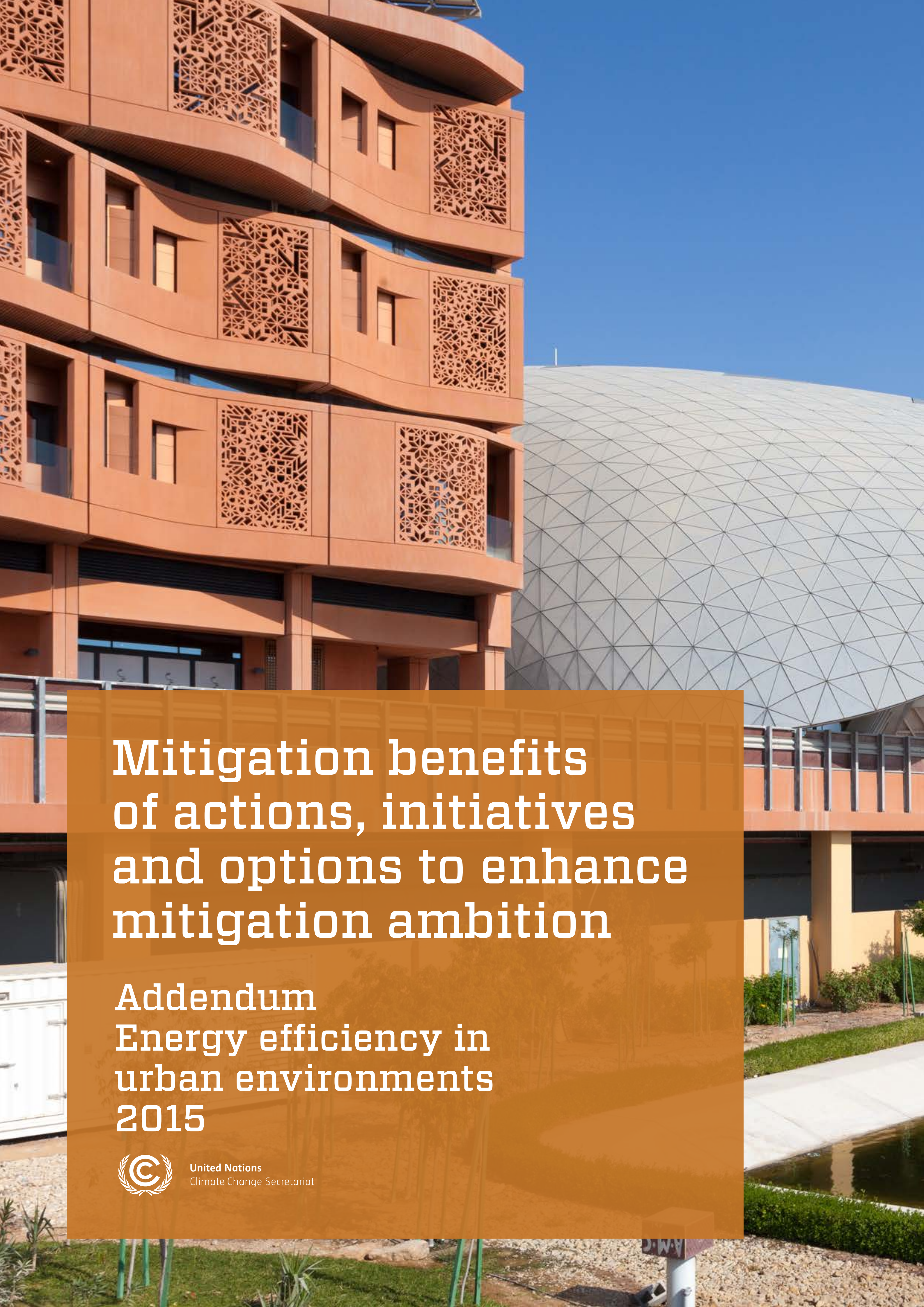

Mitigation benefits of actions, initiatives and options to enhance mitigation ambition

Addendum
Energy efficiency in urban environments
2015

United Nations
Climate Change Secretariat

SUMMARY

This updated technical paper compiles information on mitigation benefits of actions, initiatives and options to enhance mitigation ambition, with a focus on two thematic areas: promotion of renewable energy supply and acceleration of energy efficiency in urban environments. It also compiles information on support for actions in those thematic areas and possible actions to be undertaken by the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP). Information for the update was provided at the technical expert meetings that took place during the ninth part of the second session of the ADP, held in June 2015 in Bonn, Germany, and at the other meetings dedicated to the discussion on workstream 2 held during 2015, as well as in relevant submissions from Parties and observer organizations and in relevant literature on the implementation of policy options. This update builds on the previous versions of the technical paper, which are contained in documents FCCC/TP/2014/3 and Add.1 and FCCC/TP/2014/13 and Add.1–4.

This updated technical paper consists of the main document and two addenda. The addenda are focused on the promotion of renewable energy supply and acceleration of energy efficiency in urban environments. They elaborate on drivers for accelerated implementation and key policies, practices and technologies for catalysing action in those thematic areas.

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I. Introduction

01. This updated technical paper on mitigation benefits of actions, initiatives and options to enhance mitigation ambition was requested by the Conference of the Parties at its twentieth session.[1] The previous versions of the technical paper are contained in documents FCCC/TP/2013/4, FCCC/TP/2013/8 and Add.1 and 2, FCCC/TP/2014/3 and Add.1 and FCCC/TP/2014/13 and Add.1–4. This latest update does not supersede the previous versions but rather builds on the findings, information and options to enhance mitigation ambition contained therein.

02. This update is based on information provided at the technical expert meetings (TEMs) that took place during the ninth part of the second session of the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP), held in June 2015 in Bonn, Germany, on unlocking mitigation potential through the promotion of renewable energy (RE) supply and accelerated energy efficiency (EE) in urban environments.[2] It draws on relevant submissions from Parties and observer organizations as well as other relevant information on the implementation of RE and EE policy options, including through multilateral cooperation.

03. This addendum covers the discussions on the acceleration of EE in urban environments and consists of two parts: one focusing on drivers for accelerated implementation and the other on key policies, practices and technologies for accelerating the deployment of EE. The scope of this addendum is defined by the following topics discussed at the latest TEM: policies to accelerate EE in transportation, buildings, lighting and district energy systems. Issues related to other policy options discussed at the previous TEM are not covered.

II. Technical summary on the acceleration of energy efficiency in urban environments

A. Drivers for accelerated implementation

04. Significant mitigation efforts must be undertaken on a large scale and in the near future if the 2 °C temperature goal is to be met. Much of the potential for mitigating climate change lies within the energy sector, which accounts for 60 per cent of global carbon dioxide equivalent (CO_2 eq) emissions.[3] The International Energy Agency (IEA) suggests that EE measures could reduce emissions by the equivalent of 1.5 Gt CO_2 eq by 2020 (IEA, 2013c), with power generation (efficiency and fuel switching) and energy end-use (fuel and electricity efficiency) providing more opportunities for emission reductions. At a carbon price of USD 70/t CO_2, the United Nations Environment Programme (UNEP) estimates that 2.5–3.3 Gt CO_2 eq emissions could be avoided by 2030 relative to a baseline scenario (UNEP, 2014). According to REmap 2030, the renewable energy road map up to 2030 of the International Renewable Energy Agency (IRENA), EE measures could support a reduction of 7.3 Gt CO_2 eq emissions per year by 2030 (IRENA, 2014[4]).

05. The potential for improved EE is demonstrated in part by the extensive gains made over the past decade and a half, in which energy intensity is estimated to have been reduced by 1.6 per cent each year from 2002 to 2012 (IEA, 2014c). EE is also increasingly becoming known as the ‘first fuel’, given the fact that avoided energy usage is providing a larger share of the energy mix than conventional sources, such as oil, electricity and gas. However, in addition to reduced energy intensity, whereby less energy is needed

[1] Decision 1/CP.20, paragraph 19(b).
[2] Detailed information on the TEMs held under the ADP in June 2015, including the initial summaries of the discussions at the meetings, is available at <http://unfccc.int/bodies/awg/items/8895.php> and <http://unfccc.int/bodies/awg/items/8896.php>.
[3] Presentation made by the International Energy Agency (IEA) at the ADP TEM on EE in June 2015.
[4] All such references refer to publications listed at the end of the main document, FCCC/TP/2015/4.

to produce a given service or good, net energy savings will also be needed to reach climate change mitigation targets.

06. Much of the potential for EE gains lies in urban areas, which contribute 71–76 per cent of energy-related CO2 emissions globally and 37–39 per cent of greenhouse gas (GHG) emissions, according to the Intergovernmental Panel on Climate Change (UNEP, 2015a) (see spotlight box 1).[5]

Spotlight box 1

Opportunities for action on energy efficiency at the city level

The 2015 report on the New Climate Economy (NCE) recommends that enhanced efforts be undertaken by multilateral partnerships that engage governments at all levels, businesses, investors and communities in order to achieve the necessary climate change mitigation goals. Regarding opportunities for accelerating energy efficiency in urban environments, NCE recommends the following actions:

- Accelerating low-carbon development in the world's cities, with a focus on public, non-motorized transport, building efficiency, renewable energy and efficient waste management;
- Investing at least USD 1 trillion a year in clean energy;
- Raising energy efficiency standards to the global best.

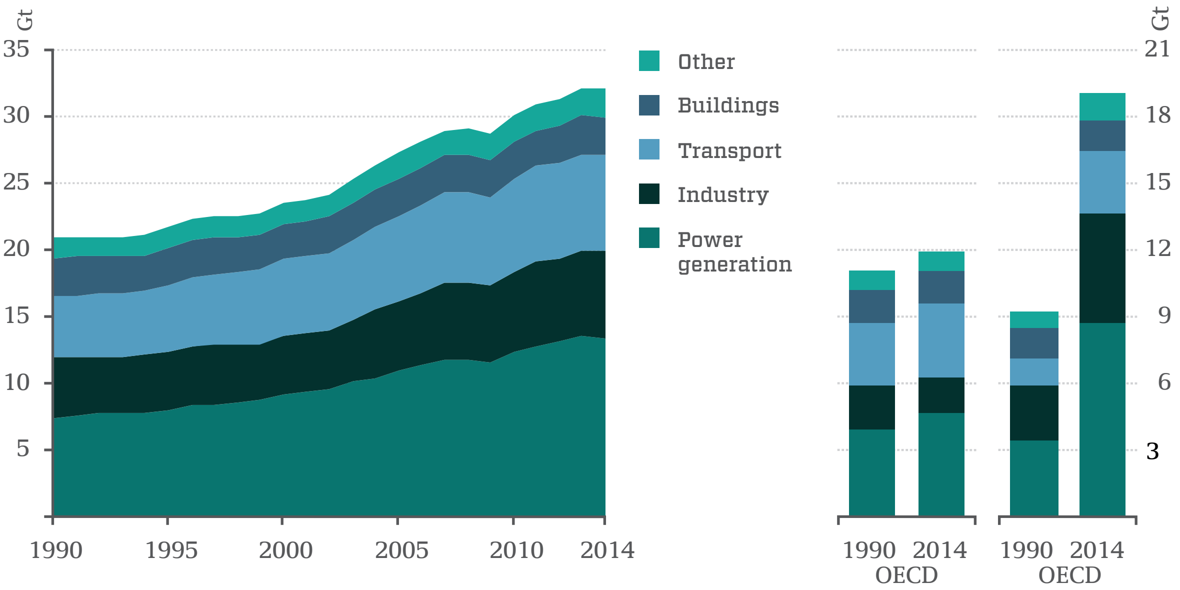
Although such actions require significant investment, the economic co-benefits would be tremendous.

Source: The Global Commission on the Economy and Climate. 2015. New Climate Economy 2015. Available at <http://2015.newclimateeconomy.report/wp-content/uploads/2014/08/NCE-2015_Seizing-the-Global-Opportunity_web.pdf>.

07. Cities are the engines of the economy, with most production, trade and transportation occurring within urban settings. As an example, an estimated 80 per cent of Asia's gross domestic product is generated within cities. By 2050, the number of megacities is expected to have grown significantly and the number of cities with populations of over one million will be in the thousands.[6] According to IEA, global energy-related CO_2 emissions from the buildings, transport, industry and power generation sectors have been increasing over the past two and a half decades (see figure 1).

[5]Presentation made by Sustainable Energy for All (SE4ALL) at the ADP TEM on EE in June 2015.
[6]Presentation made by UNEP at the ADP TEM on EE in June 2015.

Figure 1
Global energy-related carbon dioxide emissions by sector and region



Notes: "Other" includes agriculture, non-energy use (except petrochemical feedstock), Oil and gas extraction and energy transformation. International bunkers are included in the transport sector at the global level but excluded from the regional data.

Source: International Energy Agency. 2012. World Energy Outlook.
Abbreviation: OECD = Organisation for Economic Co-operation and Development.

