Briefing series

Sectoral implementation of nationally determined contributions (NDCs)

May 2017

ENERGY EFFICIENCY WITH A FOCUS ON BUILDINGS

This publication forms part of a series of NDC sectoral overviews, which provide information about current sectoral contributions to global greenhouse gas emissions and prospects for implementing NDCs in these sectors.

Each briefing paper presents concrete options for integrating sectoral measures in future NDCs, as well as more general cross-sectoral recommendations for moving forward with emissions-reductions measures.

Written primarily from the perspective of climate change experts, with input and suggestions from sector colleagues, the briefing series' intended target audience is twofold: first sectoral experts, who are facing the challenge of implementing the NDCs and related climate policies in their respective sectors; and second climate change experts, highlighting the relevance of the sector for NDC implementation.

This briefing paper addresses the reflection and integration of energy efficiency in the NDCs. The buildings sector is singled out for specific analysis since – unlike some other areas of energy efficiency – the buildings sector is not covered in other briefing papers within this series.

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Energy efficiency and climate change

Enhancing the global rate of energy efficiency is critical to the achievement of the Paris Agreement objectives. Whilst this briefing paper focuses on the buildings sector, energy efficiency is a relevant issue for many sectors, including industry, transport, electricity transmission, agriculture, buildings structures and appliances. Due to its cross-sectoral nature, it holds substantial potential for synergies between various sectors (IEA 2014a). For example, the building sector is responsible for approximately half of global electricity consumption. If, amongst other things, more efficient appliances were used to lower the energy demand of buildings, and the energy supply were to be decarbonised, the buildings sector would experience significant emissions reductions.

The energy supply and industry sectors emit about 17 GCO_2e and 7.0 GCO_2e respectively, compared to 3.2 GCO_2e in the buildings sector (IPCC 2014). While in absolute terms, the first two sectors report the largest reductions in greenhouse gas emissions attributable to energy efficiency (UNEP 2009), the biggest unrealized potential for energy efficiency rests in the buildings sector (IEA 2014b). In particular, low-carbon and energy-efficient heating, cooling, building shells, and lighting, coupled with system control technologies for buildings, have the potential to reduce CO_2 emissions by up to 5.8 Gt by 2050, thereby lowering emissions by 83% below business-as-usual for the buildings sector (IEA 2011).

To achieve a pathway compatible with limiting global average temperature increase to well below 2°C, a large part , 38% according to IEA calculations, of all mitigation will need to come from energy end-use efficiency improvements (OECD; IEA 2016a). Energy efficiency is cost-effective and also vital for decoupling economic growth from greenhouse gas (GHG) emissions growth. Furthermore, it offers additional benefits, such as monetary savings, productivity growth, employment effects and better air quality. In developing countries, enhancing energy efficiency can be a very attractive means to keep emission growth in check while increasing energy security, grid stability and sustaining economic growth.

The importance of energy efficiency as a driver for emission reductions is widely recognised: 143 out of 189 Parties explicitly mention energy efficiency in their NDCs (OECD; IEA 2016a). However, while technology is readily available to improve energy efficiency, current investments in energy efficiency neither match the technological potential nor the requirements for meeting the mitigation targets set out in the Paris Agreement. Financing energy efficiency improvements in line with a below 2°C pathway are estimated to require a cumulative investment of USD 13 trillion over the next 20 years (IEA 2014b). Current annual investments amount to USD 221 billion (OECD; IEA 2016b). Investment needs are particularly high in the transport and buildings sectors, with USD 8.1 trillion and USD 4 trillion needed respectively (IEA 2014b).

Despite significant economic potential for enhanced energy efficiency, this potential is largely unrealised. Indeed, Figure 1 shows that under current projections, approximately two-thirds of the economically viable energy-efficiency potential remains untapped. This issue is especially critical for the buildings sector (OECD; IEA 2016a).

