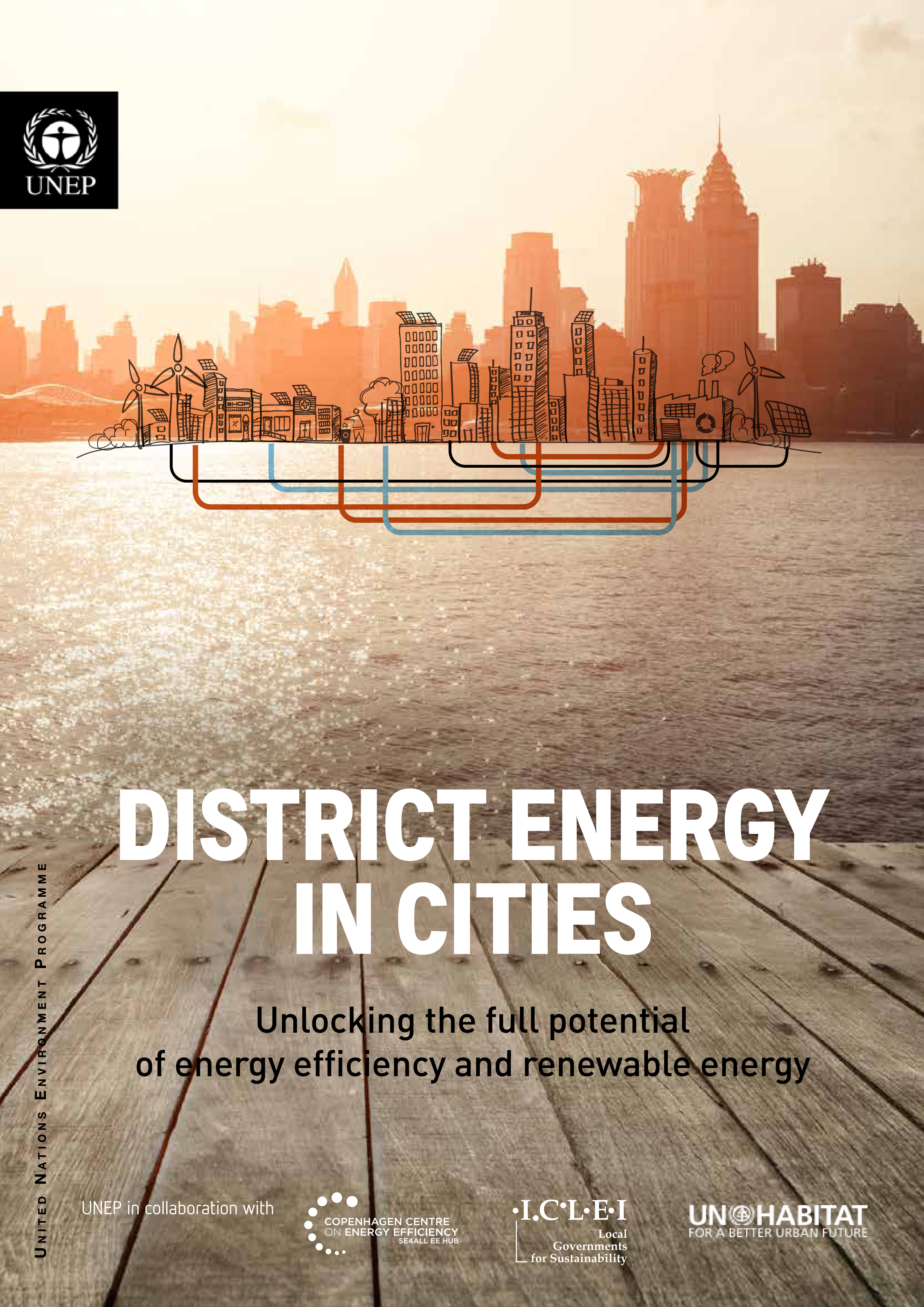


UNEP

DISTRICT ENERGY IN CITIES

Unlocking the full potential of energy efficiency and renewable energy

UNITED NATIONS ENVIRONMENT PROGRAMME

UNEP in collaboration with

COPENHAGEN CENTRE ON ENERGY EFFICIENCY
SE4ALL EE HUB

I·C·L·E·I
Local Governments for Sustainability

UN-HABITAT
FOR A BETTER URBAN FUTURE

WHY DISTRICT ENERGY?

Accelerating the uptake of energy efficiency and renewable energy in the global energy mix is the single biggest contribution to keep global temperature rise under 2 degrees Celsius (°C) and to reap the multiple benefits of an inclusive green economy. Cities account for over 70 percent of global energy use and, 40 to 50 percent of greenhouse gas emissions worldwide. Half of cities' energy consumption is for heating and cooling. Any solution for the climate and energy transition must explicitly address sustainable urban heating and cooling, as well as electricity. One of the least-cost and most efficient solutions in reducing emissions and primary energy demand is the development of modern (climate-resilient and low-carbon) district energy in cities. To facilitate this energy transition, UNEP has initiated a new initiative on District Energy in Cities, as the implementing mechanism for the SE4ALL District Energy accelerator (see Figure 1).