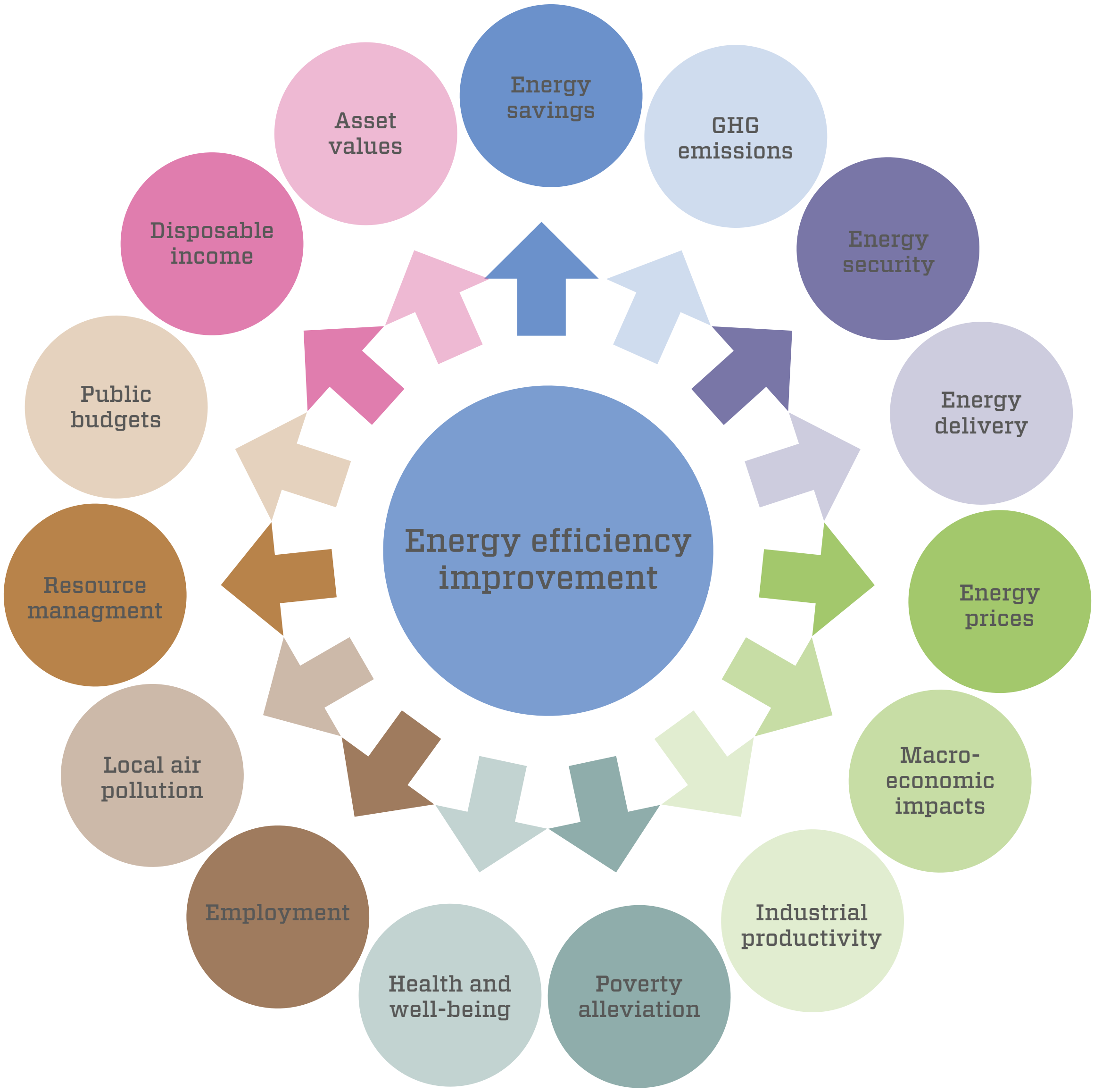
08. The good news is that there is some evidence to suggest that economic growth and energy intensity may be decoupling: in 2014 energy usage held steady, while the global economy grew at an average rate of 3 per cent (The Global Commission on the Economy and Climate, 2015). Without the acceleration of the deployment of EE technologies, it is estimated that roughly two thirds of the potential for EE will remain unrealized by 2025 (IEA, 2012b).

09. Policymakers are increasingly appreciating the sustainable development co-benefits that EE technologies can provide, in addition to their reduction of energy usage and emissions. This is an important step, as the multiple co-benefits of EE have typically been left unevaluated or undervalued in the past, and thus the potential developmental impacts were not incorporated into policy decisions. The lack of consideration of the co-benefits of EE has been in part due to a lack of good data and methodologies and difficulties assessing barriers and risks (IEA, 2014).

10. To address that challenge, IEA undertook an extensive analysis of the potential co-benefits of EE and found that EE "is a means to enhance energy security, support economic and social development and promote environmental goals". More specifically, EE can help national and subnational governments to achieve the following goals:
(a) Expand access to the power supply to more people with the existing energy infrastructure;
(b) Support economic growth through industrial productivity and a reduction in fossil fuel imports;
(c) Alleviate poverty by increasing the affordability of energy on a per unit cost basis;
(d) Improve climate change resilience by reducing vulnerable energy infrastructure and improving the durability of buildings (IEA, 2014).

11. In addition to the above-mentioned benefits, IEA also identified a broad-sweeping set of potential positive co-benefits associated with EE, which are illustrated in figure 2. Further details on the co-benefits of EE related to climate resiliency and adaptation are highlighted in spotlight box 2.

Figure 2
Examples of a broad range of potential positive impacts of energy efficiency improvements



Source: International Energy Agency. 2014. Capturing the Multiple Benefits of Energy Efficiency.
Abbreviation: GHG = greenhouse gas.

Spotlight box 2

Adaptation co-benefits of energy efficiency

The deployment of energy efficiency (EE) technologies can provide adaptation co-benefits in addition to providing mitigation benefits. Specifically, EE provides the following co-benefits:

- Reducing demand on power systems that could be operating at lower output levels due to higher ambient temperatures;
- Lowering demand for peak power, which may become more extreme owing to higher ambient temperatures and/or unexpected weather events;
- Improving the comfort of buildings, especially when there are greater fluctuations in weather or unexpected weather events;
- Lowering ambient temperatures in cities via the installation of cool and green roofs.

Source: Alliance to Save Energy. 2012. Energy Efficiency: A Tool for Climate Change Adaptation. Available at <https://www.ase.org/sites/ase.org/files/ASE-EE_A_Tool_For_Climate_Change_Adaptation.pdf>.

12. EE is sometimes called the 'home-grown fuel' as it is produced domestically and can have many local co-benefits for a diversity of stakeholders at the international, national, sectoral and individual levels (IEA, 2014a). Given differences in the assessment of co-benefits, and the interests of specific stakeholders and national circumstances, it is important to note that assessments of co-benefits will vary by country and even within subnational territories (IEA, 2014a). Several co-benefits specific to certain sectors are described below:

(a) **Improved transportation** infrastructure and practices can both reduce health risks resulting from lower pollution levels and increase overall health due to higher exercise levels and reduced traffic accidents.[7] Green transport can reduce poverty by improving access to jobs and markets and increasing overall economic activity, including net job creation (UNEP, 2011). Efficient transport can also have positive impacts on the economy: shifting to energy-efficient vehicles is estimated to have the potential to save USD 300 billion by 2025 in oil import bills and USD 600 billion by 2050;[8]

(b) **Enhancing the EE of buildings** improves health and economic productivity by reducing pollution and increasing comfort levels (UNEP, 2011). Energy-efficient buildings may require less operations and maintenance labour, be safer and result in increased property values.[9] Builders may experience faster sales and lettings through the ability to differentiate themselves on the market and improve safety and satisfaction;[10]

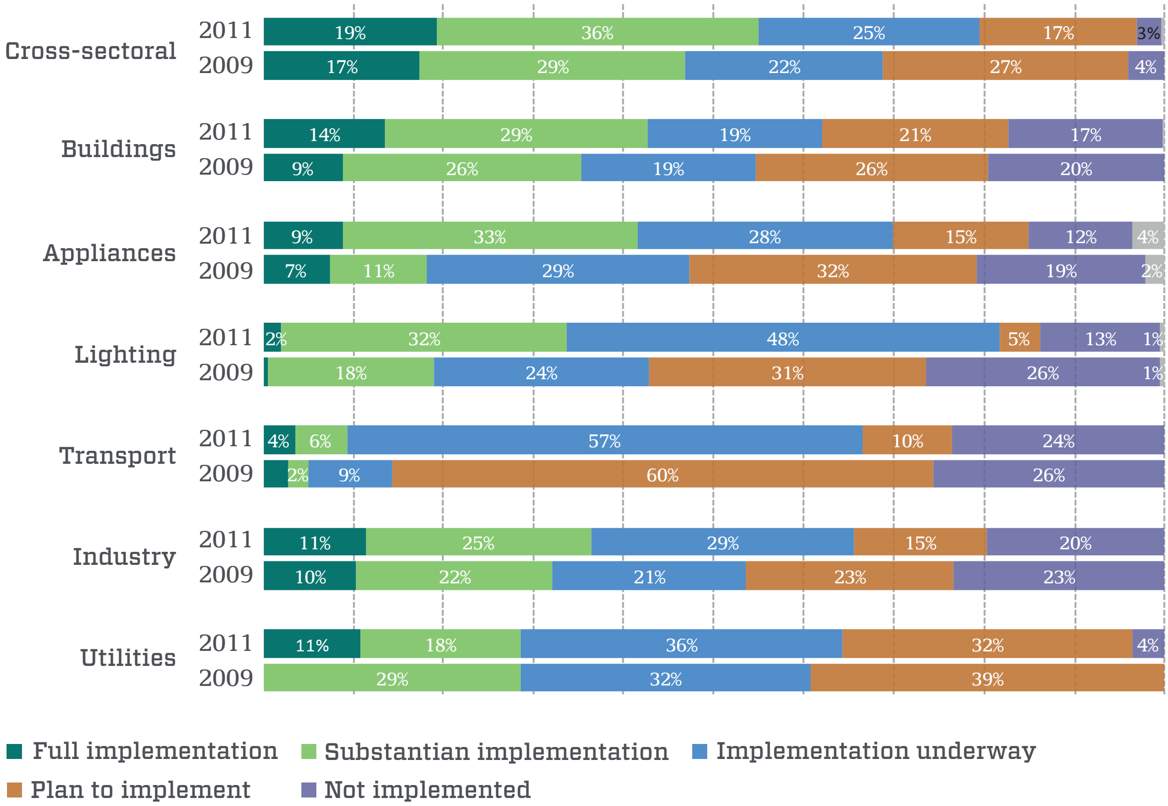
(c) **Energy-efficient lighting** can help reduce expenditure on electricity, improve the reliability of the grid and increase business competitiveness. UNEP estimates that the transition to using energy-efficient lighting could save 1,044 TWh electricity each year and USD 120 billion in electricity bills (UNEP, 2014a);

(d) **District energy** systems can support reduced air pollution, climate adaptation, access to energy, green job creation and the use of RE resources and related benefits (UNEP, 2015b).

13. National and subnational governments are increasingly taking action to spur on the deployment of EE through the implementation of policies, programmes and direct procurement. As demonstrated in figure 3, there has been significant growth in the number of IEA member countries implementing EE policies over the relatively short period of 2009–2011, with especially strong growth in the appliances, lighting and transport sectors.

[7] Presentation made by the World Health Organization at the ADP TEM on EE in June 2015.
[8] Presentation made by the Global Fuel Economy Initiative at the ADP TEM on EE in June 2015.
[9] Presentation made by SE4ALL at the ADP TEM on EE in June 2015.
[10] Presentation made by IEA at the ADP TEM on EE in June 2015.

Figure 3
Percentage of countries implementing the energy efficiency policy recommendations of the International Energy Agency



Source: International Energy Agency. 2012. Progress Implementing the IEA 25 Energy Efficiency Policy Recommendations.

14. Many countries have implemented a variety of EE policies for the purpose of encouraging or requiring the adoption of efficient technologies. According to IEA, over half of its member countries have begun to implement or are already implementing policies, with a significant portion of the remaining countries having policies that are under development (IEA, 2012a). The following are more specific trends in EE policy implementation by sector:
(a) **Cross-sectoral policies**: National strategies and action plans, financial incentives for accelerating EE, and the phasing out of inefficient lighting technologies are some of the most commonly implemented policies (IEA, 2012a);
(b) **Buildings**: Countries are strengthening building codes, developing building certification schemes and improving the public's awareness of the potential and best practices for energy-efficient buildings. Additional policies that are being frequently utilized include mandatory auditing and retro-commissioning, reporting and benchmarking of performance data, and government leadership and procurement;
(c) **Transport**: In an effort to catalyse the deployment of efficient transport technologies and practices, countries have been enacting: (i) regulations regarding tyre pressure monitoring systems; (ii) labelling programmes for tyre rolling resistance; and (iii) standards for CO2 emissions from passenger vehicles and eco-driving (IEA, 2012a). In addition, national and subnational governments are conducting holistic

transportation planning efforts, building infrastructure to encourage the use of non-personal motorized transport and expanding or enhancing mass public transport systems;

(d) **District energy**: Either of their own accord or in alignment with national policies, cities are building, expanding and improving district energy systems that provide cooling and heating to urban areas. Increasingly, waste heat, free cooling via outdoor bodies of water, RE and two-way communication and energy exchanges are being utilized (UNEP, 2015b). Cities are building the systems, procuring the services via concessions and/or attracting investment through financial incentives.

