

Energy Technology Perspectives 2016

Towards Sustainable Urban Energy Systems

Executive
Summary



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- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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International Energy Agency

9 rue de la Fédération
75739 Paris Cedex 15, France

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The agreement reached at the 21st Conference of the Parties (COP21) in Paris could prove to be a historic turning point for reversing the currently unsustainable trends in the global energy system, provided that this heightened low-carbon ambition is translated into fast, radical and effective policy action. Even in the context of low fossil fuel prices, policy support for low-carbon technologies should mobilise all levers available to accelerate research, development, demonstration and deployment (RDD&D) to make decarbonisation the preferred development path. Chief among such levers is governments' support for urban energy transitions, a conclusion that is supported by the analysis of *Energy Technology Perspectives 2016* (ETP 2016), which shows the vast number and size of cost-effective, sustainable energy opportunities available in cities. Realising this potential, and the multiple non-climate benefits it presents, will require national and local governments to work together effectively.

COP21 boosted the momentum for accelerating low-carbon technology deployment, but concrete action will need to match ambitions

2015 may prove to be a pivotal year for climate change mitigation because for the first time in history all the world's nations agreed by consensus to implement actions aimed at decarbonisation under a common legally binding framework.

The Paris Agreement could prove to be a historic milestone for the global energy sector, sending a strong signal through its aims to peak global emissions as soon as possible and reach net-zero emissions in the second half of this century, as well as to keep the global temperature increase well below 2°C and to pursue efforts to limit it to 1.5°C.

The Paris Agreement was a milestone for implementation. For the first time, non-state actors were invited to be an intrinsic part of the process. Not only were public energy stakeholders included in the process but non-governmental organisations (NGOs), the private sector, and regional and local entities as well. Cities were among the front runners, with their strong role in the lead-up to COP21 through the Lima-Paris Action Agenda as well their support for the Paris Pledge for Action. The need to accelerate low-carbon technology innovation has also received significant attention in international fora, with the newly created Mission Innovation and the Breakthrough Energy Coalition aimed at catalysing investments in transformational technologies to accelerate decarbonisation.

A low fossil fuel price outlook poses both unique opportunities and threats for low-carbon technology deployment.

While low fossil fuel prices might slow down clean energy technology deployment, they also present opportunities to better align policies with decarbonisation targets, for instance, by accelerating the roll-out of carbon pricing mechanisms and dismantling costly fossil fuel subsidy programmes. Both oil-exporting and oil-importing countries took advantage of the mid-2014 collapse in oil prices to unroll costly subsidy programmes. Low coal prices offer similar opportunities to reduce subsidies on fuel and electricity prices, but this potential window of opportunity needs to be exploited quickly since the current favourable conditions might not be in place for long.

The transition requires massive changes in the energy system, and the 2 Degree Scenario (2DS) highlights targeted measures needed to deploy low-carbon technologies so as to achieve a cost-effective transition.