Figure 2 and Figure 3 present an overview of major energy-demand sectors relating to final energy consumption and their integration in NDCs. Considerations for major energy-demand sectors are summarised below:

» ***Buildings:*** Buildings, including activities within them, accounted for approximately 32% of final energy consumption worldwide in 2014 (IEA 2016b). More than half of this energy demand comes from heating and cooling, whilst the remainder is accounted for by lighting, appliances and cooking. Overall, buildings are responsible for 18.4% of global GHG emissions and represent the single largest contributor to indirect emissions[1] (Riahi 2014). Despite this, Figure 3 shows that the buildings sector is one of the least frequently included sectors in NDCs.

» ***Industry:*** Industry accounted for approximately 30% of global final energy consumption in 2014 (IEA 2016b). The industrial sector is very diverse: major energy-consuming industries include cement, chemicals and petrochemicals, iron and steel, aluminium, and pulp and paper. In total, the sector accounted for approximately 32% of global GHG emissions in 2010 (IPCC 2014). The heterogeneous nature of different industries makes it difficult to provide a general analysis of industrial energy efficiency potential with the purpose of integrating the issue in NDCs. Nonetheless it is noted that more than half of Parties include the sector explicitly in their NDCs.

1 Indirect emissions are defined as emissions from electricity and heat production attributed to the sectors that use the energy, in this case the buildings sector.

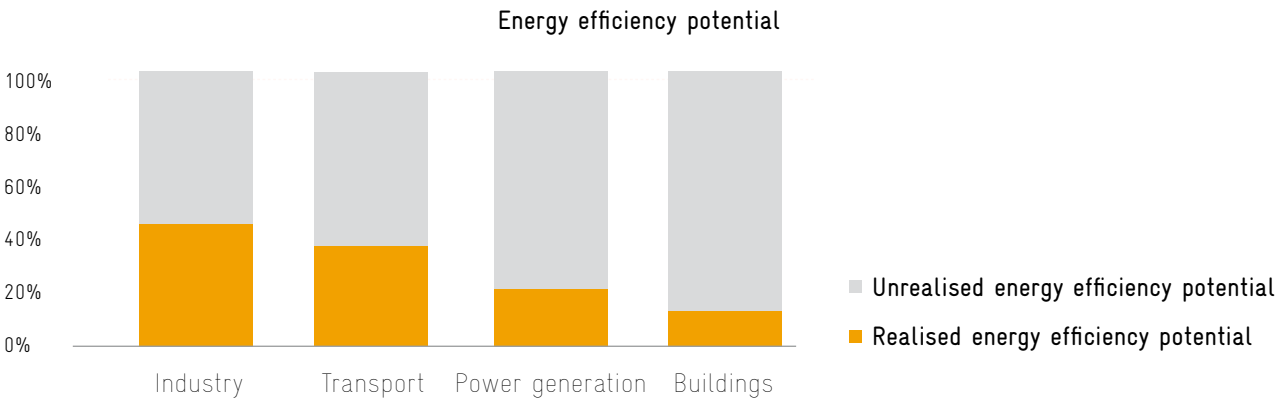

FIGURE 1: Unrealised long-term energy efficiency economic potential, based on New Policies Scenario, 2011–2035. Adapted from World Energy Outlook 2012 (IEA 2012).

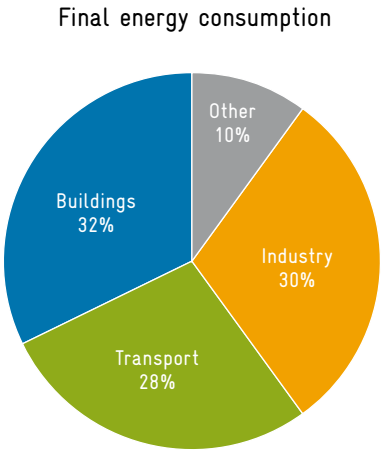

FIGURE 2: Final energy consumption (percentage of total final consumption globally in exajoule) in 2014 (Energy Efficiency Market Report 2016 (OECD; IEA 2016b)).