15. Despite the significant mitigation potential, recognized co-benefits and progress in EE policy implementation across a multitude of sectors, there are several barriers that could hinder the speed and scale at which EE technologies are deployed around the world. Fossil fuel subsidies are one of the more significant overarching barriers to EE, as subsidies hide the true cost of energy usage and the associated externalities. Policymakers must also take into account rebound effects, whereby cost savings resulting from lower energy demand are used to buy additional energy, which can reduce if not cancel out any initial energy savings.[11]

16. Another challenge is that EE is an invisible commodity, represented by energy not purchased (IEA, 2014a). The invisibility of energy savings can be unattractive to policymakers, who may feel that public investment in EE does not have sufficiently tangible co-benefits to be appreciated by the broader public.[12]

17. An additional important barrier to overcome is the lack of attention paid by stakeholders in both the public and private sectors to the opportunities that investments in EE represent. Stakeholders may also be inexperienced in the quantitative and qualitative assessment of both the tangible and intangible benefits of improvements in EE (IEA, 2014a). A more complete list of key overarching barriers to EE is outlined in table 1, with additional barriers specific to transportation, buildings, lighting and district energy listed in table 2.

Table 1
Overarching barriers to energy efficiency deployment

Information-related	Institutional	Financial and market-related
• Lack of information on opportunities • Need for country-specific benchmarking • Data and accounting challenges and a lack of methodology to assess the value of energy efficiency measures	• Poor governmental leadership • Government jurisdictional issues • Lack of policies and regulatory frameworks[a] • Insufficient enforcement of regulations[b] • Limited budgets for measurement, reporting and verification	• Fossil fuel subsidies • Rebound effect of energy savings[b] • Invisibility of energy savings resulting in energy efficiency being quantitatively and qualitatively undervalued • Electricity market structures and tariffs • Upfront investment costs

[11] ADP dialogue series on EE in urban environments, which took place in June 2015.
[12] Presentation made by SE4ALL at the ADP TEM on EE in June 2015.

Information-related	Institutional	Financial and market-related
	• Locked-in infrastructure • Rapid urbanization impeding systematic planning • Multiple decision makers and stakeholders • Lack of regular reviews and revisions to regulations[c] • End-users influenced by lifestyle choices	• Lack of funding and financing models • Perception of high risks and thus high discount rates • Trade barriers[d] • Market fragmentation • High transaction costs due to smaller project sizes[a]

Sources:
[a] Presentation made by the European Bank for Reconstruction and Development at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[b] Bongardt D, Creutzig F, Hüging H, Sakamoto K, Bakker S, Gota S and Böhler-Baedeker S. 2013. Low-Carbon Land Transport: Policy Handbook. Available at <https://www.routledge.com/products/9781849713771>.
[c] Ad Hoc Working Group on the Durban Platform for Enhanced Action dialogue series on energy efficiency in urban environments, which took place in June 2015.
[d] United Nations Environment Programme. 2014. Green Paper: Policy Options to Accelerate the Global Transition to Advanced Lighting. Available at <http://www.enlighten-initiative.org/Portals/0/documents/global-forum/Green_Paper_FINAL%20reduced.pdf>.

Table 2
Barriers to energy efficiency deployment specific to transportation, buildings, district energy and lighting

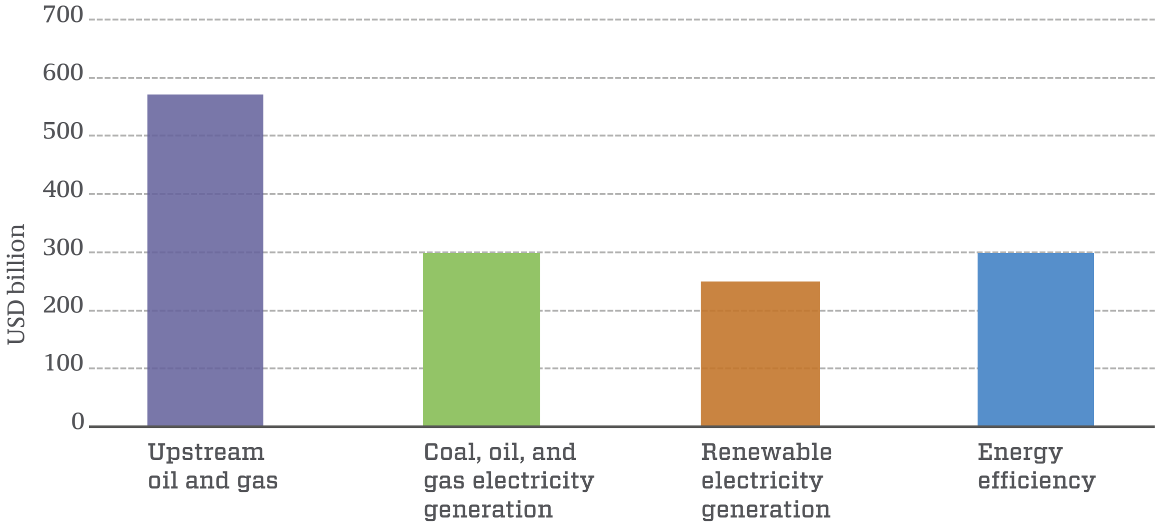
Transportation	Buildings	District energy	Lighting
• Demand for personal motorized vehicles outstripping energy efficiency (EE) savings • Existing infrastructure encouraging personal motorized vehicle use[a] • Poor coordination between	• Lack of incentives for landlords to finance EE improvements in rented housing ('split incentives') • Builders' decisions influenced by split incentives • Bidding based on upfront and not operational costs by builders[c]	• Infrastructure and land-use planning not integrated[e] • Unclear or impeding interconnection standards and regulations and lack of access to the grid[e] • Energy pricing schemes that make it difficult for district energy to	• Lack of energy service companies or market structures that limit their participation • Lack of recycling facilities • Barriers to technology transfer regarding intellectual property and trade[f]

Transportation	Buildings	District energy	Lighting
transportation and land-use planning agencies • Lack of land for road space and other infrastructure[b] • Challenges in coordinating services of various public transport providers[b] • Urban sprawl caused by market drivers towards lower-cost and less dense housing[b] • Prioritization of funds towards roadway development	• Investments in EE by homeowners and small businesses that are too small to access affordable financing require market aggregators to pool smaller projects to access cheaper capital[d] • Limited know-how on appraising the EE-related value of buildings[d] • Barriers for energy service companies	compete[e] • Electricity tariffs that may not fully account for the services provided by district energy[e]	

Sources:
a United Nations Environment Programme. 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. Available at <http://www.unep.org/greeneconomy/Portals/88/documents/ger/ger_final_dec_2011/Green%20EconomyReport_Final_Dec2011.pdf>.
b Bongardt D, Creutzig F, Hüging H, Sakamoto K, Bakker S, Gota S and Böhler-Baedeker S. 2013. Low-Carbon Land Transport: Policy Handbook. Available at <https://www.routledge.com/products/9781849713771>.
c International Energy Agency. 2008. Energy Efficiency Requirements in Building Codes, Energy Efficiency Policies for New Buildings. Available at <https://www.iea.org/publications/freepublications/publication/Building_Codes.pdf>.
d Presentation made by the European Bank for Reconstruction and Development at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
e United Nations Environment Programme. 2015. District Energy in Cities: Unlocking the Potential of Energy Efficiency and Renewable Energy. Available at <http://www.unep.org/energy/portals/50177/Documents/District%20Energy%20Report%20Book_RZ_singlepage.pdf>.
f United Nations Environment Programme. 2014. Green Paper: Policy Options to Accelerate the Global Transition to Advanced Lighting. Available at <http://www.enlighten-initiative.org/Portals/0/documents/global-forum/Green_Paper_FINAL%20reduced.pdf>.

18. In order for technology development and deployment to take place, sufficient and appropriate types of capital are required for each step in the technology cycle, from research and development to commercialization, demonstration and deployment. IEA estimates that, in 2011, the global level of public and private investment in EE was in the range of USD 300 billion, as indicated in figure 4. Such a level of investment is roughly on par with that in coal, oil and gas, electricity and RE electricity, although it is only about half of what was invested in upstream oil and gas.

Figure 4
Global levels of investment in the energy system in 2011



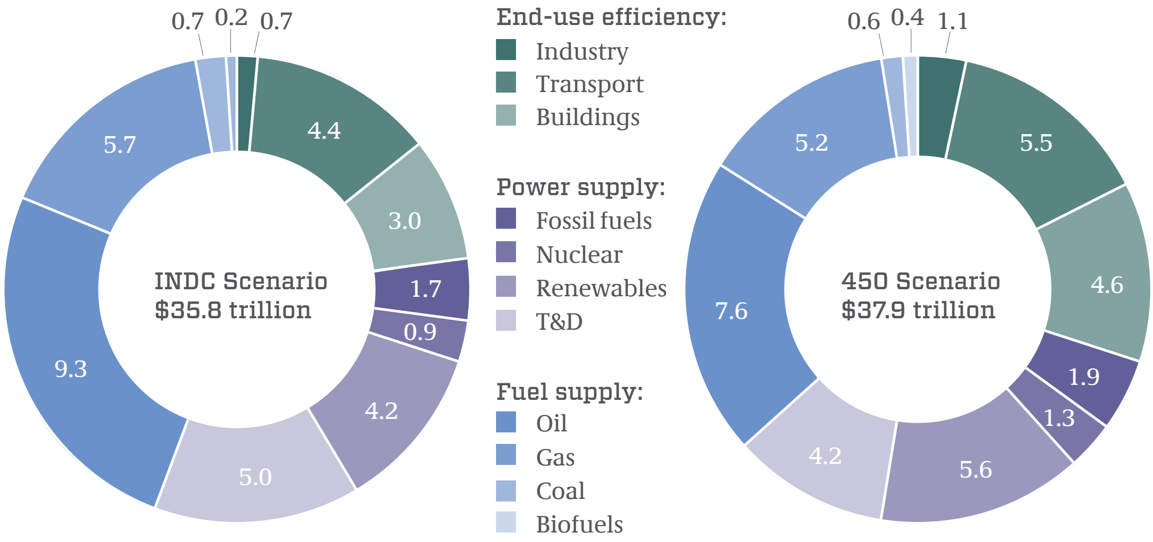
* Estimated range of USD 147 billion to USD 300 billion. Investment figures include public and private investment.
Source: IEA (2013), Energy Efficiency Market Report 2013: Market Trends and Medium-Term Prospects, OECD/IEA, Paris.

Source: International Energy Agency. 2013. Energy Efficiency Market Report 2013: Market Trends and Medium-Term Prospects.

19. To align with the intended nationally determined contribution (INDC) scenario[13] and the 450 scenario,[14] and as presented in figure 5, IEA estimates that between USD 8.1 and 11.2 trillion (2013) in investments would be needed between 2015 and 2030. Much of that investment will need to come from the private sector, with more minimal investments coming from governments in terms of the procurement and provision of incentives and concessional financing. There is also an important role for multilateral development banks to provide financing, which to date has been relatively small for investments in EE as compared with the banks' support for the energy sector as a whole.[15]

[13] The INDC scenario "represents an assessment of the implications of the submitted INDCs and signalled potential content of INDCs for some countries", according to the World Energy Outlook publication Special Report on Energy and Climate Change: Scenarios & Assumptions, available at <http://www.worldenergyoutlook.org/energyclimate/energyandco2trendsintheindcscenario/scenariosassumptions/>.
[14] The 450 scenario presents an energy pathway to limiting GHG concentration in the atmosphere to 450 parts per million of CO2.
[15] Presentation made by IEA at the ADP TEM on EE in June 2015.

Figure 5
Investment levels required under the intended nationally determined contribution Scenario and the 450 Scenario, in 2013 USD trillion



Note: T&D is transmission and distribution.

Source: International Energy Agency. 2013. Redrawing the Energy-Climate Map: World Energy Outlook Special Report.
Abbreviations: INDC = intended nationally determined contribution, T&D = transmission and distribution.