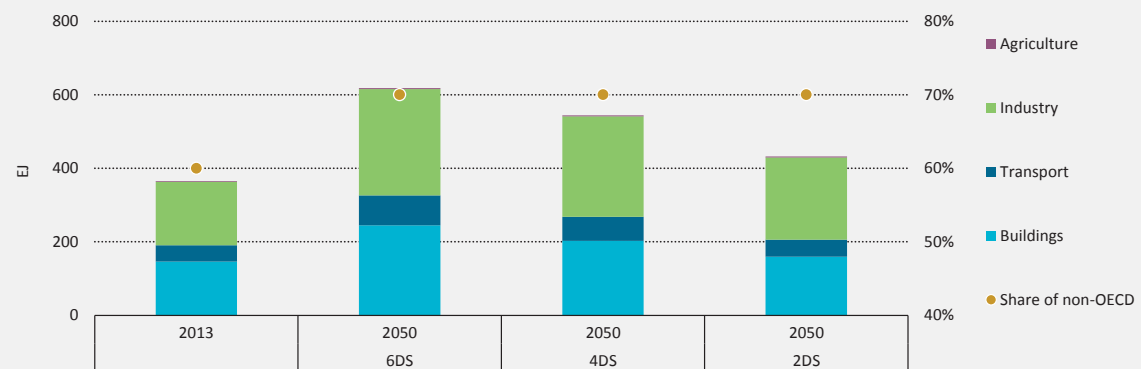
With the appropriate policies, such large-scale transformation is realistic and can dramatically reduce both the energy intensity and carbon intensity of the global economy. Compared with a scenario wherein technology deployment is driven only by the policies currently in place (the 6 Degree Scenario [6DS]), in the 2DS, with the right support for low-carbon technologies in conversion processes and end uses, primary energy demand can be reduced by 30% and carbon emissions in the energy system by 70% (and by one-half relative to current levels) by 2050. The two largest contributions to cumulative emissions reductions in the 2DS over the period 2013-50 would come from end-use fuel and electricity efficiency (38%) and renewables (32%). Carbon capture and storage (CCS) would come in third place with 12%, followed by nuclear with 7%.

The investment costs of the 2DS across the power sector and the three end-use sectors (buildings, industry and transport) would not require unreasonable additional financial efforts from the global economy.

Decarbonising the power sector in the 2DS would cost about USD 9 trillion between 2016 and 2050 (equivalent to 0.1% of the cumulative global gross domestic product [GDP] over the same period). Achieving the potential energy savings of the 2DS in the buildings, industry and transport sectors would entail combined additional investment costs of USD 6.4 trillion between 2016 and 2050. In particular, if the full potential for reduced demand for vehicles and road and parking infrastructure associated with the “avoid” and “shift” options in transport systems is considered, the 2DS in the transport sector could be achieved with lower investment costs than the 6DS.

Cities are at the heart of the decarbonisation effort

The energy landscape is shaped by cities. With more than half of global population and about 80% of the world's GDP in 2013, cities account for about two-thirds of primary energy demand and 70% of total energy-related carbon dioxide (CO₂) emissions. The energy and carbon footprint of urban areas will increase with urbanisation and the growing economic activity of urban citizens. By 2050, the urban population will grow to two-thirds of global population, and the urban share of global GDP will be about 85%. Continuing current energy system trends, driven by existing policies such as in the 6DS, will increase urban primary energy demand by 70% from 2013 levels to about 620 exajoules (EJ) in 2050 when it will account for 66% of the total (Figure I.1). In parallel, carbon emissions from energy use in cities (including indirect emissions from power and heat generation) would increase by 50%. Hence, efforts aimed at fostering sustainable urban energy paths are crucial to meet national and global low-carbon ambitions.

Figure I.1 Urban primary energy demand in the ETP scenarios, 2013-50


Note: 4DS = 4°C Scenario.

Key point

Under the 2DS, growth in primary energy use attributable to urban areas can be slowed considerably.