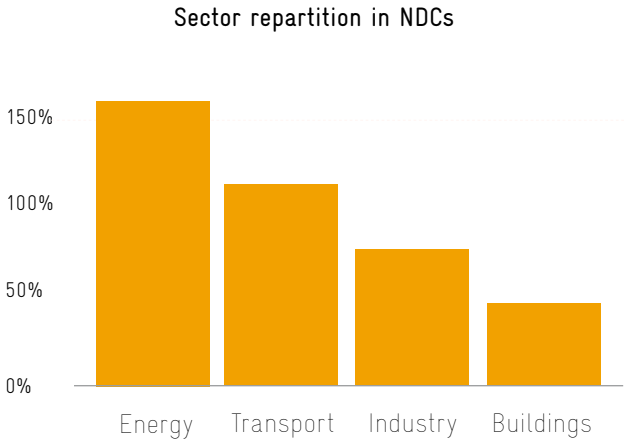

FIGURE 3: Sector repartition in NDCs (no. of Parties). Authors' own elaboration, based on World Bank (2016).

» ***Transport:*** Transport accounted for approximately 28% of global final energy consumption in 2014 (IEA 2016b), contributing to approximately 14% of global GHG emissions in 2010 (IPCC 2014). The transport sector, including energy efficiency, is discussed in greater detail in a dedicated briefing paper within this briefing series.

» Other final energy demand sectors including ***agriculture and forestry*** are also of key relevance for energy efficiency. These two sectors, which account collectively for approximately 2% of global final energy consumption (IEA 2016a), are discussed in greater detail in two dedicated briefing papers within this briefing series. However, emissions from energy consumption are not a key focus due to the small proportion of GHG emissions within these sectors.

» Apart from the final energy demand sectors, energy efficiency is of major importance for emissions in the ***energy supply sector***, including production, transformation, transport and distribution. This issue is addressed in a dedicated briefing paper on the energy supply sector within this briefing series.

The buildings sector and climate change

Implications of the Paris Agreement for the buildings sector

Under current projections and considering floor area growth of 90% by 2050 compared to 2015 associated with population and economic growth, energy demand in buildings is set to increase by 50% by 2050. This will be accompanied by a growth in the number of building-related appliances and use of air-conditioning (IEA 2016) as living standards improve. From 1990-2010, the sector's GHG emissions more than doubled to over 9 $GtCO_2e$ (IPCC 2014). Indirect emissions account for most of this growth, largely from increased electricity use and its fossil fuel-based generation, which contributes to about 6 $GtCO_2e$. In contrast, direct building-related emissions, mainly through heating (56%), hot water usage (23%) and lighting (12%) have been steady at 3 $GtCO_2e$ (IEA 2016). Other indirect upstream and downstream emissions from a building's life cycle, such as the production of construction material, also have a significant impact on the environment, but are mostly not accounted for (e.g. steel and glass production or the treatment of waste).

Figures 4 and 5 illustrate the degree to which emissions will need to be cut and renovations/retrofits implemented to achieve a below 2°C compatible pathway. A need for deep retrofitting and higher renovation rates of existing buildings, especially in developed countries, is evident; however, even greater attention is needed with regard to new builds, especially in developing countries, where a risk of lock-in to inefficient building construction exists. The building floor area in Southeast Asia is expected to grow from 15.6 billion m^2 in 2015 to 32.6 billion m^2 by 2050 and from 18 billion m^2 to 56 billion m^2 in Africa (IEA 2016a). In addition, around 80% of the increase in the buildings sector's energy demand by 2050 is expected to come from developing and emerging economies (Global Alliance for Buildings and Construction 2016).

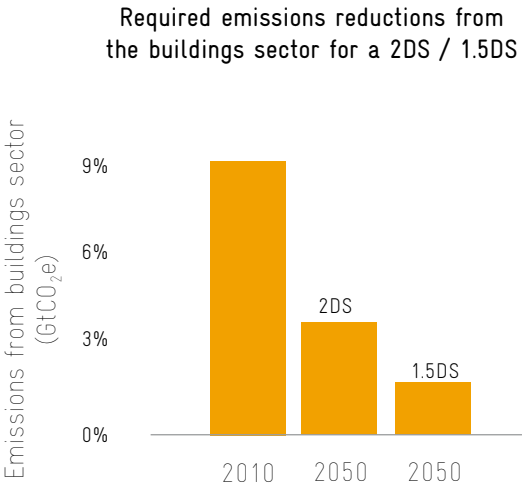

FIGURE 4: Required emissions reductions from the buildings sector for a pathway compatible with limiting warming to below 2°C / 1.5°C (UNEP Emissions Gap Report 2016 (UNEP 2016)).