20. Although many EE improvements have the potential to be cost neutral or save costs, deploying new technologies and practices does have upfront costs. In the case of residential lighting, the investment in compact fluorescent lamps (CFLs) is small enough that medium- to high-income households can take on the higher outlay, while poorer households may require some subsidy. District energy and transport systems can be financed by municipalities, public–private partnerships or private ventures. In the case of transport, the private sector can obtain management contracts for light rail and bus rapid transport systems and make capital and operating investments in citywide bus services and parking facilities, among other opportunities (Energy Sector Management Assistance Program, 2014). Payment for services (especially in the cases of public transportation and district energy), taxes, fees and other sources of revenue can go towards financing the initial investments.

21. Investors can also support the development of the following technologies (among others): high-speed rail technologies, efficient vehicles, cleaner fuels, telecommunication technologies and global positioning systems. Municipalities can finance new energy-efficient government buildings and visible demonstration building projects. Both municipal and private investors can utilize energy service contracts, whereby an energy service company (ESCO): assesses the opportunities for improving the EE of buildings (including, potentially, lighting systems); finances the upfront costs; installs and maintains the systems; and is repaid by the occupant via energy savings.[16]

22. In some countries and cities, carbon offsets are helping to increase the financial appeal of investments in EE by providing another revenue stream in terms of earnings from carbon offsets. However, for the

[16] For more information on ESCOs, see the International Institute for Sustainable Development report on ESCOs in developing countries, available at <https://www.iisd.org/pdf/2009/bali_2_copenhagen_escos.pdf>.
[17] Presentation made by the European Bank for Reconstruction and Development at the ADP TEM on EE in June 2015.
[18] ADP dialogue series on EE in urban environments, which took place in June 2015.

most part, carbon offsets at current prices alone are not driving investments in EE.[17] There is a real need to add a sufficient climate premium to truly drive transformational investments in EE,[18] especially for those investments that are on the margins of providing net-positive or cost-neutral returns. In addition to the energy savings and resulting cost savings, national and subnational governments are offering tax incentives, grants and other subsidies as well as instituting fees and cost-adders for increased energy consumption, as is the case in the transport and power sectors (e.g. time-of-use pricing). Finally, and of critical importance, policymakers (likely at the national level) must explore whether fossil fuel subsidies, which are projected to reach USD 5.3 trillion globally by 2015 (International Monetary Fund, 2015), are guiding investment choices towards conventional fuels and reducing the financial viability of EE.[19]

B. Key policies, practices and technologies

23. The following chapter highlights policy options that are relevant to cities interested in encouraging the deployment of EE in the transportation, buildings, lighting and district energy sectors. Overarching policy considerations[20] are provided for each technology group, with enabling practices specific to each policy option outlined within the tables. Short case studies and city-specific examples are also referenced in the tables and spotlight boxes.

B1. Strengthening enabling frameworks for policy implementation in urban environments

24. Policymakers have a wide variety of possible interventions that can be undertaken to encourage the deployment of EE policies, practices and technologies at different governance levels. Often national governments provide the overarching policy framework, sometimes in conjunction with regional or State/provincial governments. It is important for those national frameworks to be flexible enough to allow for subnational governments and cities to offer policies and programmes that reflect local needs and priorities. National governments and subnational governments are coordinating on both climate change commitments and sectoral initiatives, with national governments going as far as incorporating subnational plans as a means of achieving their climate commitments (Organisation for Economic Co-operation and Development (OECD), 2015).

25. Cities are especially well suited to improving EE, given local governments' roles in planning, procurement and enforcement. However, in order to have an effective impact on energy usage, local governments must implement strong and clear policies. Many city governments are aware of the need to take action on climate mitigation and of the significant opportunities for saving energy and reducing emissions, with well over 10,000 taking part in climate action initiatives and many making firm mitigation commitments (UNEP, 2015a).

26. Given the longevity of transportation infrastructure, buildings and district energy and even lighting systems, policymakers at the local level have an important opportunity to lock in efficient technologies for decades to come. However, the transition to energy-efficient built environments takes time, as existing infrastructure needs to be upgraded or replaced, which can be costly and is likely to require incremental investments. Conversely, if inefficient infrastructure, buildings and systems are procured, those systems will entrench inefficiency for several years into the future. Thus, if mitigation goals are to be met, efficient pathways must be implemented immediately and from this day forward.

27. In an effort to meet their climate change commitments or as distinct initiatives, cities are enacting sectoral policies that support climate change mitigation, including EE targets, regulations, incentives and

[19] For more analysis of the impacts of fossil fuel subsidies, see the International Monetary Fund report How Large Are Global Energy Subsidies?, available at <https://www.imf.org/external/pubs/ft/wp/2015/wp15105.pdf>.
[20] The following policy recommendations are adapted from the IEA report 25 Energy Efficiency Policy Recommendations - 2011 Update, available at <https://www.iea.org/publications/freepublications/publication/25-energy-efficiency-policy-recommenda-tions---2011-update.html>, and the other references cited.

procurement (see spotlight box 3). EE policy options can be coupled with other measures in the energy sector, such as with RE targets and tariffs and other incentives to ensure that the RE procured is used with minimal losses and that cost savings from efficiency measures help to keep down overall expenditure on energy. In addition to RE-related initiatives, EE targets can be paired with emission reduction targets in an effort to guide investments towards lowest-cost abatement measures, as has been done in the European Union (OECD, 2015).

Spotlight box 3

The role of non-State actors in accelerating energy efficiency deployment

Non-State actors, such as cities, regional organizations, companies and non-governmental organizations, together can spur on the deployment of energy efficiency (EE) in urban environments by:

- Supporting stakeholder engagement processes and policy design;
- Raising awareness of the potential for EE deployment;
- Investing in or procuring EE systems.[a]

In addition to broad, collaborative efforts, companies can play an important and more individualized part in mobilizing EE technologies through their roles as technology and project developers, financiers, funders and collaborative stakeholders. For example:

- VELUX Group has developed prototypes for energy-efficient housing;
- PHILIPS not only offers energy-efficient lighting technology, but has also provided foundational support to the en.lighten initiative;
- BYD has developed electric buses and taxis;
- Danfoss offers EE and renewable energy technologies and services.

There are countless other companies that are engaged in providing EE technologies and working collaboratively with governments and other institutions to address barriers to technology transfer and deployment.[b]

Sources:
[a] United Nations Environment Programme. 2015. Climate commitments of subnational actors and business: a quantitative assessment of their emission reduction impact. Available at <http://apps.unep.org/publications/pmtdocuments/-Climate_Commitments_of_Subnational_Actors_and_Business-2015CCSA_2015.pdf.pdf>.
[b] Presentations made by Velux and BYD at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.

28. Complementing emissions trading schemes by household appliance labelling is another example of how policy options can work in tandem (OECD, 2015), with the intention in this case being to influence the decisions of both energy suppliers and end-users. Thus, EE measures not only help cities and national governments to meet climate commitments, but they can also complement and strengthen other energy sector and mitigation policy options.

29. Municipal, State/provincial, national and regional governing agencies can coordinate on the implementation of EE policy options to ensure their efficacy. Cities can partner with utilities[21] to implement EE programmes, such as by offering incentives for home EE improvements, working with utilities to facilitate electric car charging and coupling the incentives with time-of-use energy tariffs.

30. Also, some policy options are more appropriate to lower or higher levels of government. For example, minimum performance levels for light bulbs may be developed for a regional market given that many countries may not have the manufacturing capacity, at least initially, to develop such new technologies. While national governments are often responsible for setting vehicle and fuel mandates and regulations; however, cities can support the implementation of such policies as well as implement complementary actions. For example, cities can build the infrastructure for electric vehicle charging.

31. Policymakers influence vehicle efficiency and emissions via fuel and vehicle standards, speed limits, fiscal incentives for efficiency and 'cash for clunkers'[22] programmes. In order to select the appropriate portfolio of policy options for the energy sector, policymakers need to understand the interplay between the energy users. For example, energy-efficient buildings will rely on lighting, heating and cooling provided by district energy systems. District energy infrastructure could be built in conjunction with transportation infrastructure. The location of buildings, residential and commercial, will have an impact on transportation patterns, needs and efficiency.

32. Cities can play an important role in supplementing international, national and State/provincial policy options by: implementing stricter, more ambitious policy options; and enforcing national or regional regulations (see table 3).

[21] Presentation made by SE4ALL at the ADP TEM on EE in June 2015.
[22] A 'cash for clunkers' programme is when a government (or other implementing organization) buys older, inefficient vehicles to remove them from the road.

Table 3
Roles and functions of city and subnational authorities

Role	Functions
Strategic planning	• Define a strategy, outline a vision and develop an action plan for the local government's operations and the whole community, including urban and public space planning • Set development targets (for technology deployment, energy intensity, emissions, etc.) and develop public procurement guidelines[a] • Regulate via laws, by-laws, permissions and regulations, including in the financial sector[b] • Own and/or manage infrastructure and offer public services
Information and research	• Conduct outreach to communities by offering information and raising awareness[c] • Analyse, gather and disseminate data, develop indicators and monitor, report and verify impacts[d] • Support research and development and develop knowledge sharing networks
Economic	• Establish a competitive energy market by removing fossil fuel subsidies[e] • Encourage private-sector investment via taxes, levies and subsidies[e] • Catalyse a local supply chain to maximize climate-related benefits
Coordination and engagement	• Coordinate by engaging stakeholders, including various government agencies, consumers, private-sector representatives,[e, f] financial institutions, utilities and transit system personnelc

Sources:
[a] Presentation made by Sustainable Energy for All at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[b] Presentation made by the Inter-American Development Bank at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[c] United Nations Environment Programme. 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. Available at <http://www.unep.org/greeneconomy/Portals/88/documents/ger/ger_final_dec_2011/Green%20EconomyReport_Final_Dec2011.pdf>.
[d] FCCC/TP/2014/13.
[e] Presentation made by the International Energy Agency at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[f] Additional engagement of small and medium-sized enterprises could be facilitated through capacity-building, audit support, information and tools and access to finance.

B.2. Policy options for accelerating energy efficiency in transportation in urban environments

33. Governments, both national and subnational, are instrumental in transportation planning and have several policy levers at their disposal to reduce energy consumption in the sector. Governments can improve the efficiency of the transport sector by implementing various policy options and also by directly procuring EE technologies, vehicles and fuels, which in a number of cases are linked to the use of RE. Energy usage in the transportation sector is affected by the modes of transport used and the efficiency of the vehicles and fuels being utilized (see spotlight box 4).

Spotlight box 4

Promotion of biofuels and electric vehicles

Replacing fossil fuels with biofuels can reduce emissions and reliance on conventional fuel sources. Biofuels can be liquid or gaseous and produced from various forms of biomass waste or feedstock. Such fuels are typically used in road transport, by both passenger cars and heavy-duty vehicles. Biofuel policies generally aim to promote domestic feedstock or biofuel production (e.g. excise tax credits or exemptions and grants for production facilities) and/or domestic consumption through fiscal support and blending mandates. Today, regulatory policies are important instruments, especially in Europe, and can include sustainability and environmental standards.

Next to biofuels, electric vehicles charged with renewable electricity, or fuel-cell vehicles using fuels (e.g. hydrogen) converted from renewable electricity or biomass, will help to increase the deployment of renewable energy in the transport sector. Electric vehicle deployment can be encouraged by means of tax incentives and the installation of charging infrastructure.

Source: World Bank. 2014. Formulating an Urban Transport Policy: Choosing Between Options. Available at <https://openknowledge.worldbank.org/handle/10986/20950>.

34. Policy options can include both ‘carrots’, which reduce investment or usage costs (e.g. tax incentives for procuring efficient vehicles), and ‘sticks’, whereby users incur additional costs or fees (e.g. congestion charges). On the other hand, cities can, for example: implement transportation and land-use planning; ensure investment flows and service planning and procurement; enforce regulations (e.g. vehicle inspections); adopt finance programmes; and provide capacity-building.

35. **Cross-cutting policy options** support general transport system efficiency and urban planning. Cities can examine the overall efficiency of their transport systems, including intermodal and regional connections, to develop transportation strategies and action plans. Transportation planning should be closely integrated with urban planning, including energy system planning, and often requires inter-agency collaboration. Cities can analyse their existing transport system to determine opportunities for improvement and integrate transport planning with other city functions, such as land-use planning.

36. Transportation policies that are organized around the 'avoid-shift-improve' framework allow for the paradigm shift needed to reconcile transportation and climate change objectives.

37. **'Avoid' policy options** reduce the demand for travel, in other words, the number of motorized vehicle trips taken. They primarily concern city structure and transport infrastructure and can be best addressed via urban planning (Bongardt et al., 2013) and include the following options:
(a) **Promotion of non-motorized travel**: Cities implement policy options and programmes to encourage the use of non-motorized modes of transportation, such as biking and walking. For example, cities can implement bike sharing and rental schemes; build pedestrian bridges, malls and sidewalks; and establish car-free zones;
(b) **Changing mobility patterns**: This is another approach to discouraging the frequency at which or distances for which personal vehicles are used, which can be done through a variety of policy options, including: congestion charges; cost-adders (taxes, tolls, parking fees or proof of parking space ownership, registration and taxes); limits on road space; parking restrictions; high-occupancy lanes; car sharing programmes; and restrictions on vehicle purchases.