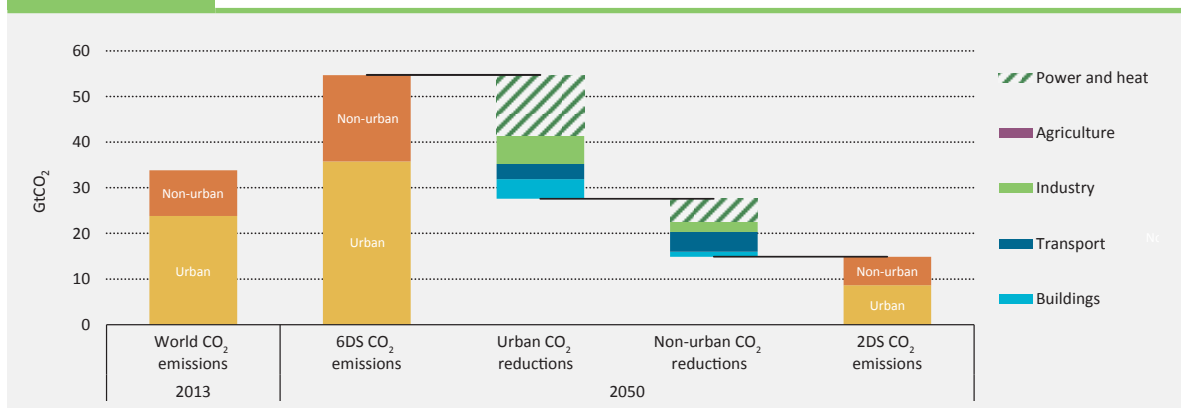
Cities should be at the heart of the sustainable energy transition. The 2DS provides a vision for meeting demand for end-use energy services in cities while at the same time significantly reducing primary energy use and its environmental impacts. In fact, cities not only drive energy demand and its environmental impacts; they also offer great opportunities to steer the global energy system towards greater sustainability. Accelerating the deployment of clean energy technologies in the urban environment and supporting behavioural changes among urban citizens can significantly decouple growth in urban primary energy use and carbon emissions from GDP and population growth while ensuring continued access to end-use services. For example, in the 2DS, urban primary energy demand globally can be limited to 430 EJ by 2050 (65% of total primary energy demand), which represents less than a 20% increase from 2013, while urban populations are expected to increase by 67% and GDP by 230% over the same period. Relative to 6DS levels, carbon emissions from urban energy use could be reduced by 75% in 2050. Overall, the potential emissions reduction related to urban energy use by 2050 in the 2DS amounts to 27 gigatonnes (Gt), equivalent to 70% of the total emissions reduction in the 2DS (Figure I.2), which would otherwise not be possible without a transformation of urban energy systems.

Urban energy systems provide significant opportunities for increased efficiency in delivering transport and building services. In the 2DS, final energy demand in the urban buildings and transport sectors in 2050 is reduced by 60% (about 80 EJ) compared with the 6DS. These energy savings can be realised through the avoided “need” for a portion of energy end-use services (e.g. reduced length and frequency of trips in compact cities) and more energy-efficient options to meet the same level of service demand, as in the case of mode shift from personal cars to public transport, walking and cycling. Energy savings and lower-carbon fuels in urban buildings and transport can lead to direct and indirect (i.e. avoided generation of electricity and heat) carbon emission reductions of about 8 Gt by 2050 in the 2DS (relative to the level achieved in the 6DS) – which is equivalent to almost two-thirds of the total emissions reduction for these two sectors and to about 40% of the total for all end-use sectors. Key to a significant portion of this urban sustainable energy

potential is increased electrification in end uses (electricity is the largest urban energy carrier in the 2DS by 2050), such as through heat pumps and electric vehicles, coupled with a decarbonised power sector.

Figure I.2

Carbon emissions reductions in the buildings and transport sectors, 2013-50



Key point

Urban areas are key to decarbonising the buildings and transport sectors.

The way new cities in emerging economies are going to be built is crucial to make the 2DS a reality.

In emerging economies, urbanisation can increase access to modern energy services and potentially improve standards of living. In the 6DS, about 90% of the growth in urban primary energy demand (256 EJ) between 2013 and 2050 will take place in cities in non-Organisation for Economic Co-operation and Development (OECD) economies, with even larger shares in the 4DS and 2DS. In parallel, energy-related CO₂ emissions from urban energy use would almost double. However, cities in emerging economies can avoid the lock-in of carbon-intensive urban design characterising many single-use and low-density urban centres in OECD countries while providing access to modern energy services and a wide range of other sustainability benefits to their citizens. In the 2DS, the urban primary energy demand of non-OECD countries grows by about 40% between 2013 and 2050, yet the carbon intensity of their cities is significantly reduced while their urban economies more than quadruple.