This advanced summary of the forthcoming UNEP publication, ***District Energy in Cities: Unlocking the Full Potential of Energy Efficiency and Renewable Energy***, in collaboration with the Copenhagen Centre on Energy Efficiency (C2E2), ICLEI (Local Governments for Sustainability) and UN-Habitat, is the first of a series of guidance documents and tools within the new District Energy in Cities Initiative.

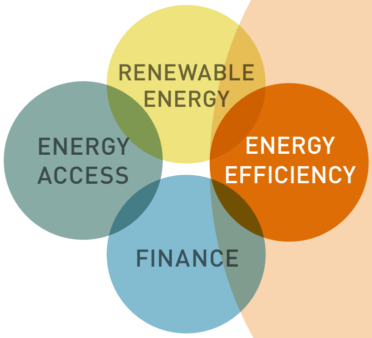
FIGURE 1. THE ROLE OF "DISTRICT ENERGY IN CITIES INITIATIVE" IN SE4ALL

SUSTAINABLE
ENERGY FOR ALL

SE4All is a global multi-stakeholder partnership, led by the UN Secretary-General and the President of the World Bank, which has three interlinked objectives for 2030:

- Ensure universal access to modern energy services
- Double the global rate of improvement in energy efficiency
- Double the share of renewable energy in the global energy mix

Sustainable Energy for All (SE4All) Sub-Committee's



Co-chairs:
- UNEP Executive Director
- CEO Accenture
- Minister for Trade and Development Cooperation, Denmark

Global Energy Efficiency Accelerator Platform: to scale up efficiency gains and investments at the national, sub-national and city levels through technical assistance, support and public-private sector collaboration

Individual accelerators focus on specific energy efficiency sectors

- Buildings
- Transport
- DISTRICT ENERGY
- Lighting
- Appliances & Equipment

Modern district energy systems combine district heating, district cooling with combined heat and power (CHP), thermal storage, heat pumps and/or decentralised energy. They are increasingly climate resilient and low carbon, allowing the:

- Recovery and distribution of surplus and low-grade heat and cold to end-users (e.g., previously unused waste heat from industry or power stations, waste water and use ofnatural water reserves such as lakes, rivers);
- Storage of large amounts of energy – such as surplus wind power or surplus heat in the summer – at the lowest cost compared to other energy storage options; and
- Integration and balancing of a large share of variable renewable power – for example, through conversion to heat and stored for use seasonally or during peak thermal demand.

A transition to low-carbon district energy systems could avoid over 35 gigatons of carbon dioxide (CO_2) emissions at low cost by 2050 – equivalent to 58 per cent of the global CO_2 emissions reductions required to keep the global temperature rise to 2-3°C. Modern district energy systems could result in a 7 per cent reduction in overall capital investment in the power sector by 2030 – an investment savings of US$795 billion by replacing the use of electricity for heating and cooling and thereby reducing peak and overall power demand.

District energy has been deployed for many years in several markets, increasingly in those countries or cities that aim to replace fossil fuels in space heating, hot water and

The **DISTRICT ENERGY IN CITIES INITIATIVE** is viewed as the implementing mechanism of the District Energy Efficiency Accelerator. UNEP and Danfoss are co-leads, ICLEI and UN-Habitat are lead partners. Through a multi-stakeholder partnership model in two phases the project will support:

DEMONSTRATION:

Technical assistance and capacity building to 1-2 cities to concretely demonstrate how to develop and implement a replicable district energy approach.

SCALE UP:

Provide tailored assistance to other targeted cities using the district energy modules from the UNEP publication “District Energy in Cities: Unlocking the Full Potential of Energy Efficiency and Renewable Energy.”

- stimulate the uptake of district energy in cities around the world to contribute to climate change mitigation efforts
- empower climate and energy action planning and the green economy for resilient urban futures
- develop integrated district energy policy and investment roadmaps with interested local governments
- address investment barriers through a policy-finance continuum bridging approach involving private sector partners and financing institutions

This initiative aims to support cities and sub-national/national governments to develop, retrofit or scale up district energy systems. 19 cities in various geographical regions have recently expressed their interest to join the new Global Initiative in support of the SE4ALL Accelerator on District Energy. Private sector companies and industry associations such as Danfoss, Grundfos, Siemens, Vattenfall, Veolia, Climespace, Empower, the International District Energy Association, Euroheat and Power, Global Wind Energy Council, World Bioenergy Association and World Wind Energy Association commit to contribute technical and technological expertise. Networks like ICLEI – Local Governments for Sustainability and Energies 2050 commit to share their experience with urban multi-stakeholder engagement and project implementation. International organisations like UNEP (including with support from the Copenhagen Centre on Energy Efficiency), UN-Habitat, the International Energy Agency, and the U.S. Department of Energy are interested to join the initiative to support policy and partnership development for the district energy accelerator.