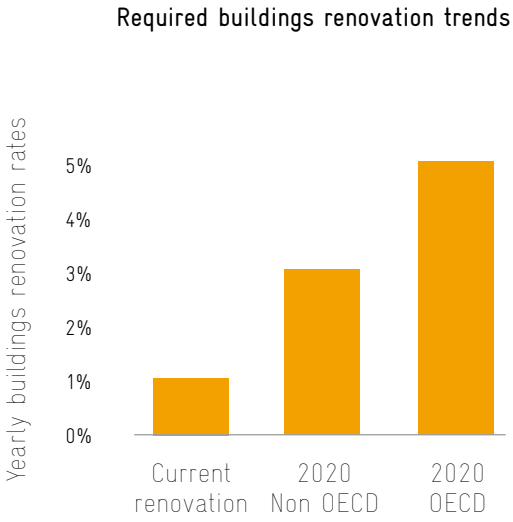

FIGURE 5: Required building renovation trends for a pathway compatible with limiting warming to below 2°C. Authors' own elaboration, based on Karlien Wouters et al. (2016) and Artola et al. (2016).

TABLE 1: Selected implications of the Paris Agreement targets for the buildings sector

INDICATOR / SUB-SECTOR	SELECTED IMPLICATIONS OF PARIS AGREEMENT FOR REQUIRED PATHWAY
Emissions (whole sector)	**2°C:** Total GHG emissions would need to fall by 77% by 2050, compared to 2010 (IEA 2012). This means a reduction of emissions by 3% on average per year (IPCC, 2014). **1.5°C:** Emissions would need to fall by 75-90% below 2010 levels by 2050 (Wouters et al. 2016). *Direct emissions* can be reduced by modifications in the buildings themselves, both building envelopes and heating/cooling systems installed (Wouters et al. 2016) Increasing the efficiency and share of renewables in the power sector can reduce *indirect emissions*, although end-use energy efficiency also plays a critical role (Wouters et al. 2016).
Emissions intensity (whole sector)	**2°C:** The buildings related emissions intensity would need to fall by at least 80% by 2050. Building envelope improvements to reduce heating and cooling energy consumption will be critical (IEA 2016).
Renovation/ Retrofitting	**1.5°C:** Renovation rates would need to increase from the current 1% to 3% in non-OECD and by 5% in OECD countries by 2020 (Climate Action Tracker 2016)
New built	**1.5°C:** New buildings would need to be zero-energy by 2020 in OECD countries, and by 2025 in non-OECD countries (Wouters et al. 2016)
Financing needs	**2°C:** Financing this transition will require additional investments of USD 220 billion annually by 2020 (OECD; IEA 2016a).

Approaches and opportunities for an energy-efficient buildings sector

10-40% of countries' GDP typically comes from the construction, renovation and maintenance of buildings and contributes on average to 10% of employment (UNEP 2009). Buildings also account for 50% of combined global wealth. At the same time, the business case for a low-carbon, 2°C compatible buildings sector is generally well understood and includes economic (employment effects, productivity gains, monetary savings) and other societal benefits (e.g. health benefits due to better air quality).

In addition to being cost-effective, energy efficiency measures offer multiple development benefits. In developing countries, building energy efficient or net-zero energy buildings has the potential to lift people out of energy poverty. Developing a low-carbon buildings sector also carries adaptation benefits, with an opportunity to reduce coastal sand extraction and thus directly decreasing the vulnerability of coastal zones where many human settlements are located.

While the buildings sector offers great potential for reducing emissions, saving money (IEA 2014a), as well as an investment opportunity of USD 300 billion globally by 2020 (UNEP Finance Initiative 2014), the sector also faces financial, economic and cultural barriers. The barriers, such as high up-front investment costs, a general lack of information, difficulty with accurately pricing risks and rewards, and market fragmentation, have slowed down the uptake of measures to align the sector with a 2°C pathway and the creation of a zero-carbon building stock.