Though no one-size-fits-all solution exists to ensure urban energy sustainability, compact and dense urban development is a structural prerequisite to many of the sector-specific options for carbon emissions reduction.

The built environment can lock the energy system of a city into either inefficient or sustainable energy-use patterns for decades. For instance, urban form and density can create the premises for reduced demand for mobility and for greater efficiency of energy use in buildings, including the opportunity to integrate low-carbon district heating and cooling networks with heat generated by low-carbon fuels or waste heat from industrial plants. Urban form that incorporates, for instance, mixed-use and public-transport oriented developments, as well as size, density, maturity, economy and the local policy-making capacities of urban areas will heavily influence the appropriate choices of policies and technologies required to meet 2DS goals, but pathways exist to enable sustainable urban energy transitions in all circumstances.

Box I.1

ETP 2016 country case study: The role of cities in the Mexican sustainable energy transition

With the official goal of reducing carbon emissions by 50% below 2000 levels by 2050, Mexico has embarked on a very ambitious sustainable energy transition that requires an accelerated low-carbon deployment in all sectors. The 2DS for Mexico shows that this path is achievable with existing or near-commercial technologies and that it can also provide important additional benefits, such as reducing air pollution and traffic congestion. A fast roll-out of a portfolio of technology options will help to reduce CO₂ emissions in the 2DS by more than half by 2050 relative to the 6DS.

The Mexican 2DS is feasible only if local decision makers can step up their efforts to achieve greater sustainability, including reversing urban development patterns that have led to significant sprawl. About 50% of total domestic transport and 75% of buildings final energy demand were associated with cities in 2013. Such demand would obviously grow with demographic and economic drivers, and, under the 6DS, almost doubles from 2013 to 2050. If left unchecked, direct CO₂ emissions from urban buildings and transport will grow in parallel, increasing by 80%

between 2013 and 2050 with transport accounting for most of this growth. Tackling the growth of individual transport activity with carbon-intensive fuels is crucial for the feasibility of the Mexican 2DS. Reduced demand for urban mobility, a shift to public transport and deployment of low-carbon vehicles in cities would provide more than 60% of the emission reductions in transport in Mexico in the 2DS relative to the 6DS levels by 2050.

Effective policy action to take advantage of the urban decarbonisation potential would enable Mexico to lock in its urban infrastructure to more sustainable paths that could achieve more efficient energy use for decades. For example, metropolitan areas in hot climates that will experience high demand for social housing could set an example by rolling out sustainable social housing programmes with high-efficiency multi-residential buildings. This strategy would allow for the provision of increased thermal comfort but with limited associated energy costs. In addition, federal and state governments should foster greater co-ordination with municipalities so that unsustainable trends such as urban sprawl are reversed.

Cities can enable unique, cost-effective options and synergies to accelerate the decarbonisation of the buildings sector

Urban buildings today account for about two-thirds of final energy consumption in the buildings sector. Under the 6DS, urban buildings energy consumption will grow by as much as 70% over 2013 levels. If the potential for building energy efficiency options is realised in line with the 2DS, urban buildings final energy consumption could be reduced by more than 30% in 2050 compared with the 6DS. At the same time, annual buildings sector direct CO₂ emissions would be reduced by over 50% compared with 6DS levels. The most important levers to achieve such potential are the construction of high-efficiency new buildings, deep energy renovations of existing buildings, and the deployment of energy-efficient space heating and cooling technologies.

The energy demand of buildings is dominated by space heating and cooling demand in cities, but accelerated deployment of low-carbon technologies could help meet or even improve thermal comfort demand while reducing negative environmental impacts. Representing about 40% of global buildings energy use, space heating and cooling continues to be a critical area of needed action in the buildings sector, especially in cities. In particular, space cooling demand will increase significantly in emerging economies; in the 6DS, by 2050 energy demand for space cooling increases more than fivefold in urban areas in non-OECD economies, with even higher growth rates in a few countries, particularly in India where it increases by a factor of 25.