38. **'Shift' policy options** seek to replace inefficient travel with more efficient modes, such as replacing personal motor vehicle use with the use of public transport. They are mostly implemented via transportation planning and management (Bongardt et al., 2013) and include, for example, the **promotion of mass public transit**: governments can procure or otherwise create public–private partnerships to build new mass public transport systems or expand or improve upon existing systems. Mass public transport can include subways, light rail, trams, ferries, commuter buses, bus rapid transit (BRT), intermodal transfer hubs and bus lanes. A BRT system in Bogor, Indonesia, is one of the selected examples of good practice (see spotlight box 5).

39. **'Improve' policy options** increase EE and reduce energy intensity for a given trip and are implemented primarily through vehicle and fuel regulations and incentives (Bongardt et al., 2013) and include the following options:
(a) **Vehicle and fuel efficiency and fuel switching**: Emissions associated with motorized vehicles can be reduced via enhanced vehicle and fuel technologies and driving practices. More efficient motors, lighter vehicles, improved tyres, eco-driving and more efficient and/or lower-emitting fuels, including electric and biomass-powered vehicles, can all provide for lower emissions while still delivering the same energy services as conventional technologies;
(b) **Taxis and paratransit transportation services** (e.g. tuk tuks and motorized riskshaws): Taxis and paratransit play an important role in improving access to mass transport or filling a transport need that is not met by mass transport systems. However, if left unchecked, the vehicles can be potentially heavy polluters and present other challenges, such as those pertaining to safety and road congestion.

Spotlight box 5

Examples of successful energy-efficient urban transportation projects

Bogor, Indonesia, which is one of the pilot cities of the Sustainable Urban Transport Programme Indonesia (NAMA SUTRI) and one of the two model cities of the Urban Low Emission Development Strategies project in Indonesia, began implementation of a more efficient bus system in 2014. In an effort to reduce emissions, the buses will be switched to using natural gas. In addition, over 1,000 of the city's microbuses will also be switched to run on natural gas or electricity.[a]

Belgrade, Serbia, faces several transport-related challenges, including growth in travel demand, long distances between jobs and homes, increased car ownership and an aging transport system. In an effort to address those issues, the city, along with the Urban Planning Institute, undertook an extensive evaluation and developed its Master Plan to 2021. The plan takes into account multiple actions to: optimize connectivity; improve the safety and quality of public transport; reduce traffic volume; oversee land-use planning; and provide funding for transport projects. Thus far, a bridge has been built; the tram and bus fleets and the traffic management systems have been modernized; park-and-ride stations have been developed; and a pricing scheme for downtown parking has been launched. Public ridership tripled within the first six months.[b]

In Seoul, the Republic of Korea, the Mayor and the metropolitan Government have revitalized the city's transport system in an effort to improve the quality of the bus service, reduce noise and air pollution, lessen growth in demand for travel and provide funding for the development of the metro system. Improvements include: a reorganized bus service; new bus rapid transport (BRT) corridors; harmonization of the BRT and metro services; development of an integrated public transport fare; parking reforms; implementation of fuel taxes; new pedestrian facilities; and the use of buses running on compressed natural gas, among other changes. As a result of those improvements, bus speeds have increased, as has passenger use of buses.[b]

Johannesburg, South Africa: In October 2015, the EcoMobility World Festival will convene in Sandton, Johannesburg. Building on a recent, similar experience in Suwon, the Republic of Korea, the festival will turn the business district into a car-free zone for one month. The effort is intended to address growing congestion in the city, in which the number of commuters has been increasing by 3 per cent each year. To facilitate the closure, the city has outlined a detailed plan, which includes: the identification of closed streets; the provision of alternative transport; the improvement of infrastructure for non-motorized transport (e.g. sidewalks); the development of park-and-ride facilities; and the installation of signage.[b]

Sources:
[a] Presentation made by Bogor at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015. More information on NAMA SUTRI is available at <http://transport-na-mas.org/wp-content/uploads/2015/02/Indonesia_NAMA-SUTRI_Full-NAMA-Concept-Document.pdf>.
[b] International Energy Agency. 2013. A Tale of Renewed Cities: A policy guide on how to transform cities by improving energy efficiency in urban transport systems. Available at <https://www.iea.org/publications/freepublications/publica-tion/Renewed_Cities_WEB.pdf>.

40. Mobilizing the deployment of efficient transportation technologies and behaviours requires the capacity to develop effective policy options and to track and communicate impacts. For transportation policy to be effective, its design must take into account existing infrastructure, culture, income levels, traffic patterns, geography and weather. Urban transport policy options often require coordination among construction/public works agencies, land-use agencies[24] and transport agencies, among others.[25]

41. Another key challenge with all EE policy options, including those focused on transport, is that of induced travel resulting from improved infrastructure and/or energy savings (Bongardt et al., 2013). For example, adding a lane to a highway could reduce congestion initially, but ultimately the improved travel conditions could encourage additional purchases of personal motorized vehicles. In summary, cities have a selection of incentives and enforcements that can be enacted to spur on the deployment of energy-efficient transportation.

42. Effective policy options can steer finance and investment towards public transportation, infrastructure and efficient vehicles and fuels. Public funding at the city, national and international levels is needed to transform the current energy transportation paradigm by leveraging private-sector investment. City governments can fund urban transport policy options through a variety of means, such as city budgets, license fees, bus concession fees, congestion charges, national and regional revenue and taxes (employer, property, gasoline and parking).[24]

43. Table 4 summarizes policy options for catalysing the deployment of energy-efficient transport technologies as well as the enabling practices that can enhance the efficacy of those policies. Also included in the table are city-specific examples.

Table 4
Policy options for promoting energy-efficient transportation in urban environments

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Cross-cutting policy option: enhanced efficiency of the transport system and urban planning	
• **Facilitate easy interchange** between travel modes around transfer hubs and coordinate local, regional and national transport systems through a local public transport association[a] • **Provide easy access** to public transport in city centres (< 500 m) • **Study growth trends and cost differences** between transport system sizes to access opportunities for economies of scale • **Consider enacting** building codes that support mixed-use buildings and high population density, integrating biking and public transportation infrastructure, exploring underground or elevated systemsa and approvals for gas stations on the basis of the availability of low-emission fuels	• Bogor, Indonesia – multimodal mobility development policy[b] • Curitiba, Brazil – integrated transport and land-use planning[c] • Madrid, Spain – integrated transport and land-use planning[d] • Qingdao, China – integrated transport and land-use planning[e]

[24] There is a strong relationship between transportation and land-use planning. Policies that pertain specifically to the nexus of transportation and land use include standards for floor area ratios, mixed-use planning and urban-growth boundaries.
[25] Presentation made by the World Bank at the ADP TEM on EE in June 2015.

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Cross-cutting policy option: enhanced efficiency of the transport system and urban planning	
• **Consider co-financing** by area/stakeholder benefitting from improved public transport • Consider employing 'sustainable neighbourhood' schemes like Leadership in Energy and Environmental Design neighbourhood development, which encompasses detailed ideas for efficient transport	
Avoid' policy option: promotion of non-motorized travel	
• **Consider current trends** in the usage of non-motorized transport and personal motor vehicles, spatial patterns, income levels and economic growth • **Explore investments** in non-motorized transport infrastructure and policy options to limit the use of personal vehicles • **Design cycling and walking routes** that are connected, direct, safe, enjoyable to use and attractive[a] • **Offer bike sharing programmes** that are free or low cost to replace short-distance personal vehicle travel and facilitate connections to public transport[a]	• Istanbul, Antalya, Sakarya, Eskişehir, Konya and Kayseri, Turkey – BikeLab projects to improve bike lanes[f] • Madrid, Spain – car-free zones[g] • Mexico City, Mexico – law prioritizing walking and cycling modes[h] • Paris, France – public bike rentals[i] • Johannesburg, South Africa – one-month car-free zone
'Avoid' policy option: changing mobility patterns[j]	
• Explore policy options for motorbikes (e.g. limiting use within certain areas, time frames or purposes)[c] • Reduce availability or increase cost of parking to discourage personal vehicle usage • Consider introducing measures such as congestion charges, taxes, tolls, vehicle registration, limited road space, high-occupancy lanes, car sharing and restricted vehicle purchases	• Belgrade, Serbia – pricing scheme for downtown parking[k] • Valletta, Malta – user charges • Milan, Italy – area charging policy for private vehicles[l] • London, United Kingdom – congestion charges for urban transport[m]

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
'Shift' policy option: promotion of mass public transport	
• **Consider cost recovery** from public transport fares and corresponding quality–cost trade-offs as well as impact on low-income groups • **Integrate considerations** such as passenger safety, comfort and satisfaction, reliability, timeliness and ease of use[a] • **Consider a payment system** for non-users for tangential benefits • **Attract various users** by offering tiered classes (e.g. one level that provides more services at a higher cost and another that provides fewer services at a lower cost) • **Explore impact of bus lanes** on traffic flows, which could be made worse and result in increased emissions • **Study and plan for alternatively fuelled buses**, considering potential cost increases and resulting impacts on the number of buses deployed and/or fare increases • **Analyse trade-offs** between different modes (e.g. BRT may require less upfront investment and may be more flexible than rail)[a]	• Auckland, New Zealand – bus rapid transit (BRT)[n] • Belo Horizonte, Brazil – BRT[o] • Bogor, Indonesia – efficient bus system project[p] • Bogota, Colombia – BRT and land-value capture[q] • Cagliari, Italy – light-rail servicer • Chengdu, China – BRT[s] • Hong Kong, China – land-value capture[t] • Seoul, Republic of Korea – BRT[k] • Singapore, Singapore – metro rail system[u] • Tokyo, Japan – land-value capture[t]
'Improve' policy option: enhanced vehicle and fuel efficiency and fuel switching	
• **Explore the impacts of increasing parking spaces** (e.g. more space reduces time spent finding parking but could result in greater use of personal vehicles) • **Consider** fiscal incentives, vehicle standards, user sensitization, leadership through public procurement, research and development, and developing harmonized standards for infrastructure for the promotion of biofuel use, if relevant • **Look for** options to reduce vehicle weight, increase occupancy rates and encourage eco-driving	• Aguascalientes, Mexico – fuel efficiency standard for light-duty trucks[v] • Beijing, China – vehicle inspections and maintenance systems[w] • Taj Mahal area, India – Taj Trapezium Zone with limitations on the types of vehicle that can access it

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
'Improve' policy option: enhanced vehicle and fuel efficiency and fuel switching	
• **Consider impacts on the grid** and the power mix of the use of electric vehicles, if relevant • **Analyse opportunities** to encourage the efficiency of non-engine components (e.g. tyres) • **Consider taxi licensing programmes**, operation and maintenance standards and driver training for paratransit services such as taxis, if relevant, and explore opportunities for integrating alternative and electricity-fuelled vehicles into the taxi fleet[z]	
'Improve' policy option: enhanced vehicle and fuel efficiency and fuel switching	
• **Consider taxi licensing programmes**, operation and maintenance standards and driver training for paratransit services such as taxis, if relevant, and introduce scrapping and recycling schemes • **Explore opportunities for integrating alternative and electricity-fuelled vehicles** into the taxi fleet[z]	• Cairo, Egypt – scrapping and recycling of taxis[x] • Rajkot, India – auto rickshaw entrepreneurship programme[y] • Shenzhen, China – transitioning conventional taxis to electric taxis[z]

Sources:

[a] Bongardt D, Creutzig F, Hüging H, Sakamoto K, Bakker S, Gota S and Böhler-Baedeker S. 2013. Low-Carbon Land Transport: Policy Handbook. Available at <https://www.routledge.com/products/9781849713771>.

[b] Presentation made by Bogor at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.

[c] Curitiba, Brazil: A model of transit oriented planning. Available at <http://www.ecomobility.org/fileadmin/template/project_templates/ecomobility/files/Publications/Case_stories_EcoMobility_Curitiba_PDF_print.pdf>.

[d] Carpio-Pinedoa J, Aldecoa Martínez-Conde J and Amíquiz Daudéna F. Mobility and Urban Planning Integration at City-regional Level in the Design of Urban Transport Interchanges (EC FP7 NODES Project–Task 3.2.1.). Available at <http://www.sciencedirect.com/science/article/pii/S1877042814062351>.

[e] World Resources Institute. Project Directory. Integrating transport and land use planning in Qingdao, China. Available at <http://www.wricities.org/our-work/project-city/integrating-transport-and-land-use-planning-qingdao-china>.

[f] World Resources Institute. Great expectations: EMBARQ Turkey grows BikeLab project. Available at <http://www.wricities.org/news/great-expectations-embarq-turkey-grows-bikelab-project>.