Donors and the international community are invited to support this new initiative and project implementation in cities.

cooling. Shares are significant and growing, such as 12 per cent of heat demand in Europe, 23 per cent in China and 50 per cent in Russia. In a number of European cities, nearly all of the required heating and cooling is supplied via district networks. The largest district cooling capacity is in the United States at 16 gigawatts-thermal (GWth), followed by the United Arab Emirates at 10 GWth and Japan at 4 GWth. In South Korea, district cooling more than tripled between 2009 and 2011.

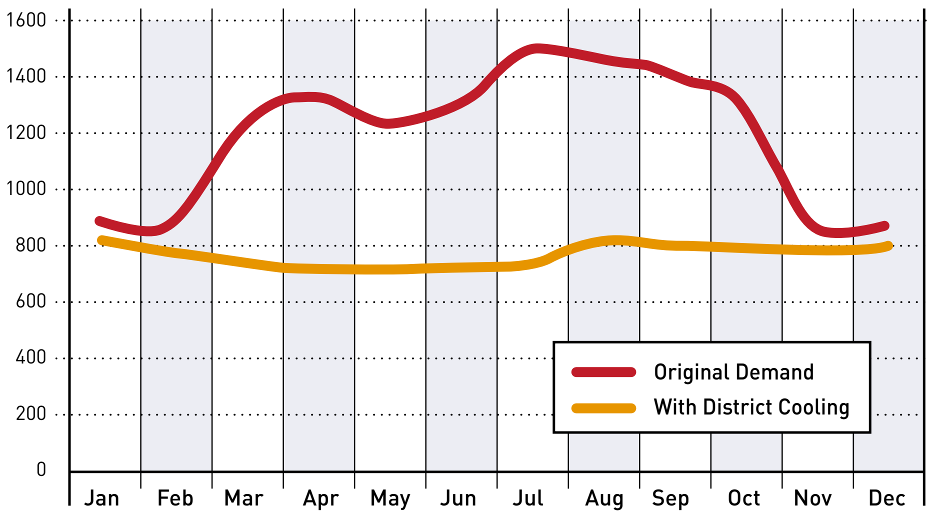
The full potential of modern district energy systems remains largely untapped and limited to a handful of countries.Significant opportunities exist for growth, refurbishment and new development. For example, 60 per cent of the networks in Russia need repair or replacement; China's largely coal-fired boilers are undergoing modernization; and, in the Gulf countries, district cooling could provide 30 per cent of forecasted cooling needs by 2030,avoiding 20 gigawatts in new power capacity and 200,000 barrels of oil equivalent per day in fuel.(See Table 1)

TABLE 1. DISTRICT COOLING EFFICIENCY PERFORMANCE

SOLUTION	Energy Efficiency Ratio	Primary Resource Factor
Conventional building-bound solution		
Conventional residential air conditioning and commercial air conditioning	1.5 to 3.5	1.7 to 0.7
Conventional chillers combined with aquifers	3 to 6	0.8 to 0.4
District cooling solution		
Industrial chillers with efficient condenser cooling and/or recovered heat to DH	5 to 8	0.5 to 0.3
Free cooling/industrial chillers	8 to 25	0.3 to 0.1
Free cooling	25 to 40	0.1 to 0.06
Absorption chiller driven from surplus heat or renewable source	20 to 35	0.13 to 0.07

Source: Adapted from: Euroheat&Power, Cooling More With Less, 2006

"Where applied, district cooling takes away the summer peak demand in electricity. Although district cooling needs electricity as a driving force itself, the demand for electricity per unit cooling delivered is much lower than with traditional local cooling production."



Source: International Disctrict Energy Association

Policymakers in many countries and cities, recognising the multiple benefits of district energy systems, have set targets and strategies to advance their use and deployment. To facilitate these efforts, the new Global Initiative on District Energy Systems aims to concretely demonstrate and develop replicable district energy approaches for growth, modernization and new development (see Figure 1).

POLICY OBJECTIVES

In 2013, UNEP initiated research and surveyed low-carbon cities to identify the key factors underlying their success to scale up energy efficiency and renewable energy, and to attain targets for zero or low greenhouse gas emissions. District energy systems emerged as a best-practice intervention to provide a local, affordable and low-carbon energy supply – and represented a significant opportunity for other cities to move towards climate-resilient, resource-efficient and low-carbon pathways.

Through district energy infrastructure, the cities were pursuing the following key policy objectives:

- **Reduce greenhouse gas emissions:** Achieve rapid, deep and cost-effective emissions reductions, with reduction of primary energy consumption by 30-45 per cent.
- **Improve air quality:** Address indoor and outdoor air pollution and their associated health impacts, by reducing coal and oil consumption.
- **Improve energy efficiency:** Achieve operational efficiency gains of up to 90 per cent, by using district energy infrastructure to link the heat and electricity sectors.
- **Local and renewable resources:** Harness local energy sources, including from waste streams, reject heat, natural water bodies and renewable energy. Pilot new technologies, such as thermal storage, to integrate renewables.
- **Resilience and energy access:** Reduce import dependency and fossil fuel price volatility. Manage electricity demand and reduce the risk of brownouts.
- **Green economy:** Achieve savings from avoided or deferred investment in generation infrastructure and peak power capacity. Create wealth through reduced fossil fuel bills and generate local tax revenue. Create jobs for design, construction, operation and maintenance.