Cities have several key enabling characteristics that provide additional options for reducing energy use in buildings. The potential greater concentration of households in high-rise buildings can provide for lower energy use to meet the same level of end-use services. In addition, the possibility of connecting to district energy networks can provide urban households with a more cost-effective and less carbon-intensive heating and cooling supply than would be available through individual heating systems. Cities also enable the possibility of developing local expertise to supply energy-efficient buildings technologies as well as the benefits of economies of scale due to the concentration of demand. Technology providers can have market access to a large customer base, and urban communities can spread best practices and customer information faster, accelerating technology diffusion.

Local policy makers have the levers available to drastically shape or reshape the built environment. Local authorities can foster decarbonisation of the urban buildings sector through regulatory land-use planning functions by enforcing buildings codes as well as through planning for efficient, low-carbon or zero-carbon district energy networks. National policies can foster and complement urban low-carbon buildings policies in many ways, including through mechanisms affecting the buildings sector as a whole (e.g. by setting minimum performance standards, fiscal policies, etc.) or, more specifically, for urban buildings by introducing sustainable urban land-use planning frameworks coupled with capacity-building initiatives for local planners.

Gathering information is also essential to understand where to prioritise actions so as to get the biggest return. One prerequisite to enable local planning to achieve greater sustainability of building energy use is understanding trade-offs between different clean energy solutions, such as whether it is more cost-effective to extend an existing district heating network or to pursue deep building energy retrofits. For example, as local planners assess renovation packages for existing buildings stock and determine the point at which deeper renovations are no longer cost-effective, that information will help to guide the effectiveness of buildings policy targets. Capacity for data gathering and analysis is, therefore, crucial to ensure that decisions can be made with a full understanding of the opportunities, challenges and trade-offs among the various solutions.

Urban transport systems can lead the low-carbon transition in mobility

Cities are the main drivers of global mobility demand as a result of direct passenger transport activity within and among urban areas, as well as indirectly through freight activity needed to meet the demand for goods of city residents. Urban transport activities accounted for about 40% of total transport energy use and total well-to-wheel greenhouse gas emissions in 2013. In addition, a significant portion of non-urban transport activity results from the material and product demand of urban businesses and households. Different regional patterns of urban mobility will, in turn, determine the range of options available to increase the energy sustainability of urban transport. For instance, in OECD countries, most urban mobility currently takes place with personal light-duty vehicles, so a shift from personal transport to public transport, walking and cycling is vital to achieve the 2DS in transport. The role of public transport is equally relevant in non-OECD economies to avoid sprawl and the associated high share of personal transport characteristic of some cities of the developed world.

Many opportunities exist in cities to curb transport-related carbon emissions by reducing trips and trip distances, shifting activity to public transport, and progressively adopting more efficient, low-carbon vehicles. In the 2DS, urban areas can directly deliver nearly half of the energy savings and two-fifths of the emissions reduction of the transport sector compared with the 6DS by 2050. Higher vehicle efficiency and low-carbon fuels are necessary pillars for the decarbonisation of urban transport; together they

provide about two-thirds of the emissions reduction potential. “Avoid” and “shift” options in urban areas would deliver 36-39% of the emissions reduction in urban transport (and about 15-16% of the total for transport), which highlights the strategic relevance of urban planning and municipal travel demand management (TDM) policies for the 2DS.

The benefits of less energy- and carbon-intensive urban mobility go beyond the emissions reductions that can be realised in cities. Low-carbon mobility can leverage additional local sustainability benefits such as reduced air pollution, decreased congestion and increased safety. In addition, cities are also important test beds for the penetration of advanced transport technologies such as new mobility concepts like “Mobility as a Service” or the incorporation of information and communication technologies (ICTs) into urban transport (e.g. as a means of integrating public transport services across modes or even with the eventual advent of autonomous vehicles). Moreover, urban driving is well suited for the deployment of battery electric vehicles (BEVs) through conventional ownership models, car-sharing, or dynamic ride-sharing programmes. The urban environment can provide a suitable niche for BEVs due to lower range requirements and the potential availability of a concentrated network of public charging points.

