is the largest energy-consuming sector on the global scale and in a number of regions (IEA, 2013). Energy efficiency is one of the most cost-effective ways to reduce energy consumption in buildings and is particularly important for developing countries in order to avoid a harmful lock-in effect of potential energy savings (Urge-Vorsatz, Petrichenko, et al. 2012). Depending on a few parameters related to the national cost of energy and the current standard for buildings' energy efficiency, a considerable proportion of energy efficiency investments in buildings can be usually considered to be non-regret options, however, there is ample evidence in the sector that investments in energy efficiency measure and investments are hindered by a variety of barriers (Lucon, Urge-Vorsatz, and et.al. 2014).

NAMA framework applied with the aim to improve energy efficiency in buildings can help to reduce a number of existing barriers. Table 1 summarizes the existing barriers as institutional, financial, regulatory, technological and behavioural. It presents examples of activities that can constitute a NAMA that is designed to address a particular type of a barrier. NAMAs can incorporate a number of activities, some of which can be executed under domestic policies as well. However, framing the activities as NAMAs may have additional benefits, such as access to additional sources of financing; contribution to national emissions reduction commitments; access to international technical or advisory support and acceleration of efficiency-related policy actions through application of international best practices and technology transfer.

So far UNFCCC registry has received around 20 submissions for NAMAs in the buildings sector (UNFCCC 2014). They cover various aspects of sustainable development in the building sector and are at different stages of development. They vary in scale, intervention type and type of action. Most of them are seeking international support or additional support to compliment national public funding. Measures are driven by the advancement of technology, deployment of better design and more efficient technologies as a source of emissions reductions. As submissions to UNFCCC Registry are voluntary and it is not compulsory to provide detailed information on NAMAs, the availability of information on existing NAMAs is quite limited. A positive exception might be NAMAs developed in Mexico, which are already on the advanced stage of the implementation process in comparison to other NAMAs (Fenhann & Antonsen 2014).

NAMAs present a significant opportunity for developing countries to harness their GHG emission potential in the building sector by using already available energy efficiency technologies and policies. To seize the technological opportunity domestic institutional settings, regulatory frameworks and enabling environment need to be advanced to support the uptake of technologies.

NAMA Cycle Implications

To demonstrate existing interpretations of NAMA concept, the current state of progress on buildings-specific NAMAs has been assessed utilizing available NAMA submissions to UNFCCC Registry (UNFCCC; 2014) as aggregated in the NAMA Pipeline (Fenhann & Antonsen 2014) and NAMA Database (Ecofys 2014) in order to identify the most important aspects of NAMAs design and implementation. The paper applies SWOT analysis to evaluate strategies for the effective utilisation of such policy NAMAs in the building sector in developing countries.

Even though no formal NAMA cycle has been agreed at the international level, identification, formulation and implementation of a NAMA will have to follow common principles (Desgain & Sharma 2014). To simplify, NAMA cycle will consist of three main stages: preparation, design and implementation. Each stage requires a number of efforts in order to minimise potential threats and weaknesses, benefit from strengths and utilise opportunities. The analysis will follow in the next section.

PREPARATION

The first preparatory stage of any NAMA requires utilisation of a holistic approach to assess the national context, identify existing challenges and barriers. In this preparatory process it is recommended to include the following efforts: assessment of market readiness, evaluation of the institutional context and analysis of stakeholders' behaviour.

Assessment of market readiness for energy efficient buildings

This type of assessment should focus on consideration of existing framework related to energy efficiency in buildings, which may include current and planned policies, programs and projects in the field, level of regulation enforcement, presence of institutions supporting or aggravating energy efficiency improvements, as well as any other barriers, which may hinder energy efficiency acceleration.

It is also important to take into account other local conditions, which may influence proliferation of energy efficient practice (such as climate, construction activity, cost of energy, building energy demand, etc.).

One of the most important areas to analyse is financial conditions, including macroeconomic situation, level of the banking sector development, cost of financing, etc.

Table 1. Barriers to energy efficiency and how NAMAs can address them (own compilation).

Type	Barrier	NAMA activity
Institutional	Lack of coordination and overlapping mandates among administrative and regulatory entities	All relevant national institutions should be involved in NAMA development in order to make sure that the NAMA is mainstreamed into existing administrative system and institutional framework. Further entities involved in the NAMA process may include civil institutions, interest organizations, and, of course, private business. In order to navigate among all these stakeholders and institutions a national coordinating agency should steer the process and make sure that all relevant stakeholders are included, namely policy-makers, implementing agencies, constructors, developers, investors and etc.
	Enforcement and compliance gaps	*Compliance:* It is important to make sure that stakeholders are adequately informed about their rights and duties, since requirements might be too complex to know of and to understand. New rules and regulations applied need to be explained and communicated in the adequate manner. *Enforcement:* An enforcement strategy is necessary for every NAMA and has to offer relevant incentives to various stakeholders, ensure cooperation and coordination between national institutions, capture multiplicity of national authorities and be adjusted to the extent to which targeted stakeholders will comprehend regulatory requirements and comply despite potential costs of compliance.
	Non-conducive enabling environment, lack of incentives	The approach of policy packages that can be implemented in many different configurations (e.g., levels of standards and incentives; different rating systems; agents responsible for implementation; form and identity of beneficiary of the incentives, etc.) has the potential for greatly expanding the reach and impact of the individual policies.
Financial	Understanding of incremental costs	Including later returns the assessment can leverage complexity of incremental costs determination. Access to incremental finance can be incentivized through guarantees that costs and benefits accrue to the same stakeholders.
	Limited public finance	Public finance can be raised in traditional manner of creating tax schemes that penalize inefficient operations and inspire energy efficiency innovations.
Technological	Limited access to technology	Technologies needed for energy efficiency improvements may not be available locally. NAMA offers the opportunity for technology transfer from developed countries and international climate finance to ensure availability of necessary technologies on the local market.
	Lack of understanding of how to adapt technology to regional conditions	NAMA framework allows implementing countries to seek international support for building capacity locally within international climate change agreement architecture. Engagement of the experts from the countries, which have experiences with certain technologies, can help to ensure that technologies and practices, which are being transferred, are adapted to local conditions to maximize their effectiveness.
Regulatory	Regulatory insufficient legislative and regulatory base, lack of regulatory incentives	Development of regulatory support framework for energy efficient buildings such as national policies, regulations, and engagement programs have to play a key role in domestic transition towards higher levels of energy efficiency in the building sector. The support framework includes energy efficient buildings targets (building code), financial incentives, loan programs, building mandates, and outreach campaigns. Elimination of frameworks that may have negative effect on energy efficiency or promote *in*efficient practices, e.g. energy subsidies.
Behavioural	Stakeholders' split incentives and conflicts	Use of an integrated mixture of instruments encompassing fiscal, behavioural and technology change encouraging consideration for efficiency measure among all stakeholders involved (owners, tenants, developers, constructors, investors, governmental officials and etc.). For instance, awareness raising and education on sustainable planning, investment and utilization of energy efficient technologies in buildings or establishing developer saving guarantees.