The forthcoming UNEP publication on district energy draws on 40 city case studies to identify the various policy, finance and technology applications of district energy systems in different social and political contexts worldwide. It explores how local governments have overcome barriers in implementing such systems and the lessons learned for successful replication and scale up. Table 2 provides a snapshot of five cities (of the forty surveyed) around the world that have integrated renewable energy and energy efficiency through district energy systems.

OVERCOMING KEY CHALLENGES AND CAPTURING OPPORTUNITIES

Local governments are uniquely positioned to advance district energy systems in their various capacities: as planners and regulators, as facilitators of finance, as consumers and/or providers of energy, and as role models and advocates. Planning guidance and regulations are critical to create the conditions for technical and financial viability, market demand and reduced capital investment risk – as demonstrated by 96 per cent of the case-study cities.

Cities need to address diverse barriers and challenges to enable the deployment of modern district energy systems. The best strategic policy response will depend on local conditions, including a city's social, economic and environmental objectives; market structure; population density and size; availability of capital; credit rating; local expertise; existing infrastructure; and energy mix.

Twinning between cities – matching champion ones with learning ones – will be a key component of the new district energy initiative to transfer and scale up lessons learned and best practices. The following is a summary of some of the main barriers common to cities, and the lessons learned. The forthcoming UNEP publication on district energy provides more detailed guidance on responses to different barriers given different city conditions; see also Figure 2.

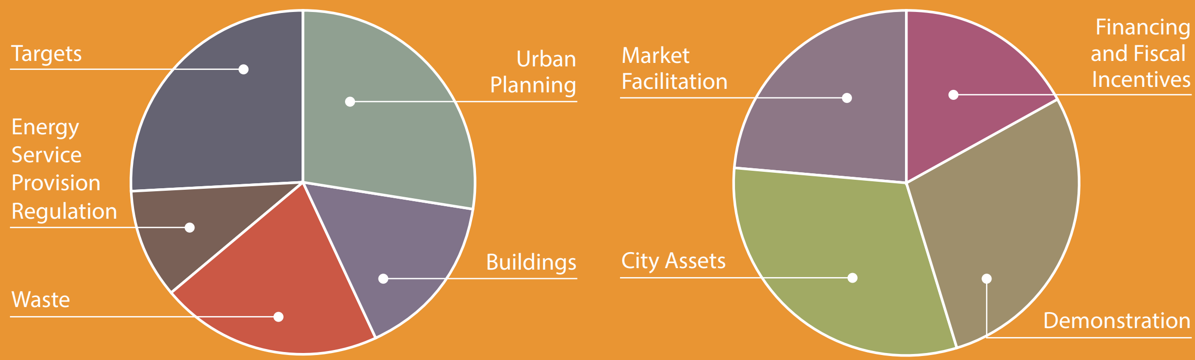
TABLE 2. FIVE EXAMPLE CITIES WORLDWIDE THAT HAVE ADOPTED DISTRICT ENERGY TARGETS AND/OR STRATEGIES

CITY AND COUNTRY	COPENHAGEN, DENMARK	DUBAI, UNITED ARAB EMIRATES	FRANKFURT, GERMANY	HELSINKI, FINLAND	HONG KONG, CHINA
CO_2 EMISSIONS REDUCTION TARGET	20% by 2015 (from 2005 base); carbon neutral by 2025	20% reduction of CO_2 emissions from buildings by 2030	40% by 2020; 95% by 2050	20% by 2020 (from 1990 base); carbon neutral by 2050	Reduce carbon intensity 50%-60% by 2020 (from 2005 base).
RENEWABLE ENERGY AND/OR ENERGY EFFICIENCY TARGET	By 2025: 100% renewable energy supply, 20% reduction in heat demand, 20% reduction in power consumption in commercial/service companies.	30% reduction in energy demand by 2030. 5% renewable electricity by 2030.	100% renewable energy supply by 2050, while reducing demand.	20% share of renewables in energy production in 2020 (up from 7% in 2013).	By 2020, reduce coal to less than 10% of the electricity generation mix. By 2030, phase out existing coal plants; reduce energy intensity by at least 25% (from 2005 base).
DISTRICT ENERGY-RELATED GOALS	By 2025, 100% share of renewable energy and waste incineration heat in the district heating system (up from 35% today) By 2016, ban oil-fired installations in existing buildings where district heating (or gas) is available.	By 2030: Meet 40% of cooling capacity through district cooling (up from 20% in 2011). Use district cooling in all new developments. Incorporate thermal energy storage into all new district cooling plants, with a capacity of at least 20% of the design capacity of the plant.	Expansion of district energy network and integration of renewable energy. Biomass and bio-methane CHP.	By 2015, cooling capacity of over 200 MW. By 2020, expand cooling to new residential areas.	Expand use of district cooling such that by 2020 up to 20% of all commercial buildings will be up to 50% better in refrigeration performance compared with buildings using regular air conditioners.
FEATURES	Climate-neutrality target. District heating systems/CHP as cornerstone of energy policy to integrate renewables.	Use of effluent water instead of fresh water. Reduced investment in power infrastructure.	100% renewable energy target.	District Heating, Cooling and Power; utility-set target.	Reduced consumption of coal and power for cooling.