[g] Central Madrid Rolls Out a Tough-Love Plan to Limit Cars. Available at <http://www.citylab.com/commute/2014/09/central-madrid-rolls-out-a-tough-love-plan-to-limit-cars/380642/>.

[h] World Resources Institute. Project Directory. Guaranteeing the "right to mobility" in Mexico City. Available at <http://www.wricities.org/our-work/project-city/guaranteeing-right-mobility-mexico-city>.

[i] Complete Guide to Velib' Bike Rentals in Paris. Available at <http://goparis.about.com/od/gettingaround/ss/Guide-To-Paris-Bikes-Velib.htm>.

[j] Additional motorbike-specific policies include restricting two-stroke engines, implementing higher taxes to discourage high engine power, and linking motorbikes with public transport through parking fee reductions and other complementary services.

[k] International Energy Agency. 2013. A Tale of Renewed Cities: A Policy Guide on How to Transform Cities by Improving Energy Efficiency in Urban Transport Systems. Available at <https://www.iea.org/publications/freepublications/publication/Renewed_Cities_WEB.pdf>.

[l] European Platform on Mobility Management. E-update on congestion charging. Available at <http://www.epomm.eu/newsletter/v2/content/2015/0415/doc/eupdate_en.pdf>.

[m] Energy Sector Management Assistance Program. Good practices in city energy efficiency. London, United Kingdom – Congestion Charges for Urban Transport. Available at <https://www.esmap.org/node/1279>.

[n] Auckland Rapid Transit System, New Zealand. Available at <http://www.railway-technology.com/projects/auckland_rapid/>.
[o] World Resources Institute. MOVE Bus Rapid Transit (BRT) – Belo Horizonte, Brazil. Available at <http://www.wricities.org/media/photo-essay/move-bus-rapid-transit-brt-belo-horizonte-brazil>.
[p] Ministry of Transportation Indonesia and the Deutsche Gesellschaft für Internationale Zusammenarbeit. 2014. Supported NAMA. Sustainable Urban Transport Programme Indonesia (NAMA SUTRI). Pilot Phase; available at <http://transport-namas.org/wp-content/uploads/2015/02/Indonesia_NAMA-SUTRI_Full-NAMA-Concept-Document.pdf>, and presentation made by Bogor at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[q] World Resources Institute. TransMilenio BRT in Bogotá, Colombia. Available at <http://www.wricities.org/media/image/transmilenio-brt-bogot%C3%A1-colombia>.
[r] International Railway Journal. Cagliari opens light rail extension. Available at <http://www.railjournal.com/index.php/light-rail/cagliari-opens-light-rail-extension.html>.
[s] World Resources Institute. Project Directory. Multimodal transport integration in Chengdu, China. Available at <http://www.wricities.org/our-work/project-city/multimodal-transport-integration-chengdu-china>.
[t] Murakami J. 2012. Transit Value Capture: New Town Co-Development Models and Land Market Updates in Tokyo and Hong Kong. Value Capture and Land Policies, eds. Ingram, Gregory K., and Yu-Hung Hong. Cambridge, MA: Lincoln Institute of Land Policy. Available at <https://www.lincolninst.edu/pubs/2198_Transit-Value-Capture-New-Town-Co-Development-Models-and-Land-Market-Updates-in-Tokyo-and-Hong-Kong>.
[u] SMRT. Available at <http://www.smrt.com.sg/>.
[v] International Council on Clean Transportation. 2013. Mexico light-duty vehicle CO2 and fuel economy standards. Policy update. Available at <http://www.theicct.org/sites/default/files/publications/ICCTupdate_Mexico_LDVstandards_july2013.pdf>.
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[x] World Bank. 2015. Scrapping and Recycling Old Vehicles in Egypt. Available at <http://www.worldbank.org/en/results/2015/08/12/scrapping-recycling-old-vehicles-egypt\>.
[y] World Resources Institute. 2012. Review of Literature in India's Urban Auto-rickshaw Sector: A Synthesis of Findings. Available at <http://thecityfix.com/blog/new-release-review-of-literature-in-indias-urban-auto-rickshaw-sector/>.
[z] Presentation made by BYD at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.

B.3. Policy options for promoting energy efficiency in the buildings sector in urban environments

44. With rapid urbanization and many new buildings, governments have a good opportunity to institute policy options and regulations that can lock in EE technologies for the coming decades. EE building policies can be applied to residential and/or non-residential buildings and new and older/existing buildings. Much of the older building stock, especially in developing countries, is in need of upgrading, and thus there is also significant potential to improve building efficiency via retrofits.[26]

45. Policies can reflect the type of investor and use of the building as well as the building's location in terms of climate, surrounding demography and other considerations. Policymakers can consider options that encourage 'bioclimatic' design, whereby the building's envelope responds to the local climate, primarily with passive measures (e.g. insulation, airtightness, low ventilation losses and daylighting). Bioclimatic design can also enable the use of RE systems. Energy-efficient buildings not only reduce energy consumption but also provide healthier environments with improved ventilation and comfort in terms of temperature control.

46. Buildings consume energy for heating, cooling, ventilation, water heating, lighting and running appliances and equipment.[27] Building design considerations that effect efficiency include orientation, floor plan, envelope,[28] daylighting[29] and electrical and water systems.[30] Additional aspects of building design include: green and cool roofs; smart systems that utilize information technology

[26] Presentation made by Tshwane, South Africa, at the ADP TEM on EE in June 2015.
[27] For further information on technologies and policies relevant to the efficient heating and cooling of buildings, see the IEA report Technology Roadmap: Energy Efficient Buildings: Heating and Cooling Equipment, available at <https://www.iea.org/publications/freepublications/publication/buildings_roadmap.pdf>.
[28] The building envelope includes the floors, ceilings, walls, roofs and areas surrounding cooling, heating and ventilation systems (IEA. 2008. Energy Efficiency Requirements in Building Codes, Energy Efficiency Policies for New Buildings. Available at <https://www.iea.org/publications/freepublications/publication/Building_Codes.pdf>).
[29] Presentation made by Velux at the ADP TEM on EE in June 2015.
[30] Also important is the efficiency of the appliances and equipment, although policies specific to those technologies are not covered in depth in this report.

communications to manage energy consumption; and on-site distributed RE, such as solar hot water and solar photovoltaics. [31]

47. The EE of buildings can be affected by urban planning, which influences the arrangement and size of buildings as well as the space between buildings, which can give rise to heat island effects and affects the ability to utilize distributed generation, such as solar energy, urban wind turbines and geothermal energy. Policymakers can take into account the life cycle impacts of certain building designs and materials, such as the manufacturing, building and recycling practices that affect lifetime energy use, environmental impacts and costs. In some cases, demolishing existing, low-efficiency buildings and replacing them with high-efficiency buildings can be the most cost- and energy-effective option in the long term.

48. There are several policy options that governments in both developing and developed countries can implement to spur EE investments and market creation in the commercial and public sectors.[32] In general, cities can deploy voluntary programmes and mandatory regulations, utilize community empowerment models and engage broad groups of stakeholders to provide clear short-, medium- and long-term policy signals. [33]

49. Policy options are often differentiated for new and existing buildings. However, policies for new buildings could have an impact on the efficiency of the existing building stock as buildings age and retrofits bring older buildings up to current standards, however stringent or lax (IEA, 2008b). Policymakers have to balance the ambition of the regulations versus the costs and the potential economic impacts, although many EE measures provide net positive returns on investment. The ability to enforce regulations, including building codes, is vital to ensuring the intended policy impacts. A few examples of successful building policies are presented in spotlight box 6.

[31] Presentation made by UNEP at the ADP TEM on EE in June 2015.
[32] Presentation made by ICLEI Local Governments for Sustainability at the ADP TEM on EE in June 2015.
[33] Presentation made by Tshwane at the ADP TEM on EE in June 2015.

Spotlight box 6

Successful policies and programmes for urban energy-efficient buildings

Tshwane, South Africa, has an innovative green building by-law and development policy that was implemented to address electricity supply shortages, water shortages, lack of solid waste disposal sites, transportation issues and anticipated higher energy demand due to the higher temperatures anticipated with climate change. The green building by-law was approved by the City Council in 2012 and will be fully implemented by the end of 2015. It applies to new buildings, major retrofits and building additions and includes mandatory requirements and standards, supported by an incentive scheme.[a]

Recife, Brazil, recently passed its Green Roof Law, which requires a vegetation layer to be applied to the top of buildings and garages for the purposes of improving aesthetics, reducing heat islands, absorbing rainwater run-off and improving the local microclimate. The policy is also anticipated to reduce building temperature, protect buildings from ultraviolet rays and sudden temperature changes, provide areas for urban gardens, reduce external noise, save energy and improve air quality. The policy applies to residential buildings with four or more floors and non-residential buildings with more than 400 m2 of roof area. Recife is complementing the Green Roof Law by other energy efficiency programmes, including improving access to non-motorized transport, public transportation via ferries and a light-rail system.[b]

Byron Shire, Australia, a community of villages in New South Wales, is the first in the country to commit to zero emissions, a goal that it aims to reach within 10 years via a cross-sectoral approach that includes reducing energy usage in buildings. Byron Shire's road map to zero emissions from buildings began with assessing the existing building stock and the potential for energy efficiency improvements and the use of rooftop solar. Implementation centres around the Energy Freedom campaign, targeting households and partnering with local energy efficiency and solar businesses. To complement the energy efficiency measures, Byron Shire Council has also put in place Australia's first virtual net metering programme.[c]

Sources:
[a] Presentation made by Tshwane at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[b] Presentation made by Recife at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[c] Presentation made by Byron Shire at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.

50. The following are summaries of the policy options included in table 5, with brief descriptions of enabling practices that could improve the effectiveness of each policy option and city-specific examples.

51. **Building energy codes and minimum energy performance standards** are one of the key tools available to local governments to influence energy usage. Many governments have had building codes in place for decades to ensure safety and adherence to local land-use planning and zoning restrictions. However, there are significant opportunities for developing countries to implement new building codes or improve upon existing codes that specifically relate to EE (IEA, 2013b). New codes can be incorporated into overall building codes or be established as separate, supplementary regulations (IEA, 2008b). Building codes can be applied to both new and existing buildings, although typically codes for existing buildings pertain to major new renovations and do not require the revamping of the existing building stock. Standards for EE and/or GHG emissions can be part of the building code or implemented as complementary regulations and can be based on size, intended use, location and weather conditions.

52. **Mandatory auditing and retro-commissioning** can be effective policy options where there is a large portion of the existing building stock that is likely to be highly inefficient. Building codes can cover a variety of technologies and practices and can include: (1) lower U-values, which measure the rate of heat loss through various materials; (2) minimum energy requirements; and (c) airtightness.[34] Audits can be required and can be either informative or require action on behalf of the building owner to improve the EE of the building on the basis of the audit's recommendations.

53. **Building performance certificates and labelling** are used to distinguish buildings that meet building code requirements and those that exceed building codes in terms of efficiency. Builders and investors can better differentiate the EE characteristics of buildings with information provided by building performance certificates and labelling. Certificates and labelling can also help potential homebuyers and renters to compare properties in terms of estimated long-term energy expenditure.

54. **Financial incentives and models** represent the so-called policy 'carrots' that policymakers can offer to encourage the implementation of efficient building technologies and practices, as opposed to the policy 'sticks' of building codes, performance requirements, mandatory auditing and retro-commissioning. Examples of incentives are tax credits, rebates, loans, grants, green mortgages and bridging loans.[35] It is important for governments to enact clear regulations and market structures that enable financiers to provide innovative EE financing models, such as those offered by ESCOs (see spotlight box 7).

55. **Data gathering and reporting and benchmarking of performance data**: Cities need data on existing buildings and typical efficiencies in order to inform long-term planning. Geographical information systems can help to organize data on building stock and planned new construction. As a complementary effort, cities can require or encourage voluntary reporting and benchmarking of building energy performance. Reporting and benchmarking could coincide with performance labelling and benchmarking as well as with carbon pricing schemes.

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[34] Presentation made by IEA at the ADP TEM on EE in June 2015.
[35] Presentation made by the Inter-American Development Bank at the ADP TEM on EE in June 2015.

Spotlight box 7

The role of energy service companies in financing energy efficiency upgrades

Through energy performance contracts, energy service companies (ESCOs) finance, install and maintain energy efficiency (EE) upgrades to commercial and public buildings and infrastructure. ESCOs can implement a variety of EE measures, such as those pertaining to lighting, heating, air conditioning, motors, industrial processes, combined heat and power, waste heat recovery and energy management systems.a ESCOs cover the upfront costs and take on the project and financial risks. The building owner repays the ESCO through energy savings, a portion of which goes towards the return on investment of the ESCO.