Results of such assessment should be used for defining the baseline (i.e. starting point for the NAMA), better integration of the NAMA to the overall targets and plans and indicate the priorities for NAMA interventions to address identified barriers to energy efficiency in buildings.

Institutional context assessment

Institutional context differs from one country to another. One of the potential strengths of a NAMA is that it does not require establishment of a particular institutional framework, as it can typically be developed within existing structures. However, it is important to analyse whether any institutional barriers exist in a country, which may impede NAMA and/or building energy efficiency developments. One of the barriers to energy efficiency in building is sector fragmentation, which means there is a need to involve multiple stakeholders and institutions into the decision-making and implementation process. Therefore, understanding of institutional context should be a prerequisite for designing a NAMA. If there is a lack of institutional structures to support mitigation actions related to energy efficiency, it may be necessary to create a responsible entity (e.g. a focal point, coordinating committee) within existing institutions to ensure such support.

Stakeholder analysis

Stakeholder behaviour assessment is devoted to approach common for the building sector conflicting interests of different stakeholders. Various stakeholders respond in different ways to energy efficiency improvements and such reactions should be taken into account in NAMA design process as they may influence its effectiveness. Therefore, the responses need to be identified in order to design potential solutions for mitigating their impact, e.g. through targeted incentives, demand creation, awareness raising and etc.

It is also important to identify, inform and engage key stakeholders prior to design stage. In building sector depending on the type of intervention these may include: policy-makers, construction industry representatives, engineers, architects, home-owners, tenants among others.

DESIGN

Design stage of a NAMA primarily involves development of a NAMA proposal document. Although there are no mandatory requirements for the information to be presented in a NAMA proposal, it is advisable to cover several aspects, which are briefly discussed below.

Scope and objectives

The scope of a NAMA should specify geographical coverage, level of actions (national, sub-national, city, etc.); types of buildings targeted as well as indicate whether buildings are new or existing. NAMA's objectives should also be clearly stated. They include a set of measures and technologies, which are going to be applied. NAMA's contribution towards overall national energy efficiency and sustainable development goals should also be explained.

Content and timing

NAMA's content, i.e. the interventions (for more details see the implementation sub-section) that are going to take place should address one or more of the existing barriers (barriers are discussed in more details in the section on strategies) to energy efficiency in buildings. Therefore, this part of the proposal should describe those barriers that will be addressed, the means to achieve outlined objectives, the ways to secure the long-term impacts of interventions (including enforcement efforts), actors, which will be involved in implementation and their roles.

Financing Plan

Financing is needed for different aspects of NAMAs; however, the main focus of the plan should be the chosen mitigation actions. Sources of funding should be considered at the earliest stage of NAMA design. The focus of the financing plan preparation should be on integration of the expected expenditures into the current national or local budgets and aligned with the existing policies and agendas. Potential investments from the domestic private sector should also be exploited. The NAMA may need the international financial support as well, which should be reflected in the proposal. However, this type of funding should be considered as additional resources to the ones acquired from the local sources.

There are different financial instruments that can be used by a government to raise domestic financing, namely: grant, purchase of assets, fixed payments for services, subsidies, taxes, tax credits, tax reductions, guarantee schemes, loan schemes, variable or accelerated depreciation, technology standards (Lütken et al. 2011). Part of the financial plan preparation should be to analyse what financial instruments can be used, how and for what.

Furthermore private sector can often offer substantial resources for NAMAs, for example through energy efficient equipment and appliances purchases. Financial stakeholders should be considered, as advisers on the financial structures of the plan and consultations with them should be initiated at the very early stage of the NAMA design. Investments from the private sector will take place if the related risks and returns are balanced and advantageous. A number of energy efficiency measures in buildings can be profitable and therefore attractive for private investments. Energy Service Companies (ESCOs) offer financing of energy efficiency measures and equipment through the resulting energy costs savings. However, a number of barriers exist, which undermines the competitiveness of energy efficiency options. It is, therefore, important that certain public sector interventions are introduced in order to address these barriers.

International funding is usually provided through bilateral or multilateral programmes. Emerging examples for the international finance of NAMAs can be NAMA Facility and Green Climate Fund.

To summarize, the design of NAMA financing should follow 'the right order of leveraging' starting with exploring the opportunities of national public finance, then international public sources, followed by the options from national private sector and, finally, international private sector (Lütken 2014). Such 'leveraging' approach emphasizes the priority of domestic finance. It is also important to ensure the interlinkages between public and private financing. For example, allocation of public funds to financial incentives (e.g. subsidies, tax exemptions, etc.) for more energy efficient technologies and products can help leveraging private investments in such technologies and accelerate related market developments. These market trends can be further supported by respective changes in regulation (e.g. increasing energy efficiency requirements in product standards or building codes).