Buildings sector in NDCs

Despite its huge mitigation potential, the buildings sector is not well represented in the NDCs. However, as emissions associated with buildings are often captured within the energy sector, some countries may have indirectly included the buildings sector within their NDCs.

44 countries, mainly developing countries, explicitly include buildings in their NDCs. Of those, 12 developing countries indicate a specific and direct emissions reduction target for the sector. A huge variety regarding the specific measures and sectoral plans mentioned by developing countries exists. Where measures are mentioned, improving energy efficiency and the development of green building codes are the most common.

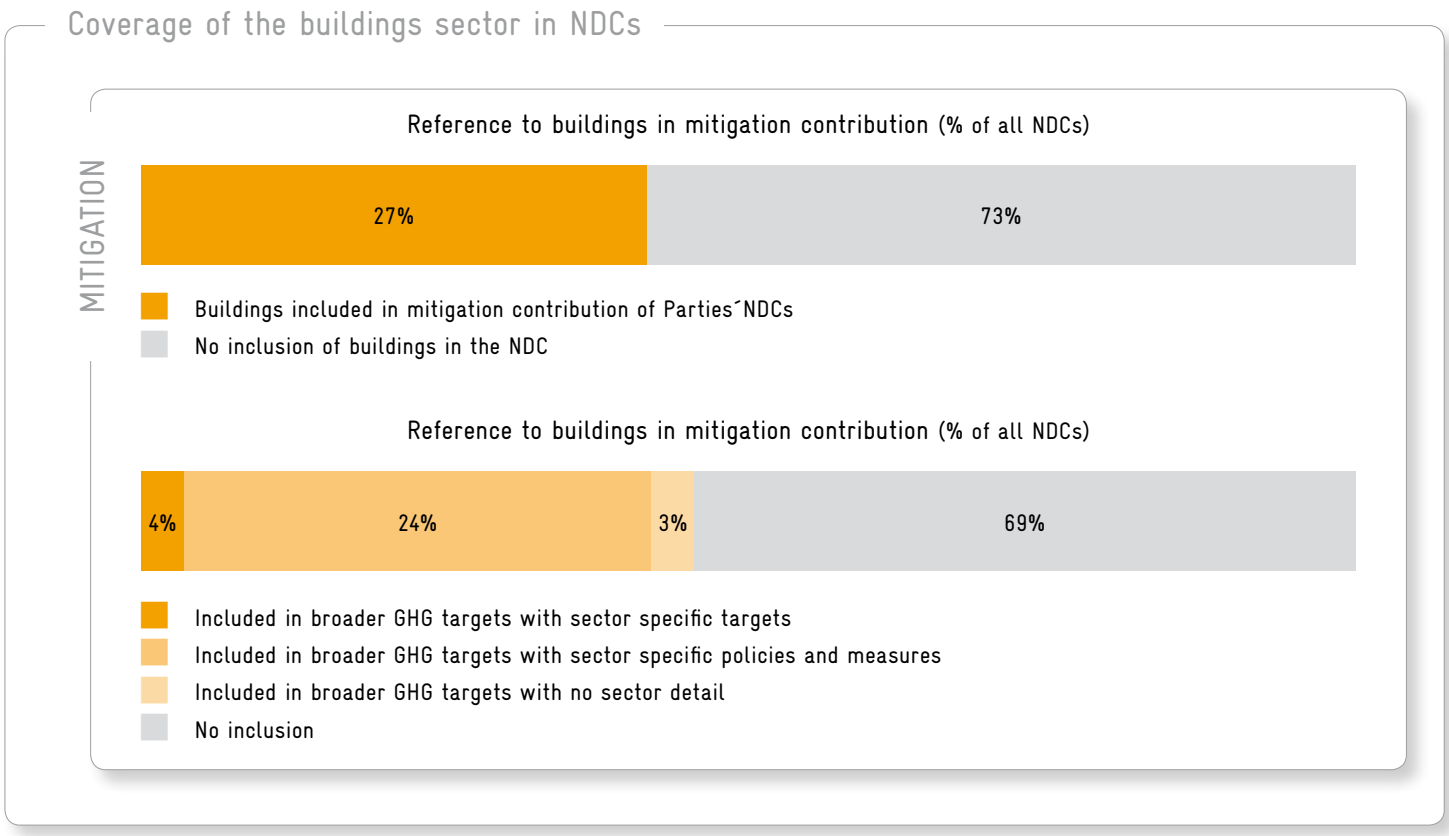

FIGURE 6: Overview of buildings sector coverage in NDCs. Authors' own elaboration, based on World Bank (2016).