There are multiple opportunities for collaboration between ESCOs and governments. Governments can utilize ESCO services for upgrades to public buildings and infrastructure and create enabling markets in which ESCOs can participate. ESCOs can also be included within stakeholder engagement processes. Examples of policy options that enable ESCO market development include:

- Implementing overarching national EE strategies and action plans;
- Clarifying the legality and tax obligations of ESCOs;
- Enabling energy agencies to coordinate with ESCOs and highlight demonstration projects;
- Implementing building codes and audit and retrofit programmes.b

Sources:
[a] International Institute for Sustainable Development. 2006. Energy Service Companies in Developing Countries. Available at <https://www.iisd.org/sites/default/files/pdf/2009/bali_2_copenhagen_escos.pdf>.
[b] United Nations Economic Commission for Europe. 2013. Development of Energy Service Companies: Market and Policies. Available at <http://www.unece.org/uploads/pics/Dev_ESCO.pdf>.

56. **Outreach, stakeholder engagement and workforce training**: Governments can play a leading role in improving the understanding of builders, renters, property buyers, financiers and others of the benefits and potential of energy-efficient buildings through public-awareness campaigns and stakeholder engagement. Key stakeholders include housing and builders associations, the financial community, energy providers and technology providers. Governments can also work with industry to offer workforce training programmes, such as those for auditors and EE technology installers.

57. **Government leadership programmes and procurement**: Governments can also drive markets and enable learning by leading by example with the procurement of highly efficient new municipal buildings and extensive EE retrofits. Additional details on enabling practices for the above-listed policy options are included in table 5, alongside city-specific case studies.

Table 5
Policy options for promoting energy efficiency in the buildings sector in urban environments

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Policy option: building energy codes and minimum energy performance standards	
• **Incorporate energy performance criteria** into building permit requirements • **Consider stricter or more comprehensive local building codes** than provincial/State or national codes • **Set specific codes** for parts of buildings, certain sectors and/or building sizes and consider complementing building codes by appliance and equipment standards • **Analyse the appropriate level of renovation** that would require adherence to building codes • **Allow for regular revisions** that reflect technological advancements and market dynamics • **Ensure that building codes are enforceable** and the appropriate institutions are in place	• Boston, United States – Leadership in Energy and Environmental Design certification requirement for large-scale developments[a] • Hong Kong, China; Singapore, Singapore; Chicago and New York, United States; Stockholm, Sweden; and Johannesburg, South Africa – additional cities with policies for existing and new buildings • Singapore, Singapore – certified rating under the Green Mark Scheme required for all new buildings and significant retrofits[b] • Stockholm, Sweden – maximum energy intensity of no higher than 55 kWh/m2 for new buildings[c] • Tshwane, South Africa – by-laws addressing energy efficiency of new buildings and major retrofits and additions[d]
Policy option: mandatory auditing and retro-commissioning	
• **Determine whether periodic audits** would be required (e.g. every 3, 5 or 10 years) • **Explore applying audits** to entire buildings or just specific	• Hong Kong, China – mandatory audits for commercial buildings of over 30 years old and taller

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Policy option: building energy codes and minimum energy performance standards	
components (e.g. heating, ventilation and air conditioning and lighting) • Complement with benchmarking and reporting schemes • Require certain renovations of existing buildings, such as replacing heating or cooling systems	than two stories[e] • Recife, Brazil – the new Green Roof Law, which requires residential and non-residential buildings of a certain size to install rooftop gardens[f]
Policy option: building performance certificates and labelling	
• **Consider labels** for specific areas of performance, such as thermal performance and use of renewables • **Require that labels be provided** in sale listings, lease contracts, financial incentives qualification and municipal or city-funded building projects • **Incorporate labels into existing standards** and make any labels easily understandable and comparable • **Explore including green construction guidelines** as part of a labelling programme along with monitoring[h]	• Beijing, China – the China Green Building Label requires all new buildings to have at least a one-star rating[g] • Hong Kong, China; Tokyo, Japan; Singapore, Singapore; New York, the United States; and Johannesburg, South Africa – additional cities with policies for existing and new buildings
Policy option: financial incentives and models	
• **Incorporate financial incentives** into a holistic energy efficiency policy package and ensure that energy market laws and regulations allow for third-party financing (e.g. contracts for energy services) • **Design incentives and financing programmes** to leverage private-sector investment • **Work with the private sector** to allow for green leases that address split incentives between landlords and tenants • **Use grants and loans** to promote building refurbishment • **Explore emissions trading schemes** as a means of providing additional revenue	• Houston, United States – property-assessed clean energy financing[i] • Monterrey (and various other cities), Mexico – Ecocasa programme's concessional bridging loans to developers[j] • Nairobi, Kenya – subsidized energy audits for property owners[k] • Shanghai, China – various incentives

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Policy option: financial incentives and models	
• **Customize instruments** to a city's context and market for maximum impact[j]	• Various cities in South Africa – Eskom's energy servicing company model for industrial and commercial customers[m]
Policy option: data gathering (including reporting and benchmarking of performance data)	
• **Consider what level of disclosure** would be effective given a city's policy priorities (e.g. information can be exchanged between a buyer and seller or posted online) • **Provide tools to support benchmarking**, such as online assessment tools • For cities with carbon emissions trading schemes, **explore interactions between reporting and emissions trading**	• For existing buildings: Hong Kong, China; Tokyo, Japan; Singapore, Singapore; Chicago and Philadelphia, New York, San Francisco and Seattle, United States; and Johannesburg, South Africa
Policy option: outreach, stakeholder engagement and workforce training	
• **Offer capacity-building** on architectural techniques, building materials and processes and conducting ex ante simulations of effectiveness • **Help owners and building occupants** to reduce energy usage by informing them of the benefits of energy-efficient components and building systems, both new and renovated, and also of the programmes and technologies available • **Consider a certification/accreditation scheme** to ensure adequate training of the personnel assessing building efficiency and implementing projects	• Houston, the United States; and Stockholm, Sweden – additional cities with policies for existing and new buildings • Lagos, Nigeria – Power Kids Programme providing extra-curricular education on the nexus of behaviour and environmental impacts[m] • Paris, France – Paris Climate Energy Action Plan, including educational opportunities for secondary students[n]
Policy option: government leadership programmes and procurement	
• **Research opportunities** to pursue ambitious and binding targets for renovations, coupled with a road map for meeting targets for public buildings • **Complement investments in social housing** with energy efficiency improvements and urban planningl	• Tshwane, South Africa – a new municipal office that aims for a five-star green rating[d]

Sources:
[a] City of Boston.gov. Available at <http://www.cityofboston.gov/eeos/buildings/>.
[b] Building and Construction Authority of the Singapore Government. Available at <http://www.bca.gov.sg/greenmark/green_mark_buildings.html>.
[c] The Stockholm Environment Programme 2012–2015. Available at <http://international.stockholm.se/globalassets/ovriga-bilder-och-filer/the-stockholm-environment-programme-2012-2015.pdf>.
[d] Presentation made by Tshwane at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[e] Buildings Department of the Government of the Hong Kong Special Administrative Region. Available at <http://www.bd.gov.hk/english/services/index_mbis.html>.
[f] Presentation made by Recife at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[g] Institute for building efficiency. Green Building Rating Systems: China. Available at <http://www.institutebe.com/InstituteBE/media/Library/Resources/Green%20Buildings/Fact-Sheet_Green-Building-Ratings_China.pdf>.
[h] Presentation made by ICLEI Local Governments for Sustainability at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[i] Presentation made by the World Business Council for Sustainable Development at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[j] Presentation by the Inter-American Development Bank at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[k] The Center for Energy Efficiency & Conservation. Available at <http://kenyasustainableenergyweek.com/about/about-the-center/>.
[l] Presentation made by the International Energy Agency at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[m] Lagos State Government Power Kids Program. Available at <http://www.lseb.gov.ng/content/lagos-power-kids-program>.
[n] Paris Green Invest For Future – Regional Strategy: Climate and Energy Framework. Available at <http://www.paris-green.com/en/regional-strategy-climate-and-energy-framework/>.

B.4. Policy options for promoting energy-efficient lighting in urban environments

58. Replacing inefficient light bulbs with more efficient technologies has great potential for reducing energy consumption and lowering emissions. In fact, since 2004 all IEA member countries plus several others have been phasing out incandescent bulbs. Energy-efficient lighting can be deployed in buildings, both public and private, and as part of municipal infrastructure, such as street lighting and traffic lights. For example, CFLs use a quarter of the energy of incandescent bulbs while providing the same amount of energy.[36] CFLs also reduce mercury emissions as compared with traditional incandescent bulbs.

59. Light-emitting diodes (LEDs) are another key technology for efficient lighting. LEDs are brighter, last longer and save energy compared with incandescent bulbs. Older fluorescent tubes can be replaced with more efficient fluorescent technologies and high-pressure sodium lights can replace mercury vapour street lights.

60. Efficient lighting policy options and incentives can be incorporated into policy options and programmes surrounding EE buildings and should be driven by minimum performance standards, which help to ensure the efficiency and quality of energy-saving lighting technologies. While standards are best set at the regional level to facilitate trade and economic development, they can also be implemented at the national level (UNEP, 2014) (see spotlight box 8).

[36] Presentation made by IEA at the ADP TEM on EE in June 2015.

Spotlight box 8

Examples of successful urban energy-efficient lighting projects

Akola, India, implemented a robust energy-efficient street lighting programme, replacing more than 11,500 fluorescent, mercury vapour and sodium vapour lights with fluorescent tube lamps. The project was financed by an energy service company (ESCO), Asia Electronics Limited, which covered the upfront costs, facilitated the changing of the bulbs and provided maintenance. Asia Electronics Limited was repaid with energy savings over an 11-month project payback period. The project has reduced energy usage for street lighting by 56 per cent and lowered the city's electricity bills by USD 133,000 annually. The model also enabled the municipality to avoid any project or financial risks. Similar projects are being replicated in the Indian States of Maharashtra and Madhya Pradesh.[a]

In **Catalonia, Spain**, the provincial Government has been working with several municipalities to upgrade public lighting systems and is also utilizing ESCOs. From 2011 to 2013, there were 19 tenders for energy service contracts, resulting in EUR 30 million in investment and 40 per cent in energy savings. The role of the provincial Government has been to provide technical assistance to municipalities and oversight as a third party and to scale and leverage investments.[b]

Sources:

[a] Energy Sector Management Assistance Program. 2009. Good Practices in City Energy Efficiency: Akola Municipal Corporation, India – Performance Contracting for Street Lighting Energy Efficiency. Available at <https://www.esmap.org/node/662>.

[b] Presentation made by the International Energy Agency at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.

61. The energy usage of street, office, residential, commercial, municipal and industrial lighting can be lessened by using more efficient technologies and practices, including by means of behavioural changes. Cities can catalyse the switch to energy-efficient lighting in four key ways: (1) public procurement; (2) incentives and policies; (3) support of regional, national and State/provincial lighting policies; and (4) outreach programmes. The corresponding policy options are described in paragraphs 63–66 below.

62. **Municipal procurement**: Municipalities can incur significant expenses to light public infrastructure, including buildings, street lighting, traffic lighting and recreational facilities. Municipalities cannot only reduce lighting bills but can also encourage the development of energy-efficient lighting markets via public procurement. Municipalities can utilize ESCOs to finance lighting improvements.

63. **Economic, market and fiscal incentives:** While many energy-efficient lighting technologies can pay for themselves through energy savings, consumers may be thwarted by even slightly higher costs. Municipalities can offer incentives to help offset higher upfront costs. Incentives can include rebates to

cover partial costs. Through clear regulations and energy market structures, municipalities and other government actors can ensure that ESCOs can participate in the market and provide energy service contracts.

64. **Phase-out of incandescent bulbs**: In terms of city-level policy options for phase-outs, the effectiveness of such policies depends greatly on the ability of consumers to access other markets (i.e. nearby cities) and to enforce such policies (i.e. avoid a black market for incandescent bulbs). Thus, the phase-out of inefficient incandescent bulbs may be most effectively implemented at the national level. In line with the common city mandate to facilitate waste management, local governments can play an important role in the safe disposal of spent bulbs, including CFLs, and the enforcement of national-level policies. LEDs are another important technology that can replace older less-efficient technologies, especially in public lighting, traffic lights and street lighting.

65. **Outreach and awareness**: There are many misconceptions about energy-efficient lighting, which governments can help to address through public outreach and awareness programmes. For example, outreach programmes can help to mitigate concerns about the aesthetics, functionality and financial feasibility of energy-efficient lighting.

66. Table 6 outlines key policy options for the acceleration of energy-efficient lighting and highlights some important enabling practices that can improve the effectiveness of those policies. Brief city-specific examples are also included in the table.