Expected impacts

NAMAs are usually expected to result in a transformational change in the market by ensuring transition towards more sustainable practices and to be aligned with the overall policy targets of the country or city. In order to demonstrate the impacts of a NAMA it is beneficial to present quantitative estimates for expected emissions reductions (either on the annual or cumulative basis). Emissions reductions are usually calculated in comparison to the baseline scenario (i.e. state in the future without NAMA interventions). However, this process is often argued to be accompanied by the lack of adequate data and applicable methodologies, which can delay or hinder the proceeds of a NAMA development. An alternative solution might be to compare expected emissions reduction to the current level at the moment of initiating the NAMA (i.e. 'base year' approach). Such an approach can reduce the uncertainties related to the future. It also might be easier to collect data for the few recent years or a sample of buildings, which can allow for certain extrapolations for the larger scale. However, it is important to recognize that NAMAs, unlike CDM, do not have additionality requirement.

As energy efficiency in buildings often results in a number of important co-benefits (IEA 2014a; Urge-Vorsatz, Novikova, and Sharmina 2009), they should be also identified and presented in the proposal where possible. Quantitative assessment of the co-benefits is often difficult; therefore at least a qualitative explanation can be included.

Measuring, Reporting and Verification

MRV stands for 'measuring, reporting and verification' and involves the creation of the framework, which will allow for tracking and communicating the progress and outcomes of NAMAs.

Such framework provides the information on NAMAs for preparation of Biennial Update Reports for the UNFCCC. Each country implementing NAMAs should develop the MRV system in line with the generic guidelines.

Measurement part of the framework should include a methodology and procedures to monitor the expected impacts, progress and the support for the NAMA. Such methodology may include geographical scope, impact boundaries of NAMA's interventions, the baselines for NAMA's actions in terms of greenhouse gas emissions, the indicators for impact measurement, data needs and gaps, data collection system, data quality verification system.

Reporting implies regular communication on the NAMA progress from the implementing entity to various involved stakeholders, particularly to the designated authority that manages the MRV system or international donors. The parties agree upon the content and format of the reporting templates.

Verification procedures ensure the reliability and transparency of the information, which has been measured and reported. Items for verification may include progress in implementation, greenhouse gas emissions reductions, impact of sustainable development benefits, etc. The exact verification process depends on the domestic and international entities providing support and on national reporting requirements.

Implementation plan

This part of the proposal presents the list of subsequent activities, which are planned to be implemented in pursue of achieving NAMA's objectives, as well as the timeframe for their implementation. It also should map all the parties involved and outline their roles and responsibilities in the process. The implementation plan should also incorporate the enforcement measures including well-designed incentives targeting various stakeholders to increase the level of potential compliance.

Once the key elements of the proposal are finalised it can be used for making the submission to the NAMA registry. The NAMA registry provides a specific template for submissions, which can be completed using the information from the extended NAMA proposal.

IMPLEMENTATION

Implementation stage presumes executing of the steps described in the implementation plan and carrying out planned NAMA interventions. There are different areas in the building sector, which NAMA can target; however, there are certain common features in building energy efficiency in hot and humid climates, which can be considered, in terms of both energy efficiency technological measures and policy development.

Energy efficiency measures

The main idea of improving building energy efficiency is to ensure sufficient level of thermal comfort and energy services with lower energy needs. It can be done through a combination of passive measures in building design and utilisation of efficient active systems.

Passive measures

In tropical climates the orientation for the building should aim at excluding or minimizing its direct exposure to the sunlight and radiant heat during the year while maximising access to cooling breezes. This strategy can be enhanced by means of shading, which can be natural (e.g. vegetation) or artificial (e.g. overhangs, louvers, awnings, internal blinds, controllable fins, etc.). In hot climates it is usually necessary to use shades for windows, uninsulated and dark-coloured walls, and outdoor living spaces (Department of Industry 2013). Besides more common static shades there are also dynamic shading devices, which can adjust the level of shading depending on the light availability, presence of occupants, etc. (Weston 2010).

Cool roofs are another strategy, which transfer less heat to the building and can protect it from overheating. They have a high solar reflectivity of the surface and low level of heat absorption, which is achieved by applying a light colour to the roof surface and highly reflective and emissive materials (EPA 2007).

Insulation can also be used to minimize heat transfer through exterior elements (e.g. walls, windows, roof). That is especially important for buildings, which use air-conditioning, as it helps to keep the coolness insider the building for longer time. In hot and humid climates insulation of roofs and ceiling is usually the most important for reducing heat gain. It should be combined with sufficient roof space ventilation in order to reduce moisture content of the air (Department of Industry 2013).

Airtightness works in a similar way as the insulation by preventing building envelope from air leakage. In hot climates it makes sense to apply airtightness to the air-conditioned rooms, and not to the naturally ventilated spaces, thereby applying the principle of 'zoning', when these types of spaces are separated from each other (Department of Industry 2013).

An important role for energy performance of energy efficient buildings can be played by advanced windows, which can serve as a source of daylighting, ensure solar heat gain and reduce heat losses. Daylighting allows for utilization of natural light for lighting the room and decrease the operation time of bulbs and lamps in the building, therefore, reducing energy consumption. Windows, however, should not cause overheating of the building through solar heat gain and in hot climates should be accompanied by shading or "low-gain" or "spectrally selective" glazing, which can help to control solar heat gain (Apte, Arasteh, and Huang 2003).

Active systems

Active technologies are used to provide energy supply for different end uses, such as space cooling, water heating, cooking, lighting and appliances.

In hot climates demand for cooling is usually quite high. There are different approaches for cooling, which can be used in hot and humid climate with reduced energy intake, for example evaporative cooling, which can be combined with dehumidification (Camargo, Godoy, and Ebinuma 2005), desiccant cooling (Kalogirou and Florides 2012), underground earth pipe cooling (Urge-Vorsatz, Eyre, et al. 2012), water-cooled air-conditioning (Chen, Lee, and Ylk 2008), solar cooling (Kalogirou and Florides 2012), heat pumps used for cooling (NREL 2014) or district cooling (Euroheat & Power 2006).

Building's cooling load can also be reduced through application of ventilation strategies. There are two main types of ventilation: natural and forced. 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, while "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). Buildings in hot and humid climates can also benefit from a combination of thermal mass with night ventilation and selective use of air conditioning (Tenorio 2007).