Across developed countries' NDCs, very few indicate a specific and direct emissions reduction target for the buildings sector. Sectoral plans mostly concentrate on improving energy efficiency through better insulation, energy conservation (i.e. reducing energy consumption) and more energy efficient appliances (World Bank 2016).

The sector is not explicitly covered in any adaptation plans (World Bank 2016) although estimates show that by 2070, 150 million people in the world's large port cities will be at risk from coastal flooding, along with USD 35 trillion worth of property—an amount that will equal 9% of global GDP (Nicholls, R.J. et al. 2007).

The importance of the buildings sector and its relative exclusion from the NDCs presents an opportunity for future work as countries seek options for increasing their mitigation ambition, protecting their investments and improving their resilience.

Moving ahead with implementation and raising ambition

Actions can be taken within the buildings sector in the immediate- to short-term to support the implementation of the NDC targets and actions, and for raising ambition. Specific considerations include the following.

» ***Given the buildings sector's fast growth in many developing countries, one of the key requirements for NDC revision is to start prioritising the buildings sector for NDC inclusion,*** encompassing the huge mitigation potential in the up-front investment. Inaction now will lock in emissions for years. A starting point could be a re-assessment and re-evaluation of the sector's energy demand and contribution to GHG emissions that also includes a re-examination of the options to reduce emissions or keep them low despite fast growing demand for cooling and appliances.

» ***In countries with large existing building stock, the thermal energy demand and GHG emission reductions often lag behind expectations, for various reasons including rebound effects.*** Renewed efforts in retrofitting and urban renewal need to take into account the experiences in developing low carbon technical solutions which fit the needs of users and owners as well as environmental concerns.

» ***While (green) building codes exist in many countries, it would be beneficial if codes with high, economy-wide energy-efficiency standards and labelling, which cover the design, construction and operation phases, were further developed and complied with in order to curb indirect emissions.*** More stringent building codes would also include requirements for the resilience of buildings and quality of buildings' materials.

» ***On the institutional side, it is important to involve building, construction, housing and urban development ministries in the development of sector-specific strategies and roadmaps, making sure that 2°C compatible scenarios are fully embedded into policy planning and implementation.*** It could also be helpful to involve urban planners and city and regional authorities, as this is where the buildings are planned and located. Sub-national governments could also be required to regularly update decarbonisation targets for their constituencies.

» ***The complexities of the buildings sector and the country specificities represent difficult challenges for designing appropriate and successful policies.*** Integrating and targeting the entire value chain, from construction companies to developers to property owners as well as tenants and the financial sector, could enable many challenges to be overcome. While considering that about three quarters of all buildings are for residential use, developing tailored approaches for the different types of buildings and segments (e.g. user-owned or rented, commercial or social housing, has proven more efficient. Split incentives can be addressed through instruments such as on-bill repayments, on-tax finance mechanisms, green leasing clauses, and tenant engagement programmes.

» ***To address the lack of information and trust, regularly updated information platforms could be developed that take stock of national and individual building-level energy performance such as building renovation / energy passports.*** These could also be used to facilitate financial flows to low-carbon / net-zero energy buildings and retrofits, for example, through green mortgages, thereby addressing the problem of high upfront costs.

» ***Building-related data is increasingly available at low cost, however, further access to data, including from the energy sector as related to buildings, is key to inform policies, identify areas for improvement and set targets.*** At the same time, higher quality data helps attract and stimulate private investments by increasing confidence. Data for the

Key steps for moving towards sector-driven implementation and ambition raising

Many of the key steps for moving ahead with NDC implementation and ambition raising are relevant for all sectors. They are summarised in this box. Further details on the individual steps can be found in the overview briefing paper of this briefing series.