FIGURE 2. KEY POLICIES USED TO PROMOTE DISTRICT ENERGY

CITY AS PLANNER AND REGULATOR
REGULATION BASED ON LEGAL RESPONSIBILITIES AND JURISDICTIONS

CITY AS FACILITATOR
ENABLING ACTIONS TO LEVERAGE FINANCE



Lack of municipal control over the energy sector

"Many cities are frustrated by the fact that they don't have their own utility and are beholden to the state-run energy company. What is so great about a district approach is that every local government can use their land-use authority to influence energy supply mix." Chris Baber, City of Vancouver, Canada

When local governments do not have regulatory powers in the energy sector, or do not have a stake in a local utility, they can incorporate energy-supply or efficiency requirements into planning, land-use and procurement policies, as has been done in Amsterdam (the Netherlands), the Greater London Authority (U.K.), Seoul (South Korea) and Tokyo (Japan).

Lack of capacity and public acceptance

"Capacity building and raising awareness in the investor community and in the public will lower perceived risk to improve the bankability of district energy projects." Maryke Van Staden, ICLEI

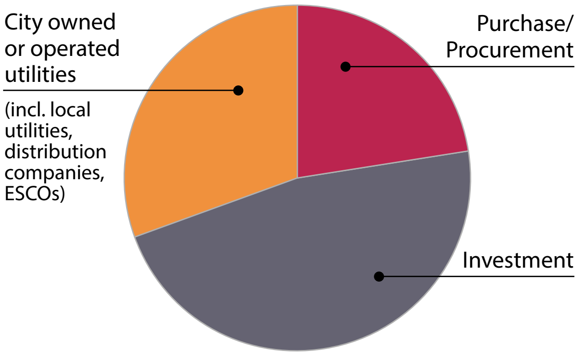
Raising overall awareness and technical understanding of district energy applications and their multiple environmental and socio-economic benefits at a local level is critical in order for city authorities to engage with the market as an "intelligent client" and to manage feasibility analyses, project and policy development, stakeholder engagement business models and public acceptance – all critical to build the trust of potential users. Capacity building examples include Milan's designated "help desks", the Greater London Authority's Sustainable Energy Delivery Unit and Frankfurt's Energy Agency. Other approaches include partnering with the private sector to leverage their expertise (e.g., Anshan, China) and developing demonstration projects (e.g., Vancouver, Canada).

Coordination and cooperation between multiple stakeholders and interests

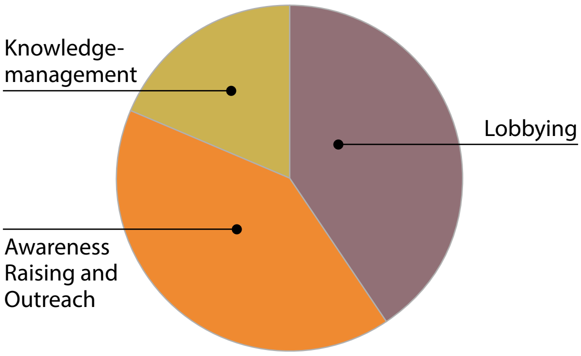
"Mapping is one way to bring the different stakeholders together: it can be used not only to inform the planning process, but also for marketing, engagement, and business development." Frodo Bosman, City of Amsterdam, the Netherlands

A strong – often public – champion is required to develop a customer base and ensure a rules-based permitting process. Local governments can establish a coordination structure to ensure integrated, holistic planning. Cities can also develop energy maps to visually communicate opportunities and bring together the different partners for business development. In Amsterdam, energy mapping was used to establish cooperation among various industrial partners on the exchange of energy and use of excess waste heat from data centres.

CITY AS CONSUMER AND SERVICE PROVIDER
OPERATION OF MUNICIPAL INFRASTRUCTURE AND SERVICES AND SELF-GOVERNANCE



CITY AS AN ADVOCATE



High cost of feasibility studies

"Cities need access to adequate, available and dispersive sources of early-stage feasibility funding to support sound engineering and design practices that will accelerate project assessment and shorten the development cycle." Rob Thornton, IDEA

A local authority runs high risk if it raises internal money for a scheme that may not proceed and that it may not have the capacity to undertake. Cities such as Tokyo and the Greater London Authority have used their planning authority to place the onus on property developers to undertake feasibility studies. An alternative is an external development grant to finance initial feasibility studies, such as the US$1 million project preparation grant from the African Development Bank for the Sea Water Air Conditioning (SWAC) Project in Port Louis, Mauritius.