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. Hot water consumption can be reduced by choosing water efficient showers, toilets, taps, washing machines, dish washers, etc., and reusing water through waste water reuse, harvesting and filtering of rain water (Department of Industry 2013). Among potential energy efficient solutions for this end-use it is worth mentioning heat pumps, efficient natural gas water heaters, tankless water heaters, solar water heaters.

Efficiency of cooking plays an important role for energy use reduction, especially in developing countries. Almost 2.7 billion people in the world rely on the traditional biomass for cooking (IEA 2014b). In order to facilitate the transition towards more sustainable cooking practices it is important to consider local conditions, typical diet, cooking habits, availability of energy sources locally, etc. Different types of the stoves can present an energy efficient solution, for example improved biomass cooking stoves, electric stoves, cooking with natural gas or solar cooking (Adria and Bethge 2013).

Lighting is another end-use, which offers potential for energy efficiency improvements, which can be realised through combination of optimized utilisation of daylighting and efficient active lighting systems. The level of daylighting need to be determined taking into account orientation of the building, shading strategies and glazing to adjust the amount, intensity and spectrum of the daylight transmitted into the building and at the same time to minimise heat gain during the cooling period (Department of Industry 2013). Daylighting can be improved through utilising light colours inside the building and aligning internal surfaces to maximise light reflection from light sources (Carins Regional Council 2011). When daylighting is insufficient or unavailable active lighting systems can use electricity to ensure sufficient light conditions in buildings. This electricity use can be reduced through installing energy efficient bulbs, such as compact fluorescent lamps (CFLs) or LEDs, and introducing control strategies for electric light usage (e.g. tuning, task lighting, lumen maintenance, scheduling, motion controls, solar lighting, etc.) (Adelaide City Council 2011; Philips 2014).

All main appliances used in residential and commercial buildings (refrigerators, freezers, dishwashers, clothes washers, ovens, stoves, computers, etc.) can be energy efficient and are already widely available on the market at no or low additional costs (WSU 2003). Energy labels (which are used for a wide range of appliances in many countries) help to inform consumers' choices about efficiency of appliances. It is recommended to promote the appliances with the highest rating, according to the energy label.

Policy support

The technological improvements briefly described above have to be accompanied by a number of supporting policy instruments, which can become a component of a NAMA. A number of policy instruments for energy efficiency improvements in buildings have proved to be cost- and environmentally-effective in a number of different environments, namely: product energy performance standards, product labels, building codes and building certification programs (Boza-Kiss, Moles-Grueso, and Urge-Vorsatz 2013).

Typically, the highest impact of policies can be achieved if they are wisely combined in policy packages. Combination of incentives, labels and standards can offer an effective policy package to improve buildings energy performance and accelerate utilisation of energy efficient technologies (Levine et al. 2012).

Minimum energy performance standards (MEPS) for products and building codes can be cost-effective and result in significant GHG emissions reduction as stand-alone instruments; however, joining them with certification or labelling programs is likely to boost their cost-effectiveness. A number of instruments can benefit from international transfer and adoption of best practices and experiences, for example, in case of MEPS, product labels, building certificates and labels. Moreover, awareness raising and information action can increase the effectiveness of any policy instruments, especially of the country already has experience and capacity for executing such activities (Boza-Kiss, Moles-Grueso, and Urge-Vorsatz 2013).

A comprehensive overview of various policy instruments applicable in developing countries to improve their building energy efficiency can be found in Boza-Kiss, Moles-Grueso, and Petrichenko (2013), which provides guidance and recommendations on constructing effective policy packages. This Handbook of the instruments can be also used for design and implementation of NAMAs along with QuickScan Tool (UNEP SBCI and 3CSEP 2013), which offers fast assessment of the local situation in a city or country and suggest several potentially effective policy packages in accordance with it.

Regardless of what policy instrument or package is being implemented as a NAMA, it is necessary to ensure proper policy enforcement as a part of implementation phase in order to safeguard adequate compliance and effectiveness. Potential enforcement strategies may include: continuous communication with the target group, capacity building and awareness raising about the policies being implemented and the role each stakeholder is expected to play, financial incentives (e.g. penalties, taxes, subsidies, etc.) or audits and inspections (where applicable) can also be used to influence behaviour.

Analysis of factors influencing potential NAMAs for energy efficiency in buildings

Decision-making in the domain of energy efficiency is often based upon mainstream neoliberal economic thinking rooted in fundamental principles of perfect symmetric information, rational actors and minimal transaction costs. A theoretical economic argument is that between market failures, market barriers and market imperfections particular public policy intervention is favoured if justified by a cost-benefit analysis. Most commonly policy interventions are prioritized based on the policy cost-effectiveness. As the case of NAMA development demonstrates, long-term sustainable policy performance and policy effectiveness require a more holistic and systematic approach that goes beyond traditional cost-effectiveness interpretations. Issues contributing to implementation of energy efficiency measures that cannot be classified in terms of market failures and non-market failures need to be elaborated on and taken into account while developing policy measures. Here we try to demonstrate how this rationale can be taken into account by utilizing traditional tools for decision making, such as SWOT analysis.

SWOT ANALYSIS APPLICATION

Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis is a conventional tool in decision support and is used to assist in identifying strategic direction for an organization or practice. This analytic tool, originally applied by private sector for strategic planning, marketing and organizational management, is often adopted in the public policy field, applied to participatory planning approaches, spatial and energy planning among others. It is well recognized and is widely employed by the decisions makers including ones in developing countries; thus, it can be a useful tool for initial assessment of a potential NAMA proposal.

SWOT analysis can provide a good basis for assessment and strategy formulation, even though it is often left only at the level of identifying the issues, and describing them in general terms (Kajanus et al. 2012). Thus, for the purpose of this study, we apply a common SWOT technique that utilizes a framework of internal strengths and weaknesses and external opportunities and threats to demonstrate that it provides a simple way to assess policy design and assist in policy planning. Within this framework, strengths are often described as resources and characteristics that contribute to improved performance of a strategy or policy. Weaknesses are inherent shortcomings and drawbacks that may affect the implementation and outcome of the measures examined. Opportunities and threats are considered to be external contributors to the policy measures performance.