Establishment of institutional bodies for oversight of implementation and monitoring of progress: Alignment of institutions based on optimisation of existing mandates, to include broader levels of governance in strategy making including finance and planning ministries, and devolvement of responsibilities to line ministries and agencies with most sector influence. Approaches developed should be resilient to government staff turnover.

Development and dissemination of knowledge on climate requirements and benefits: Enhancing understanding on the implications of the Paris Agreement for the sector, and the social and economic benefits of climate change mitigation and adaptation measures.

Plans for achievement of sector targets, and review of potential for increasing ambition in specific sub-sectors: Stock-take and integration of subnational, national and non-state action, translation to subsector targets, determination of long-term full decarbonisation targets for the sector, and collation of this information into a target-based roadmap. Potential for ambition raising can be analysed based on regional best practice policies and consideration of targets for sub-sectors not covered in climate strategy.

Planning and implementation of instruments to leverage investments: Evaluation of investment requirements and the role of private and public finance for leveraging those investments. Analysis of persisting barriers and development of concepts for projects/programmes that can address those barriers through unilateral action or international support (e.g. NAMAs).

Revision of NDC: Update content of NDC for greater transparency, clarity and in line with aligned national strategy and identified ambition raising potential.

Introduction of policy packages and programmes to kick-start action: Introduction of new policies and strengthening of existing policies, in accordance with sector planning process, and development and submission of proposals for internationally supported programmes (e.g. NAMAs).

building and energy sectors is often collected by different entities, therefore, enhancing data availability for policy-making might require significant new data collection programmes and better integration/consolidation of existing information collection systems.

» ***The identification of synergies between inter-linked sectors such as transport and energy supply, can overcome some barriers to implementation,*** for example through cost-sharing and the application of integrated planning to avoid investments in some sectors that lock in unsustainable conditions in other sectors. The concept of integrated urban planning could even be applied to climate policy and NDCs.

» ***With very fast developing distributed power generation, mini-grids and on-site generation, new and vast options for low carbon building integrated energy emerge.*** Further development of information technology will allow real-time low carbon energy allocation to thermal and appliances demand. Thus, thermal building energy services may in addition to e-mobility become an integral part of a future renewable-energy-based flexible energy system.

FURTHER READING

Further details on the topics discussed in this briefing paper may be found in the following sources, amongst others:

Emission scenarios for the buildings sector

- IEA, 2016 → Energy Technology Perspectives 2016 (more insights on requirements for a building specific 2°C compatible scenario and historic emissions covering both direct and indirect sources).

Long term implications of 2°C and 1.5°C for the sector

- UNEP, 2016 → Emissions Gap Report 2016 (further insights from the buildings sector on how to bridge the emissions gap and its linkage to energy efficiency).
- Climate Action Tracker, 2016 → 10 most important steps to limit warming to 1.5°C (requirements and feasibility of options for 1.5°C compatibility for the buildings sector).
- Global Alliance on Buildings and Construction, 2016 → Towards zero-emission efficient and resilient buildings – Global Status Report 2016 (stock take and various policy options for the buildings sector at large).

Integration of buildings sector in NDCs

- World Bank, 2016 → NDC Platform (searchable database of sector and sub-sector specific details in all NDCs).

Improving energy efficiency across sectors

- → SE4ALL Energy Efficiency Accelerator (information about energy efficiency of various sub-sectors and its links to climate change as well as relevant initiatives to improve energy efficiency in those sub-sectors).

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About the GIZ Climate Policy Support Programme

GIZ Climate Policy Support Programme aims at developing and mainstreaming innovative approaches to tackle the challenges of climate change in the context of German Development Cooperation. On behalf of the Federal Ministry for Economic Cooperation and Development (BMZ), it supports developing countries in their efforts to mitigate climate change and to adapt efficiently to its impacts. Through conceptual and practical activities, the Climate Policy Support Programme actively contributes to the implementation of the Paris Agreement and the UN Sustainable Development Goals.

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