De-risking capital investment

"Finance exists. The major barrier is properly structuring projects to get the investment in, not so much the investment itself. We have access to low-interest-rate finance and 'patient' equity, but we need to help de-risk the larger projects that yield reliable, long-term, low returns." Peter North, Greater London Authority, U.K.

For district energy projects, capital is typically invested prior to the connection of customer buildings; thus, the greatest risk in system deployment is load uncertainty. To provide investor security and alleviate financial risks, local governments can use land-use and connection policies (e.g., Ludz, Poland; Amsterdam) or designate district energy high priority and opportunity zones (e.g., Vancouver's Neighbourhood Energy Strategy, Hong Kong's district cooling zones, Singapore's district cooling zone in Marina Bay), whilst incentivizing customers to switch to district energy. To reduce risk and project cost, smaller systems can be interconnected over time as a citywide system, as exemplified in Copenhagen. Local governments can also provide loan guarantees, as in Aberdeen, Scotland, to reduce the costs of finance, particularly for projects that have high public benefit.

Existing market structure and distortions

"The Internal Rate of Return (IRR) has always been used to assess district energy, but really it is purely financial and only of interest to financiers....an economic assessment is what is of interest to the city decision makers – what is in the project for me? What does it provide for the community? Jobs, wealth retention, quality of life, etc." Ken Church, Natural Resources Canada

Modern district energy systems are negatively affected by market distortions (e.g., fossil fuel subsidies). Local governments can reform subsidies or provide financial and fiscal incentives to create a level playing field, or develop a revolving fund to provide low-cost financing of those developments that are in the public interest, with the capital then repaid and redeployed in other projects (e.g., the Toronto Atmospheric Fund (Canada), the Norwegian Climate and Energy Fund).

Multi-level Governance and National Regulations

"Cities will play a critical role in achieving multiple energy policy targets for an efficient, sustainable future. Analysis under the IEA CHP and DHC Collaborative has shown that by aligning local initiatives and national policy frameworks, it is possible to improve market structures in support of flexible, integrated and sustainable energy systems!" John Dulac, International Energy Agency

As with other aspects of the energy transition, a key factor in the successful development of district energy networks is the establishment of an appropriate policy framework. Although many of the specific decisions and measures associated with the establishment of a given system can and indeed must be made at a local level, coherent and coordinated multi-level governance is key to achieving optimal results. City-level action can help translate principles established at a supra-national, national or regional level into practice on the ground.

TABLE 3. MULTIPLE BENEFITS OF DISTRICT ENERGY SYSTEMS IN SELECTED CITIES WORLDWIDE

CASE STUDY (CITY, COUNTRY)	DISTRICT HEATING TECHNOLOGY	CAPACITY/ ENERGY DELIVERY	RESILIENCE, EFFICIENCY AND SOCIO-ECONOMIC BENEFITS	ENVIRONMENTAL BENEFITS
GÜSSING, AUSTRIA	Biomass-based district heating system, using four biomass energy plants and three CHP plants.	Delivers 56 GWh of heat and 22 GWh of electricity.	The system rejuvenated the city, leading to the creation of >1 000 indirect jobs and entry of 50 new businesses. The city also insulated itself against rising oil prices from 1990 to today.	Between 1996 and 2009, the city reduced CO_2 emissions by 40% whilst growing rapidly.
MUNICH, GERMANY	CHP network using natural gas; potential development of 17 geothermic wells.	The SWM network provides around 4 000 GWh of heat per year. It is 800 km long and is being expanded.	High supply security, as district heating is generated at SWM's own plants in Munich. Low primary energy factor helps buildings' energy certification. By 2040, Munich is to be the first large German city with district heating solely from renewables.	1.1 million tons of CO_2 emission reductions annually. Large reduction in local air pollution.
PARIS URBAN HEATING COMPANY (CPCU), PARIS, FRANCE	Cogeneration and waste-to-energy facilities, as well as 36 geothermal district heating networks; district cooling	District energy provides 32% of heat and 17% of electricity. 4 GW of district heat capacity produces 5.5 TWh of heat and 1 TWh of electricity.	Annual business results: € 358 million; benefits: € 19.5 million; dividend for the city: € 2 million annually; concession annual fee: € 7 million or 3% of the company in stock exchange	Waste-to-energy plants enable the avoidance of 800 000 tons of CO_2 emissions annually. CPCU aims to reach 60% renewable or recovered energy in the heat production mix by 2020.
ST. PAUL BIOMASS DISTRICT ENERGY, ST. PAUL, MINNESOTA, UNITED STATES	District heating network (biomass, solar, waste heat, oil, gas and coal) assisted by thermal storage and solar arrays	289 MW of heat. 300 000 tons per year of municipal wood waste displaces 275 000 tons of coal per year.	Keeps US$12 million in energy expenses recirculating in the local economy. Stable, competitive energy prices to customers.	280 000 tons of CO_2 emission reductions annually.
QATAR COOL'S INTEGRATED DISTRICT COOLING PLANT ON THE PEARL-QATAR, QATAR	District cooling system powered by gas that uses treated waste water.	130 000 tons of refrigeration.	165 employees (an almost 100% increase in the last five years); reduced consumption of fresh water, saving money and reducing freshwater demand.	56 580 tons of CO_2 emissions savings in 2012.
HELSINKI DISTRICT ENERGY SYSTEM, HELSINKI, FINLAND	CHP-based network assisted by thermal storage; fuels are natural gas, coal, fuel oil and waste water (wood pellets to be added).	7 200 GWh of heat annually.	Five times more efficient than traditional building-specific solutions.	30 000 tons of CO_2 emissions reductions annually.
OSLO DISTRICT ENERGY SYSTEM, OSLO, NORWAY	Waste-to-energy (49%), electric boilers (31%) and heat pumps.	2 580 GWh of heat delivered.	Employment benefits estimated at 1 375 jobs; more than 500 000 tons of waste recycled annually instead of going to landfill; energy recovery rate of 87%.	Annual reduction in pollution emissions equal to 150 000 cars each driving 15 000 km on Oslo streets. The city expects to achieve its target of a total phase-out of fossil fuels in district heating by 2016.