In order to prioritize factors identified by SWOT analysis and develop future recommendations, SWOT strategies matrix is applied (Table 2). In application to NAMAs 'strengths' can be considered as success factors in NAMAs' nature, which can improve the effectiveness of the mechanism, while 'weaknesses' – as the internal factors, which might aggravate this effectiveness. 'Opportunities' are the aspects of external environment, which favour NAMAs development, and 'threats' are the external barriers, which hinder design and/or implementation of NAMAs. The final result of SWOT analysis is a set of guidelines for NAMAs development, that are designed based on the following principles: 1) build on strengths; 2) eliminate weaknesses; 3) exploit opportunities; 4) mitigate (or avoid) the effect of threats (David 2011).

Table 2. SWOT Strategies.

	Strength	Weaknesses
Opportunities	S-O Strategies	W-O Strategies
Threats	S-T Strategies	W-T Strategies

SO Strategies aim at utilising internal strengths to take advantage of external opportunities.

WO Strategies pursue the goal of improving internal weaknesses by taking advantage of external opportunities. Internal weakness may serve as barriers for exploiting the external opportunities and, therefore, have to be addressed in order to improve the effectiveness of NAMAs.

ST Strategies use strengths to avoid or reduce the impact of external threats. It is possible that the 'strengths' might be insufficient or undeveloped to mitigate the impact of the 'threats'. In this case additional actions need to be taken to improve some internal features. If this is not possible the actions should be focused on the WT strategies.

WT Strategies focus on reducing internal weakness and avoiding external threats. Such strategies can be used in case the existence or implementation of NAMA itself is under question due to certain circumstances.

SWOT STRATEGIES OF A NAMA

This sub-section presents results of SWOT analysis application that highlight the constraints, potentials and challenges associated with NAMA design and implementation. Based on the UNEP Project 'NAMA Development for the Building Sector in Asia', expert consultations and literature review, our analysis reveals some of peculiar features of NAMA design and implementation, problems that are faced by decision makers, as well as strategies to deal with challenges; and allows considering long-term sustainability of the NAMA proposal. The SWOT analysis is applied to a rather generic potential policy NAMA targeting energy efficiency measures in the building sector and performed to assess policy development from a perspective of public policy decision makers.

Strengths (Ss)

NAMA is a comprehensive mechanism for GHG emissions reductions, which specifically targets developing countries and aims at helping them to frame climate change mitigation actions. NAMAs are of a voluntary and flexible nature, which allows national policy-makers and other relevant stakeholders to determine the exact efforts themselves. NAMAs can help to improve the coordination among various institutions and entities, as they require involvement and continuous communication among stakeholders. NAMA has a potential to enhance performance of existing measures with a common goal of emissions reductions through targeted coordination. National institutions can build on existing experience and capacities acquired during the previous period of participation of UNFCCC mechanisms.

NAMA presumes the establishment of the enforcement strategy, which should improve the compliance. It provides the opportunity for accessing international support in the form of additional financing, technology transfer and/or capacity building.

NAMA involves various stakeholders under a common mitigation initiative. It is particularly important for the building sector, which is comprised of multiple stakeholders often with conflicting interests.

Integration of a NAMA into existing institutional and domestic funding structures, allows for mobilisation of existing domestic capacities, e.g. private sector, public funds, and move energy efficiency higher in the list of policy priorities.

Weaknesses (Ws)

NAMA is a relatively new approach, which does not imply any compulsory obligations on the implementing countries. Nevertheless, existing sectorial barriers (Table 1) will weaken its implementation. If political will is lacking or the understanding of NAMAs process and/or energy efficiency potential in the building sector is absent, motivation of policy-makers to initiate NAMAs in the country will be lacking. As NAMAs give priority to mobilisation of domestic funding it might lead to the situation, when too much emphasis will be made on low cost energy efficiency measures ('low-hanging fruits'), which might not deliver significant mitigation impact and, moreover, might lock in a significant share of unrealised energy savings. Funding may not always be available or accessible locally, which can slow down NAMA's implementation or even delay it for uncertain time.

Absence of unified guidelines for NAMA design and implementation, methodologies for baseline analysis and tracking of impacts, as well as lack of understanding of a NAMA cycle may cause serious errors in the process and decrease the effectiveness of actions.

Ambiguity of the concept and limited understanding of the mechanism, may lead to replication of CDM-like projects or create expectation of "credited NAMAs", solely expected to rely on international finance.

Successful design and implementation requires certain degree of institutional advancement. Present or newly designed institutional arrangements for climate change mitigation will be inefficient in the context of weak coordination and overlapping mandates among national administrative and regulatory entities.

Opportunities (Os)

Climate change negotiation process and increased recognition of urgency of mitigation actions provide a solid base for future NAMA proliferation. As many countries recognise substantial mitigation potential in their building sectors, as well as cost-effectiveness of various energy saving options and energy efficiency co-benefits, the policy interest in merging the efforts to realise this potential with NAMAs development is expected to increase. Depletion of non-renewable energy reserves and increase in energy prices may also accelerate this process by making energy efficiency investments more competitive. It may contribute to increase in the number of NAMAs in different countries, allowing for distribution of lessons learnt and best practices sharing with other countries interested in implementing NAMAs.

Threats (Ts)

Most of the threats are related to the nature of the building sector and specific conditions in developing countries, which aggravate energy efficiency improvement. Most of the barriers described in Table 1 pose a threat to efficiency of NAMAs and have to be taken into account at the design and implementation stages. Table 3 demonstrates results of the SWOT analysis divided into several building blocks, presenting strengths, weaknesses, opportunities and threats described above. It also outlines the strategies to increase effectiveness of NAMAs. Based on the strategies identified the following key guiding principles for development of a policy NAMA for energy efficiency in buildings, can be summarized as follows:

1. Assess institutional structures, stakeholders, and domestic finance opportunities in the beginning of NAMA design in order to identify the barriers and integrate the NAMA into existing settings.
2. Align NAMA and its' expected outcomes with the local policy strategies and actions related to energy efficiency in buildings.
3. Identify and select NAMA interventions that are expected to have the highest mitigation potential and largest co-benefits in the long run (this should be determined during assessments on the preparation stage of a NAMA design).
4. Maximize utilization of domestic funding for the NAMA and seek for additional international financial opportunities to cover only a part of the overall cost.
5. Seek for the international support for capacity building and/or technology transfer, if needed.
6. Establish effective communication channels with key stakeholders to engage and keep them involved during the whole NAMA cycle: from preparation to implementation. Make sure that potential conflicting interests and/or responsibilities are identified and addressed in the NAMA plan.
7. Analyse available guidelines for NAMAs and current experiences from existing NAMAs to benefit from the lessons learnt.
8. Make an effort to collect the best available data for calculation of potential GHG emissions reductions, identify data gaps and address them through consultations with experts, data collection for a sample of buildings and/or utilization of existing tools and methodologies.
9. Establish a strong MRV framework and follow it throughout the NAMA cycle.
10. Ensure conditions and mechanisms for enforcement strategy at the initial stage of a NAMA design and establish incentives to ensure compliance.
11. Enhance human resources and capacities of the key institutions in the sector.
12. Develop and adopt a comprehensive strategy to address institutional barriers and limitations.
13. Adopt and implement a set of regulatory support measures for energy efficient buildings. Envision mechanisms of compliance and enforcement.

Table 3. Factors influencing NAMAs and strategies to improve NAMAs' effectiveness.

	STRENGHTS • Comprehensive mechanism for GHG emissions reductions • Flexible nature of NAMAs allows the local stakeholders to determine the mitigation actions themselves • Can be integrated into the existing institutional structures and budget • Can strengthen the position of EE in the policy agenda • Offers the way to access the international finance, technology transfer and capacity building opportunities • Requires engagement of a wide range of local stakeholders • Allows for exploiting cost-effective energy efficiency measures in buildings • Can be designed in a way to take advantage of the co-benefits resulting from energy efficiency improvements	**WEAKNESSES** • Voluntary nature of NAMAs may reduce motivation for NAMAs initiations • Risk of overexploitation of 'low-hanging fruits' in the interventions • Lack of the clear requirements for the institutional structures to design and implement NAMAs • Lack of the unified guidelines for design and implementation of NAMAs • Lack of the methodologies for estimation of energy use and GHG emissions • Lack of experience of local stakeholders in NAMAs design and implementation • Confusion between NAMA and CDM concepts • Domestic funding is not always easily accessible
OPPORTUNITIES • The need for the tools for mitigation actions in developing countries is increasing • The understanding of energy efficiency in buildings as the key way to reduce energy consumption and GHG emissions is improving • Energy efficiency in buildings is being included in the policy agendas of a number of countries • Energy prices are increasing all over the world making energy efficiency solutions more competitive • Potential for energy efficiency improvements in buildings in developing countries is substantial • Buildings offer a number of cost-effective energy efficiency options • Increasing number of NAMAs focused on energy efficiency in buildings builds capacity and knowledge base for replication	**SO Strategies** • Give the preference to program or policy NAMA, with high mitigation potential • Involve a wide range of stakeholders into NAMA design and implementation • Analyse expected mitigation potential of the NAMA, clearly state it in the NAMA Proposal and ensure its achievement during implementation • Select the interventions, which are likely to yield a number of co-benefits • Analyse the experience from other NAMAs prior to NAMA design • Maximize the utilization of domestic funding • Ensure that investors benefit from profits • Align the NAMA's interventions with local policy goals and strategies • Analyse the existing institutional structures for better NAMA integration • Develop and implement a strong MRV framework	**WO Strategies** • Design NAMA, which will be beneficial for the society and clearly communicate its benefits to the key stakeholders and policy-makers • Explore the variety of potential cost-effective interventions, having in mind a long-term perspective and co-benefits • Get familiar with the existing NAMA guidelines, materials on existing NAMAs, if needed seek the assistance from experts • Explore existing methodologies and tools for GHG emissions calculations and choose the most appropriate one to the local data availability • Involve the stakeholders from the domestic private and financial sectors in the NAMA design to explore the funding opportunities • Apply for the international funding if there is a lack of domestic resources
THREATS • Insufficient regulatory legislative and regulatory base, lack of regulatory incentives • Lack of coordination and overlapping mandates among administrative and regulatory entities • Lack of incentives to implement NAMAs in the building sector • Lack of knowledge about NAMA concept and understanding of the process • Lack of available financing • Split incentives in the building sector • Fragmentation of the building sector • Lack of locally available technologies and practices for technology transfer • Lack of technical capacity available locally for implementation of energy efficiency measures in buildings • Lack of data on building energy use for baseline analysis and progress tracking • Weak enforcement and low compliance	**ST Strategies** • Design NAMA, which can address (or adapt to) existing regulatory gaps • Raise awareness of the NAMA concept among the key stakeholders • Involve both administrative and regulatory entities into the NAMA design process, clearly outline the responsibilities of various stakeholders • Increase the visibility of a NAMA among the stakeholders, communicate its progress and benefits • Collect data at least for a small sample of buildings, use expert judgments to fill some of the data gaps, propose the creation of data collection framework • Explore the opportunities for technology transfer from other countries • Maximize exploitation of passive and bioclimatic building design features • Include incentives for enforcement and compliance for various stakeholders	**WT Strategies** • Demonstrate the long-term effect of potential NAMA interventions to policy-makers • Explore all possible fundraising strategies, adapt NAMA interventions to the interests of potential funders • Seek for international support in NAMA design and building local capacity for its implementation • Reduce the scale of a potential NAMA: start with the pilot projects and then scale-up to the program or policy level • Start with regulatory NAMAs, which will help to create more favourable market conditions for energy efficiency measures and improve capacity • Strengthen the enforcement incentives for different stakeholders

Conclusions

Understanding of national regulatory, market and technological advances is crucial for analysis of a NAMA sustainability prospects for three reasons. First, designing a NAMA intervention that will have the greatest mitigation impact over long-term period bringing emissions reductions at a faster speed involves attainable and meaningful institutional transformations. Secondly, to ensure technology transfer and uptake, to adapt available existing technology solutions to domestic conditions, it is crucial to create supportive environment, encouraging institutional arrangements and market conditions. Thirdly, in case of weak institutional capacity, immature markets and lack of sufficient drivers for market incentives, NAMAs in the form of regulatory might be more beneficial choice for the commencement of NAMA policy development.