Local policy makers have many levers available to increase the sustainability of urban transport with the appropriate enabling environment. Local authorities should implement TDM measures that support the uptake of non-motorised (cycling, walking) and public transport in parallel with accelerated diffusion of electric vehicles, including electric two-wheelers, public taxi and bus fleets, and light commercial vehicles (for freight deliveries and other municipal services such as waste collection and postal services). Pricing policies (e.g. congestion charging, cordon pricing and tolls), regulatory policies (e.g. access restrictions and registration caps), and investments in and subsidies to public transport and non-motorised mobility are examples of municipal measures that need to be aggressively rolled out to meet the 2DS in urban transport. The potential of local policies to decarbonise urban transport will depend on the ability to leverage national policies that provide the appropriate pricing signals – most importantly strong personal vehicle and fuel taxation regimes – as well as national frameworks that enable sustainable transport planning (and, in particular, transport integrated with land use).

Urban low-carbon energy supply and smart urban energy networks can provide many potential benefits at both the local and national levels

Renewable energy sources located in urban areas can make an important contribution to meeting the energy needs of cities while at the same time increasing urban energy resilience and retaining economic value within urban communities. Among renewable energy sources that can be deployed in urban areas, rooftop solar photovoltaics (PV), municipal solid waste (MSW), and sewage and wastewater gas are often already cost-effective today and can play a relevant role in covering the electricity, heating and cooling needs of cities. Though the potentials from MSW, sewage, and wastewater gas are not large on absolute scales (e.g. equivalent to less than 4% of urban electricity needs in 2050 in the 2DS), these energy resources can provide relevant cost savings for waste and water treatment services provided by cities.

Rooftop solar PV can make a significant contribution to meeting electricity demand in cities. The technical potential for rooftop solar PV could provide up to 32% of urban electricity demand and 17% of global total electricity demand in the 2DS by 2050.

Taking into account the competition with alternative generation options, around 5% of the urban electricity needs would be cost-effectively covered by urban rooftop solar PV in 2050 in the 2DS. The urban solar PV potential is larger in small cities, due to their lower density. These small cities, however, are often least prepared for realising this potential. National and regional governments can play a critical role here in supporting cities by addressing the lack of data and limited financial resources and expertise as well as governance capacity.

Cities can decrease the carbon footprint of their thermal demand by reusing excess heat from industrial plants located in the proximity of urban areas. The cost-effectiveness of using industrial excess heat (IEH) in cities depends on local conditions such as the existence of thermal distribution networks and the quality of the heat source among others. The global technical potential of medium- and high-temperature IEH that could be recovered from energy-intensive industries would be equivalent to 2% of current industrial final energy use or to 3% of urban buildings energy use by 2050 in the 2DS. Regionally, cities in developing countries have an important opportunity, since 80% of the identified IEH potential lies in non-OECD economies. To increase IEH recovery, policy frameworks should encourage process integration techniques in industrial sites and foster the mapping of local energy resources and urban demands.

System integration of distributed energy services in cities can allow accelerated penetration of distributed energy sources and peri-urban renewable sources, increasing the resilience and security of both urban and national energy systems. In a global scenario characterised by a high build-up of variable renewables and distributed generation (DG), smarter urban energy infrastructure is an important prerequisite for achieving the 2DS, providing additional non-climate benefits at the national level (Box I.2). The monitoring and control potential from ICT should be incorporated into urban grid planning. In areas with significant heating demand and where much urban infrastructure remains to be built (e.g. China), low-temperature district heating networks can provide a venue for greater system flexibility of national grids.