An example of a multi-level governance approach that can facilitate finance for local district energy projects is the development of v-NAMAs – vertically integrated Nationally Appropriate Mitigation Actions. v-NAMAs support national governments of developing countries in their efforts to mobilize sub-national actors for achieving national CO_2 mitigation targets through cost-effective incentive packages and monitoring, reporting and verification systems (e.g. Indonesia and South Africa).

National regulations are needed to enable third party access to district energy networks, properly value ancillary services such as reserve capacity, grid balancing and voltage support, as well as ensure transparency of energy tariff. This will strengthen the revenue stream for district energy and create more attractive and diverse investment opportunities. The ultimate aim of such regulations is to realize the multiple benefits of district energy systems; see Table 3.

BUSINESS MODELS FOR REAPING THE MULTIPLE BENEFITS OF DISTRICT ENERGY

"[A district energy system] allows city planners and governments to rethink the interaction of energy and the economy as it is exceptionally cost-effective to reduce costly energy wastage and lower the consumption of expensive fuels. At current import prices the direct socioeconomic payback can be as short as 2-3 years." Lars Tveen, President District Energy, Danfoss

Globally, district energy systems have been developed using a variety of business models and ownership structures. Identifying the optimum business model for a city or for a new area in a city will depend on a wide variety of city-specific factors, for example the availability of funding within the local authority budget. Building on the experience of cities that face similar situations and on the experience of the private sector in delivering district energy projects is critical and is the driving force behind the new District Energy in Cities Initiative.

The local authority will always be key for delivering district energy projects, either through direct ownership or by creating the regulatory framework and development opportunities for private sector investment to thrive. A strong financial presence by the local authority enables the district energy strategy to be directed towards social and economic benefits, although such benefits can also be achieved with private sector development. The following are examples of three innovative business models – with varying local authority roles – that provide strong economic benefits for the city, and that municipalities elsewhere could potentially adopt.

ANSHAN, CHINA: public-private joint venture. Through a joint venture between local public utilities and a private sector firm, Anshan is developing a US$64 million highly efficient district heating system, including the use of 1 gigawatt of waste heat recovery from a steel plant, local geothermal sources and CHP plants. Socio-economic benefits include: the equivalent of US$14 million in annual coal savings through 173,000 tons per year in reduced coal consumption; 2 million tons annually of reduced CO_2 emissions; dramatic improvement of local air quality; and improved heating standards (through provision of reliable heat). A fast payback period of three years highlights the significant financial benefits that this project will bring to the city. The presence of the private sector has been key in developing this vision for Anshan's future.

CYBERJAYA, MALAYSIA: private sector concession. A 30-year concession contract developed by the local authority and delivered by Pendinginan Megajana Sdn Bhd, a local energy services company (ESCO), has led to a highly successful district cooling system in the city. Cofely, an international ESCO that works on district energy solutions, has now acquired a 49 per cent stake in Pendinginan Megajana Sdn Bhd, bringing finance as well as more operational experience to the company. The project has cost approximately US$50 million, with an 11.7 per cent internal rate of return over 30 years with a payback period of 8 years. The combination of larger chillers and thermal storage has led to annual cost savings of 39 per cent compared to business-as-usual and has reduced the city's peak electricity load by 3 MW, helping to tackle the growing air conditioning demand in Malaysia (equal to 30 to 50 per cent of buildings' electricity demand).