There are various factors, which may aggravate the effective utilisation of NAMA as a policy tool. It is important to identify these factors on the initial stage of NAMA planning. This paper, can serve as concise guidelines on the actions during the NAMA cycle. The analysis presented is based on the information on existing NAMAs related to energy efficiency in buildings available in public domain, expert judgements and project experiences.

The paper has identified three stages in the NAMA process: preparation, design and implementation; and provided brief recommendations for each of them. At the preparation stage it is important to conduct a thorough assessment of current situation, considering market conditions, institutional set up and stakeholders mapping. For the design phase it is crucial to elaborate a NAMA Proposal, which would present potential interventions, timing, expected impacts, financial and implementation plan. Implementation part presumes the introduction of energy efficiency measures in buildings, supported by policy instruments and enforcement incentives.

The paper has also provided brief analysis of the key features of existing NAMAs and presented a number of strategies for NAMA development based on the SWOT analysis. As NAMA stands for the nationally appropriate mitigation actions the key recommendation is to ensure maximum alignment of a new NAMA with domestic policy priorities, institutional structures, financial opportunities, stakeholders relations and technical capacities. In case it is not possible to a full extent within national capabilities, countries can seek international support. However, the idea and main efforts for NAMAs should come from the implementing country. NAMA in this regard should not be perceived as a way of obtaining international funding or development aid, but rather as a tool to design and implement mitigation actions appropriate for the local conditions.

References

Adelaide City Council. 2011. Energy Efficiency Lighting. Green Building Fact Sheets. Accessed March 27. http://www.adelaidecitycouncil.com/adccwr/publications/guides_factsheets/energy_efficient_lighting_fact_sheet.pdf.

Adria, O, and J Bethge. 2013. What Users Can Save with Energy Efficient Stoves and Ovens. BigEE. Wuppertal Institute for Climate, Environment and Energy.

Apte, J., D.P.E. Arasteh, and Y.J. Huang. 2003. 'Future Advanced Windows for Zero-Energy Homes'. ASHRAE Transactions 109 (Part 2).

Boza-Kiss, B, S Moles-Grueso, and K Petrichenko. 2013. Handbook of Sustainable Building Policies. Composing Building Blocks. United Nations Environment Programme (UNEP). http://sustainable-buildings-policy-assessment-tools.net/Content/PolicyPackages/ENG/SPoD-final-ALL.pdf.

Boza-Kiss, B, S Moles-Grueso, and D. Urge-Vorsatz. 2013. 'Evaluating Policy Instruments to Foster Energy Efficiency for the Sustainable Transformation of Buildings'. Current Opinion in Environmental Sustainability.

Building Performance Institute Europe (BPIE), 2010. Financing Energy Efficiency (EE) in Buildings, Brussels.

Camargo, J. R., E. Godoy, and C. D. Ebinuma. 2005. 'An Evaporative and Desiccant Cooling System for Air Conditioning in Humid Climates'. Journal of the Brazilian Society of Mechanical Sciences and Engineering 27 (3): 243–47.

Cameron, L. et al., 2013. Annual Status Report on Nationally Appropriate Mitigation Actions (NAMAs).

Carins Regional Council. 2011. SuStainable Tropical Building deSign. Guidelines for Commercial Buildings. Queensland, Australia. http://www.cairns.qld.gov.au/__data/assets/pdf_file/0003/45642/BuildingDesign.pdf.

Chen, H, W. L. Lee, and F. W. H. Ylk. 2008. 'Applying Water Cooled Air Conditioners in Residential Buildings in Hong Kong'. Energy Conversion and Management 49 (6): 1416–23. doi:10.1016/j.enconman.2007.12.024.

David, F.R. 2011. Strategic Management: Concepts and Cases. 13th Edition. Prentice Hall.

Department of Industry. 2013. Your Home: Australia's Guide to Environmentally Sustainable Homes. 5th Edition. Australia: Australian Government. http://canprint.com.au/yourhome/#4.

Desgain, D. & Sharma, S., 2014. Nationally Appropriate Mitigation Action: Understanding NAMA cycle, UNEP DTU Partnership, Copenhagen.

Ecofys, 2014. NAMA database. NAMAs in the buildings sector, Ecofys.

Edenhofer et al., eds., 2014. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Energy Research Group, Central Institution for Energy Efficiency Education, and Architecture et Climat, Centre de Recherches en Architecture. 2000. Natural Cooling & Ventilation. Technology module 3. Mid-Career Education: Solar Energy in European Buildings. Dublin, Ireland: University College Dublin.

EPA. 2007. Reducing Urban Heat Islands: Compendium of Strategies. Cool Roofs. Draft. US: United States Environmental Protection Agency. http://epa.gov/heatisland/resources/pdf/CoolRoofsCompendium.pdf.

Euroheat & Power. 2006. District Cooling. Cooling More with Less.

Fenhann, J. & Antonsen, R.S., 2014. NAMA pipeline. Available at: http://namapipeline.org/. UNEP DTU Partnership, Copenhagen.

G. Hansel et al., eds., MItigationMomentum. Available at: http://www.mitigationmomentum.org/downloads/Annual_Status_Report_27-11-2012.pdf.

Hinostroza, M.L., Sharma, S. & Karavai, M., 2014. Institutional aspects of NAMA development and implementation. UNEP DTU Partnership, Copenhagen.

International Energy Agency, IEA, 2013. Mobilising investment in energy efficiency. pp. 1–156.

IEA. 2014a. Capturing the Multiple Benefits of Energy Efficiency. Paris Cedex, France: International Energy Agency (IEA).

—. 2014b. World Energy Outlook 2014. OECD Publication Service. Paris, France: International Energy Agency (IEA).

IPCC. 2007. Climate Change 2007 – Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA.: Cambridge University Press.