Box I.2

The benefits of smart urban energy networks for national energy systems

Smart urban energy networks can leverage the combined potential of DG and integrated urban energy grids to provide increased flexibility to the national energy system. Smart, ICT-enabled distributed energy resources (including energy storage) within urban smart energy networks can provide a range of technical services, allowing grid operators to better plan and operate national power systems and, in turn, increase the hosting capacity for renewable and decentralised energy technologies at lower cost.

The benefits of smartening urban energy networks are not confined to power systems: integrating power, heat and fuel networks can increase the utilisation of the system, reduce total costs and offer the national electricity system greater flexibility. For instance, a district heating network can link power and heat production

and consumption locally, providing operational flexibility to accommodate periods of excess or scarce variable renewable generation in the national grid. Overall, the greater flexibility provided by such urban power-to-heat systems can not only balance variable renewable generation in the national system but also provide local balancing and other system services to support the integration of distributed energy sources.

By enabling a more distributed system where energy is produced and consumed locally, smarter integrated urban energy grids can reduce the need for investments in national energy infrastructure (including less stringent requirements on reserve capacity or transmission infrastructure). More broadly, they can also enhance energy security through greater redundancy and resilience to external shocks.

New, innovative business models are needed for effective system integration at the urban level. Examples of innovative business models are “micro-grids as a service” or the various existing models that turn consumers into producers and “prosumers”, enabling a wide range of benefits at the local level, including reduced environmental impacts, reduced energy costs for urban communities, increased energy access and greater security of supply. National and local policy makers need to work together to enable these synergies and take advantage of the benefits of smarter urban energy networks, both at the local and national levels (Box 1.2).

Mobilising the urban sustainable energy potential requires strong support from national governments to local policy makers

A large part of the potential energy savings and carbon emissions reduction offered by cities will remain untapped unless policy action is stepped up. Early, co-ordinated and effective actions are required to avoid locking in inefficient energy systems; once constructed, buildings, roadways and public transport systems will be in place for many years. The traditional focus of urban energy policies on meeting the energy service demand of urban citizens and, at the same, reducing local environmental impacts has been significantly expanded in the last few years. Many cities have taken on a broader urban sustainable energy challenge. Over the last 25 years, these cities have adopted a strong leadership and pioneering role in addressing new energy sustainability issues such as climate change mitigation and resilience.

The ability of cities to effectively address local energy sustainability issues can translate into increased opportunities to meet national energy policy goals. The capacity of cities to reduce and decarbonise end-use demand as well as to foster urban energy supply is a strategic enabler for national policies. First, smarter urban energy networks can provide for greater flexibility of the broader energy system, which in itself is a pillar for energy security and affordability. Second, reduced air pollution and traffic congestion are translated into lower costs for national health care systems and into increased productivity for national economies. Third, greater urban energy resilience to external shocks such as extreme weather events is also a prerequisite for the strengthened energy security of the national system.

Cities can also be strategic demonstration labs for innovative energy technologies and business models, but engagement from local and national decision makers is crucial to provide the right enabling frameworks for supporting the urban “innovation mine”. Urban energy systems can provide the ideal niches for innovative energy technologies (e.g. electric vehicles, building-integrated PV) to progress from the demonstration phase through deployment to commercial maturity. Accelerated technology diffusion also brings new opportunities as well as needs for new business models. Local and national policies have many levers to support the change spurred by innovative technologies and business models, but the fast pace of such change requires significant flexibility and responsiveness.

Several policy mechanisms that effectively pursue urban energy sustainability are available to local governments. Some of these policy levers can address local energy sustainability from a more holistic perspective. For example, leveraging the role that compact urban forms can play in the global sustainable transition will depend significantly on a strong capacity to implement integrated landuse and transport planning. In addition, sustainable urban energy plans have been widely adopted across thousands of cities around

the world. Innovative finance mechanisms (e.g. the Property Assessed Clean Energy mechanism) and governance approaches (e.g. the Sustainable Energy Utility model) have also shown their potential to address many barriers to tapping into the local sustainable energy potential. However, the ambition and effectiveness of these policy approaches are a function of the human, legislative and financial capacity of the municipal administration, which often lacks such capacity even in areas traditionally within its domain such as land-use and transportation planning.