BUNHILL HEAT AND POWER, LONDON, U.K.: wholly public sector development. Extensive heat mapping initiated by Islington borough council identified heat demand that would be better served by district heating. The council considered connecting to a local private heat network but found that the heat tariff would be too high to meet affordable warmth objectives. The council decided instead to develop the project completely in-house, leading to a 56 per cent reduction in the heat tariff delivered, thus meeting the council's principle objective. In addition, revenues from power sales from the CHP plant allow the council to reduce heat tariffs. By pursuing in-house development, the council now has the expertise to extend the project, incorporating local waste heat in an innovative manner and furthering connecting demand. The project has been funded by the local council, a grant from the city of London (US$4.35 million) and an EU Project Celsius grant (US$1.6 million).

The economic, social and environmental benefits of district energy systems have not always been fully accounted for in technology comparisons. For developing countries specifically, these benefits can include: increased resilience against international fossil fuel prices; improved local air quality; reduced demand on stressed power grids (particularly at peak hours); and cheaper and more stable delivery of energy services. In addition, the long-term nature of district energy investment can mean that it is ignored over simpler, short-term energy solutions that can, in the long term, be the less beneficial option. District energy systems do not necessarily need subsidies (See Table 4), but they do need financial, fiscal or policy support to bring them onto an even playing field with other technologies.

TABLE 4. COST RANGES FOR SELECTED TECHNOLOGIES PROVIDING HEAT TO A DISTRICT NETWORK

SOLUTION	Specific investment cost, in 2015	Typical capacities	Operation and maintenance cost	Fuel price (indicative)	Efficiency	Price of energy produced (single source)	Price of energy produced (two sources)
	Million Euro / MW	MW	% investment cost	euro cents/ kWh of energy in	%	euro cents/kWh of heat out	euro cents/ kWh of heat out
Centralised							
Geothermal (70°C source)	1.6 - 2.0 (very site dependent)	10 - 15 (very site dependent)	2.3 - 2.5%	-	-	8.9	3.6 (base load)
Waste-to-energy district heating plant (waste heat recovery)	1.1	15 - 50	5%	0 - 3.9 (price can be negative)	98%	7.0 (zero fuel price) - 11.0	2.5 - 6.5 (base load)
District heating boiler (wood chips fired)	0.3 - 0.7	1 - 50	1.8 - 3%	0.7 - 2.4,	108%	4.2 - 5.8	1.9 - 3.5 (baseload)
District heating boiler (gas fired)	0.06 - 0.12	0.5 - 20	2 - 5%	2.1 - 6.5	97 - 105%	2.6 - 6.7	3.3 - 7.55 (peak load)
CHP/ waste heat	-	-	-	-	-	1,4	1.4 (base load)
Electrical boilers	0.12 - 0.15	1 - 3	0.5 - 1%	6.4 - 21.0	99%	6.9 - 21.7	7.4 - 22.2 (peak load)
Electrical boilers	0.05 - 0.09	10 - 20	1 - 2%	6.4 - 21.0	99%	6.9 - 21.8	7.4 - 22.2 (peak load)
Heat pump air source	0.50-0.80	1 - 10	0.35 - 0.70%	6.4 - 21.0	280%	5.2 - 10.5	3.3 - 8.66 (base load)
Heat pump ground source (35°C)	0.45 - 0.85	1 - 10	0.35 - 0.70%	6.4 - 21.0	360%	4.7 - 8.8	2.8 - 6.9 (base load)

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"As China's economy continues on a fast track, we have been trying to explore new and sustainable ways of development. Through our recent efforts with Anshan Steel Group to use state-of-the-art technologies in our district energy system and utilize industrial waste heat we have elevated our urban heating system which has now resulted in a win-win-win situation --- our city, citizens, enterprises, energy and environment benefit. This is precisely the direction of sustainability we have long been going after and is the reason why we commend and support the District Energy Accelerator." City of Anshan, Liaoning Province, People's Republic of China

"Local governments are pivotal players in accelerating climate change and sustainable energy solutions and they are taking serious action – even in the absence of national policies. District energy is one of the most effective means of delivering sustainable efficient heating and cooling, while also integrating renewable power, particularly in dense cities like Paris. As a global leader in district energy, the city of Paris looks forward to share its technological experience and expertise with cities worldwide in support of the new District Energy in Cities Initiative and encourages partners to join in on this important effort to accelerate low-carbon district energy systems worldwide." Yann Françoise, Director of Climate and Energy, City of Paris, France

"The District Energy in Cities Initiative is a timely step towards the sustainable cities we need. We strongly support this new initiative and encourage others to join by lending their talents, energy and resources to help district energy realise its potential." Paul Voss, Managing Director, Euroheat and Power

"The U.S Department of Energy is pleased to support this exciting new initiative and to facilitate best practice policy and partnership development for the acceleration of modern district energy and combined heat and power worldwide." Katrina Pielli, Senior Policy Advisor in the Office of Energy Efficiency and Renewable Energy, U.S Department of Energy

DISTRICT ENERGY IN CITIES

Unlocking the full potential of energy efficiency and renewable energy