Table 6
Policy options for promoting energy-efficient lighting in urban environments

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Policy option: municipal procurement	
• **Procure efficient lighting** for public buildings and infrastructure to help spur markets and lead by example • **Work with energy service companies** to improve energy efficiency and reduce upfront costs • **Replace less-efficient**, high-pressure sodium street lights with light-emitting diodes (LEDs) • **Combine lighting upgrades with communication upgrades**, including sensors to oversee traffic conditions, air quality, security and others • **Conduct internal training** on the procurement of energy-efficient lighting, operations and maintenance, and proper disposal of used compact fluorescent lamps (CFLs)	Traffic light examples: • Akola, India – performance contracting for street lighting[a] • Portland, Houston, and Los Angeles, the United States – LEDs for traffic signals • Stockholm, Sweden – LEDs for traffic signals[b] • Sydney, Australia – LEDs for street and park lighting[b] • Various cities, China – solar photovoltaic lighting for streets and public spaces[c]

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Policy option: economic, market and fiscal incentives	
• **Use financial incentives** to address potential higher upfront costs associated with purchasing and installing more efficient lighting systems	• Winter Park, United States – rebates for upgrading lighting[d]
Policy option: phasing out of incandescent bulbs	
• **Raise awareness** of the broader public on the benefits of CFLs and LEDs • **Distribute limited amounts of free CFLs** to encourage uptake • **Provide information on and/or facilities for the safe disposal** of CFLs, which contain mercury vapour • **Partner with businesses** to facilitate drop-off points for disposal of CFLs	• Western Cape, South Africa – distribution of free CFLs and safe disposal programme[e]
Policy option: outreach and awareness	
• **Provide audit programmes**, including potentially discounted audits, to improve consumers' understanding of the energy usage associated with lighting • **Develop information resources** such as leaflets, websites and others to inform the public on the benefits of and other considerations for energy-efficient lighting	• Accra, Ghana – CFL distribution and education programme[f] • New Jersey, United States – Clean Energy Outreach Team high school education programme and lighting fairs[g]

Sources:

[a] Energy Sector Management Assistance Program. 2009. Good Practices in City Energy Efficiency: Akola Municipal Corporation, India – Performance Contracting for Street Lighting Energy Efficiency. Available at <https://www.esmap.org/node/662>.
[b] The European Association of Local Authorities in Energy Transition. Installing Energy Efficient Traffic Signals. Available at <http://www.energy-cities.eu/db/stockholm_566_en.pdf>.
[c] Frankfurt School–UNEP Collaborating Centre for Climate & Sustainable Energy Finance/Bloomberg New Energy Finance. 2015. Global Trends in Renewable Energy Investment 2015. Available at <http://apps.unep.org/publications/pmtdocuments/-Global_trends_in_renewable_energy_investment_2015-201515028nefvisual8-mediumres.pdf.pdf>.
[d] City of Winter Park, Florida, Energy Conservation Rebates and Incentive Program. Available at <https://cityofwinterpark.org/departments/electric-utility/energy-conservation-rebates-and-incentive-program/>.
[e] Eskom. 2014. Eskom National CFL Programme: Residential Sector. Available at <http://www.energy.gov.za/files/esources/kyoto/2014/Presentations/PoA-Eskom-National-CFL-Programme-Residential-Sector.pdf>.
[f] ECOWAS Centre for Renewable Energy and Energy Efficiency. Towards efficient Lighting Market, the case of Ghana. Presentation. Available at <http://www.ecreee.org/sites/default/files/event-att/k.agyarko-ouaga_ecreee_presentation.pdf>.
[g] New Jersey's Clean Energy Program. Available at <http://www.njcleanenergy.com/residential/programs/energy-efficient-products/lighting>.

B.5. Policy options for promoting energy efficiency in urban district energy systems

67. District energy systems (DES) have been deployed since the 1880s and already fulfil significant portions of demand for heat in several markets, for example: in Europe, 12 per cent; in China, 23 per cent; and in the Russian Federation, 50 per cent (UNEP, 2015b). However, there remains large potential for the further deployment of DES and increasing the efficiency and reducing the emissions of existing systems.

68. DES can provide steam, cold water or hot water to heat and cool buildings and homes and can also produce electricity. They may provide these services more efficiently than individual building heating or cooling systems by using centralized, nearby power sources and pumping cool or warm water through a pipe network to end-user facilities. DES can utilize combined heat and power (CHP), waste heat storage, heat pumps and decentralized energy systems, including RE (e.g. geothermal heat pumps, solar photovoltaics, wind and biomass) (UNEP, 2015b).

69. Cool air systems can be produced with waste heat, absorption chillers, lakes, rivers, seas and electric chillers and can be twice as efficient as air conditioners. Cooling systems can also reduce peak electricity demand and use of environmentally damaging refrigerants. Newer technologies are termed 'fourth generation' and operate at lower temperatures, have 'smart' features and allow for two-way district heating. There is potential for cost savings with DES given economies of scale and the potential to use renewable and waste energy sources that may be less expensive, in some instances, than conventional fuels.

70. District energy policies should be considered alongside those for the buildings sector, given the potential synergies. For example, governments may want to assess buildings' efficiencies before developing or expanding DES to ensure that the energy is not wasted or poorly utilized. Also, DES may be most effective in population-dense areas and thus there could be synergies in incorporating them within larger urban planning efforts.

71. National governments have a variety of policy options at their disposal that can help to encourage the development, expansion or improvement of DES. For example, governments can provide incentives for the use of CHP and renewables, regulations on standards and labels, tax incentives and strategic guidance for subnational governments. Subnational governments can complement national-level efforts by the policies and practices detailed in paragraphs 73–76 below.

72. **Development or expansion of district cooling/heating systems**: Given that DES are localized and require a certain level of density of buildings, city governments are well suited to play an important role in the development of DES. Municipalities can set targets or mandates for the growth of DES (e.g. by 2030, meet 30 per cent of cooling demand or provide 200 MW of heat capacity). Clear regulations can enable the interconnection of neighbouring systems.

73. **Improvement of the efficiency of DES**: Some DES have been around for decades, while others are newer; however, in either case, there may be an opportunity to improve the efficiency of existing systems. For example, improvements can be made to infrastructure to reduce losses. Governments can improve the efficiency of existing systems through mandates or the procurement of updated systems and infrastructure investments.

74. **Integrating renewables and utilizing waste heat** reduces the amount of conventional fuel needed to power DES. Depending on the source of energy and the source(s) being displaced, this could result in lower energy costs and reduced emissions. Cities can set mandates or targets for integrating renewables

and waste heat into existing or new DES. Integrating RE systems into DES can mean that thousands of end-users are using RE as a heating or cooling source overnight.

75. **Financial incentives and market structure**: In deregulated markets, the market structure must allow for district energy utilities and enable sufficient tariffs to provide for adequate returns that will attract investment. Governments can provide additional financial incentives, such as tax incentives and net metering.

76. To date, at least 45 cities have installed over 36 GW of district heat and 6 GW of district cooling, covering 12,000 km of networks and providing the equivalent energy to 3.6 million households (UNEP, 2015b). Although cities are leading the planning and implementation of projects, there may be an important opportunity for collaboration with State and provincial governments, which could provide planning, coordination and financial assistance. There are multiple options for the ownership and operation of DES, ranging from public ownership (most common), through public–private partnerships, to private-sector ownership (UNEP, 2015b) (see spotlight box 9).

Spotlight box 9

Successful urban district energy projects

In **Catalonia, Spain**, the provincial Government has been supporting the implementation of district heating and cooling systems in several cities and towns, including systems fuelled by biomass, biogas, waste treatment and natural gas. Thus far, 40 systems have been built, most of which are in mountainous areas and together account for 14 MW of capacity.[a]

Paris, France, has Europe's first and largest district energy network, which provides cooling to the equivalent of 500,000 homes and serves half of the social housing units, all hospitals and half of all public buildings. Initially built in 1991, the system consists of 71 km of pipes, eight plants of 330 MW total and three storage units. On an annual basis, the system reduces greenhouse gas emissions by 10,000 tonnes of carbon dioxide equivalent, provides 25 GWh power consumption and reduces water usage by 0.5 million m3. The goal is to use 60 per cent recovered or renewable energy by 2020.[b]

Rajkot, India, is implementing a demonstration project for district cooling and is one of the pilots of the Global District Energy in Cities Initiative. Initial activities include convening stakeholders, identifying areas for deep-dive analysis, building capacity, developing analytical methodologies for assessing baselines and tracking impacts, and formulating an implementation road map.[c]

Sources:
[a] Presentation made by Catalonia at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[b] Presentation made by Paris at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015
[c] Presentation made by Rajkot at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.

77. Key enabling policy options include: target setting; energy tariff regulations that protect customers; technical standards for system interconnection; and by-laws covering zoning, housing density and building codes (UNEP, 2015b). More specific government actions are described in table 7, along with enabling practices that could enhance the effectiveness and benefits of those policy options. Brief city-specific policy examples are also included.

Table 7
Policy options for promoting energy efficiency in urban district energy systems

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Policy option: development or expansion of district cooling/heating systems	
• **Consider in the regulations dedicating areas** to district energy systems (DES) and making it mandatory for certain energy end-users to interconnect • **Conduct an integrated energy assessment** and integrate DES planning with land-use and infrastructure planning and mapping • **Coordinate development of DES** with that of other infrastructure (e.g. coupling with a light-rail development) • **Explore public–private partnerships** that may be able to access additional investment sources and utilize development and operational expertise • **Provide capacity-building** to developers on structuring financeable projects • **Consider lower energy prices** for social housing areas	• Anshan, China – public–private partnership to development new DES[a] • Copenhagen, Denmark – regulations governing the municipal development of district heat system[b] • Cyberjaya, Malaysia – district cooling system 30-year concession contract[c] • Gujarat, India – development of a public district cooling system • Paris, France – district energy network[d] • Port Luis, Mauritius – development of the first seawater district cooling system in Africa[c]
Policy option: improving the efficiency of existing DES	
• **Interconnect energy systems** to allow for exchange of excess heat and/or reserve capacities • **Put in place energy efficiency targets for DES**	• Copenhagen, Denmark – connection of district heat network to solar thermal plant with heat storage[c] • Toronto, Canada – Lake

Policy options and key elements of enabling environments to support successful policy replication and implementation	Select city-specific examples
Policy option: improving the efficiency of existing DES	
	Ontario used to provide district cooling[e]
Policy option: integrating renewable energy sources and utilizing waste heat	
• **Set specific targets** for renewable energy procurement • Ensure that energy system interconnection, grid access and permitting rules **do not impede the installation of renewable energy systems**	• Catalonia, Spain – integration of biomass, biogas and waste treatment as renewable power sources[f] • Reykjavik, Iceland – geothermal energy use for district heating and electricity generation[g] • Vancouver, Canada – demonstration project capturing waste heat from wastewater[c]
Policy option: financial incentives and market structures	
• **Use incentives**, such as soft loans, bond financing, loan guarantees, underwriting, grants, revolving funds, subsidies and land-value capture, to steer investments away from traditional fossil fuel energy sources • **Design energy market tariffs** to reflect the cost of connecting to DES and a guaranteed heat supply (e.g. compensation for providing reserve capacity, grid balancing, voltage support and waste heat) • **Allow combined heat and power systems** to compete on the retail electricity markets • **Enact net metering policies and incentives** for distributed energy generation • **Use land-use and energy system interconnection** policies to ensure an adequate consumer base and thus reduce risk	• Amsterdam, Netherlands – land-use and interconnection policies[c] • London, United Kingdom – grants for feasibility studies[h] • Ludz, Poland – land-use and interconnection policies[c]

Sources:

[a] International district energy association. New Danfoss District Energy System in Anshan, China to Use Steel Plant's Waste Heat. 2013. Available at <http://www.districtenergy.org/blog/2013/01/18/district-energy-system-in-anshan-china-to-be-fueled-with-waste-heat-recovered-from-steel-plant/>.
[b] Danish Board of District Heating. Available at <http://dbdh.dk/district-heating-history/>.
[c] United Nations Environment Programme. 2015. District Energy in Cities: Unlocking the Potential of Energy Efficiency and Renewable Energy. Available at <http://www.unep.org/energy/portals/50177/Documents/District%20Energy%20Report%20Book_RZ_singlepage.pdf>.
[d] Presentation made by Paris at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[e] C40 Cities Climate Leadership Group. Lake Water Air Conditioning Reduces Energy Use by 90%. Available at <http://www.c40.org/case_studies/lake-water-air-conditioning-reduces-energy-use-by-90>.
[f] Presentation made by Catalonia at the Ad Hoc Working Group on the Durban Platform for Enhanced Action technical expert meeting on energy efficiency in June 2015.
[g] C40 Cities Climate Leadership Group. The World's Largest Geothermal Heating System Saves up to 4M Tons CO2 Annually. Available at <http://www.c40.org/case_studies/the-worlds-largest-geothermal-heating-system-saves-up-to-4m-tons-co2-annually>.
[h] International Energy Agency. 2009. Cogeneration and District Energy. Available at <https://www.iea.org/publications/freepublications/publication/CHPbrochure09.pdf>.

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