National governments can successfully drive local energy transitions through a combination of enabling frameworks and regulatory approaches. National public decision makers can enable cities to pursue local energy sustainability ambitions in many ways, including: instituting capacity-building programmes for local planners; extending legislative powers on local taxation, land-use and transport planning; and making available dedicated funding schemes for urban infrastructure investments. National policy makers can also introduce mandatory requirements for cities to introduce urban sustainability plans and energy efficiency minimum standards for municipally owned buildings and public transport fleets. Furthermore, in many countries, national fiscal legislation can constrain urban sprawl by setting specific provisions for local land development and use fees as well as property taxes that provide strong financial incentives for compact and dense development.

No single template exists; policy makers need to choose the appropriate mix of successful strategies and solutions according to the specifics of cities and countries. In non-OECD economies, where significant urban infrastructure still needs to be built, a vast opportunity exists for “positive” (low-carbon) lock-in. Capacity building and financial assistance are crucial for cities in emerging economies – and national governments, multilateral development banks, NGOs and international organisations all have a strategic role to play in supporting cities that still have to build significant new energy infrastructure. OECD countries, on the other hand, must work on reducing the carbon footprint of their existing infrastructure – for example, through the retrofitting of commercial and residential buildings and reserving road lanes for bus rapid transit systems. Lastly, another important role for OECD countries is to explore and pilot new financial mechanisms and governance approaches that can generate examples of best practices for emerging economies.

Box I.3

Recommendations to national policy makers

While recommended actions for decision makers in different domains such as government or industry and at different levels (national, local) are provided in each chapter of ETP 2016, the following high-level recommendations aim to summarise the main “entry points” for national policy makers seeking to foster the sustainable energy potential of cities:

- Better alignment of regulatory frameworks with technological innovations will support the uptake of new technologies and innovative business models in urban energy systems.
- The capacity of local governments to implement effective sustainable energy policies should be increased, including extending the legislative power of municipalities where appropriate.
- Extending the ability of cities to generate revenue and access financing at lower cost will support their efforts to undertake sustainable energy programmes and infrastructure projects.
- The ability of local officials to implement integrated land-use and transport planning and sustainable energy planning should be supported through nationally funded capacity-building programmes that, in turn, will greatly benefit from the experience of international organisations.
- Where not already present, establishing institutional clearing houses will enable stronger dialogue and co-ordination between the national and local government levels as well as with other energy stakeholders on such issues as identifying challenges to accelerating urban energy transitions and discussing novel solutions.

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Cities drive economic growth but can also drive sustainable change. As the share of the world's population living in cities rises, ambitious action in urban areas can be instrumental in achieving long term sustainability of the global energy system – including the carbon emission reductions required to meet the climate goals reached at COP21 in Paris. Support from national governments is a strategic prerequisite for leveraging the potential for sustainable energy technology and policy in cities that too often lies untapped.

With global energy demand set to become even greater over the coming decades, *Energy Technology Perspectives 2016 (ETP 2016)* looks at the technology and policy opportunities available for accelerating the transition to sustainable urban energy systems. Such potential could be the key to successfully driving an energy transition that many still think impossible, provided that local and national actions can be aligned to meet the sustainability objectives at both levels. Indeed, policies still have a long way to go in this regard: *ETP 2016* presents the annual *IEA Tracking Clean Energy Progress* report, which finds once again that despite some notable progress, the rate of needed improvements is far slower than required to meet energy sector sustainability goals.

By setting out sustainable energy transition pathways that incorporate detailed and transparent quantitative analysis alongside well-rounded commentary, *ETP 2016* and its series of related publications have become required reading not only for experts in the energy field, policy makers and heads of governments, but also for business leaders and investors.

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