Kalogirou, S.A., and G.A. Florides. 2012. '3.13 – Solar Space Heating and Cooling Systems'. In Comprehensive Renewable Energy, edited by Ali Sayigh, 449–80. Oxford: Elsevier. http://www.sciencedirect.com/science/article/pii/B9780080878720003139.

Koeppel, S, and D. Urge-Vorsatz. 2007. Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions from Buildings. Budapest, Hungary: Central European University, UNEP-SBCI. http://www.unep.org/sbci/pdfs/SBCI_CEU_Policy_Tool_Report.pdf.

Levine, M, S de la Rue du Can, N Zheng, C Williams, J Amann, and D Staniaszek. 2012. Building Energy-Efficiency Best Practice Policies and Policy Packages. Lawrence Berkeley National Laboratory (LBNL) and Global Buildings Performance Network (GBPN). http://eetd.lbl.gov/sites/all/files/publications/gbpn-finaloct-2012.pdf.

Lucon, O, D. Urge-Vorsatz, and et.al. 2014. 'Chapter 9: Buildings'. In Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA.: Cambridge University Press.

Lütken, S. 2014. Financial Engineering of Climate Investments in Developing Countries – Nationally Appropriate Mitigation Action and How to Finance It. Anthem Press.

Lütken, S, J Fenhann, M Hinostroza, S Sharma, and K.H Olsen. 2011. Low Carbon Development Strategies – A Primer on Framing Nationally Appropriate Mitigation Actions (NAMAs) in Developing Countries. Roskilde, Denmark: UNEP Risø. http://namapipeline.org/Publications/LowCarbonDevelopmentStrategies_NAMAprimer.pdf.

Lütken, S. et al., 2013. Guidance for NAMA Design Building on Country Experiences. UNFCCC, UNEP, UNDP.

Noailly, J., 2012. Energy Economics. Energy Economics, 34 (3), pp. 795–806. Overseas Environmental Cooperation Center & OECC, J., 2014. The NAMA Guidebook. pp. 1–97.

NREL. 2014. 'NREL: Learning - Geothermal Heat Pump Basics'. National Renewable Energy Laboratory. Learning About Renewable Energy. October 6. http://www.nrel.gov/learning/re_geo_heat_pumps.html.

Philips. 2014. 'Solar Powered Products & Solutions'. http://www.lighting.philips.com/main/application_areas/Solarlighting/products.wpd.

Tenorio, R. 2007. 'Enabling the Hybrid Use of Air Conditioning: A Prototype on Sustainable Housing in Tropical Regions'. Building and Environment 42 (2): 605–13. doi:10.1016/j.buildenv.2005.10.003.

Tyler, E, M du Toit, and Z Burchell. 2011. 'White Certificates and White Certificate Trading Schemes as Greenhouse Gas Mitigation Policy Options for South Africa'. Journal of Energy in Southern Africa 22 (1). http://www.erc.uct.ac.za/jesa/volume22/22-1jesa-tyler-etal.pdf.

Tyler, E. et al., 2013. Developing country perspectives on 'mitigation actions', 'NAMAs', and "LCDS." Climate Policy, pp. 1–7.

UNDP. 2010. Promoting Energy Efficincy in Buildings: Lessons Learned from Interantionla Experience. http://www.thegef.org/gef/sites/thegef.org/files/publication/EEBuilding_WEB.pdf.

UNEP SBCI, and 3CSEP. 2013. 'Quick Scan Tool. Sustainable Buildings Policy Assessment'. http://sustainable-buildings-policy-assessment-tools.net/Home.aspx.

UNFCCC, 2007. Decision 1/CP.13, Page 3, "Report of the Conference of the Parties on its thirteenth session, held in Bali from 3 to 15 December 2007,Addendum, Part Two: Action taken by the Conference of the Parties at its thirteenth session", FCCC/CP/2007/6/Add.1.

UNFCCC, U.N.F.C.O.C.C., 2008. FCCC/CP/2007/6/Add.1. pp. 1–60.

UNFCCC, U.N.F.C.O.C.C., 2014. Public NAMA.

Urge-Vorsatz, D., N. Eyre, P. Graham, C. Kornevall, L.D.D. Harvey, M. Majumdar, M. McMahon, S. Mirasgedis, S. Murakami, and A. Novikova. 2012. 'Towards Sustainable Energy End-Use: Buildings.' In Global Energy Assessment. Vol. Chapter 10. Laxenburg, Austria, Cambridge, United Kingdom and New York, NY, USA.: IIASA and Cambridge University Press.

Urge-Vorsatz, D., S Koeppel, and S. Mirasgedis. 'Appraisal of Policy Instruments for Reducing Buildings' CO_2 Emissions.' Building Research & Information 35 (4): 458–77.

Urge-Vorsatz, D., A. Novikova, and M Sharmina. 2009. 'Counting Good: Quantifying the Co-Benefits of Improved Efficiency in Buildings'. In Act! Innovate! Deliver! Reducing Energy Demand Sustainably. La Colle sur Loup, France: European Council for an Energy Efficient Economy.

Urge-Vorsatz, D., K Petrichenko, M Antal, and M Staniec. 2013. 'Cutting the Energy Use of Buildings: How Deep Can the Planet Go?'. In Rethink, Renew, Restart. Vol. 1543–1553. Club Belambra Les Criques, Presqu'île de Giens, Toulon/Hyères, France.

Urge-Vorsatz, D., K Petrichenko, M Antal, M Staniec, M Labelle, E Ozden, and E Labzina. 2012. Best Practice Policies for Low Energy and Carbon Buildings. A Scenario Analysis. Budapest, Hungary: Research report prepared by the Center for Climate Change and Sustainable Policy (3CSEP) for the Global Best Practice Network for Buildings. http://www.globalbuildings.org/global-projects/.

Weston, M. 2010. 'Memory Mesh: Conformationally Adaptive Solar Shading'. In Disrupción, Modelación Y Construcción: Diálogos Cambiantes. Bogotá, Spain.

WSU. 2003. How to Buy Energy Efficient Appliances. Fact sheet WSUCEEP00- 300. Washington, DC, US: Washington State University (WSU) Extension Enrgy Program.

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