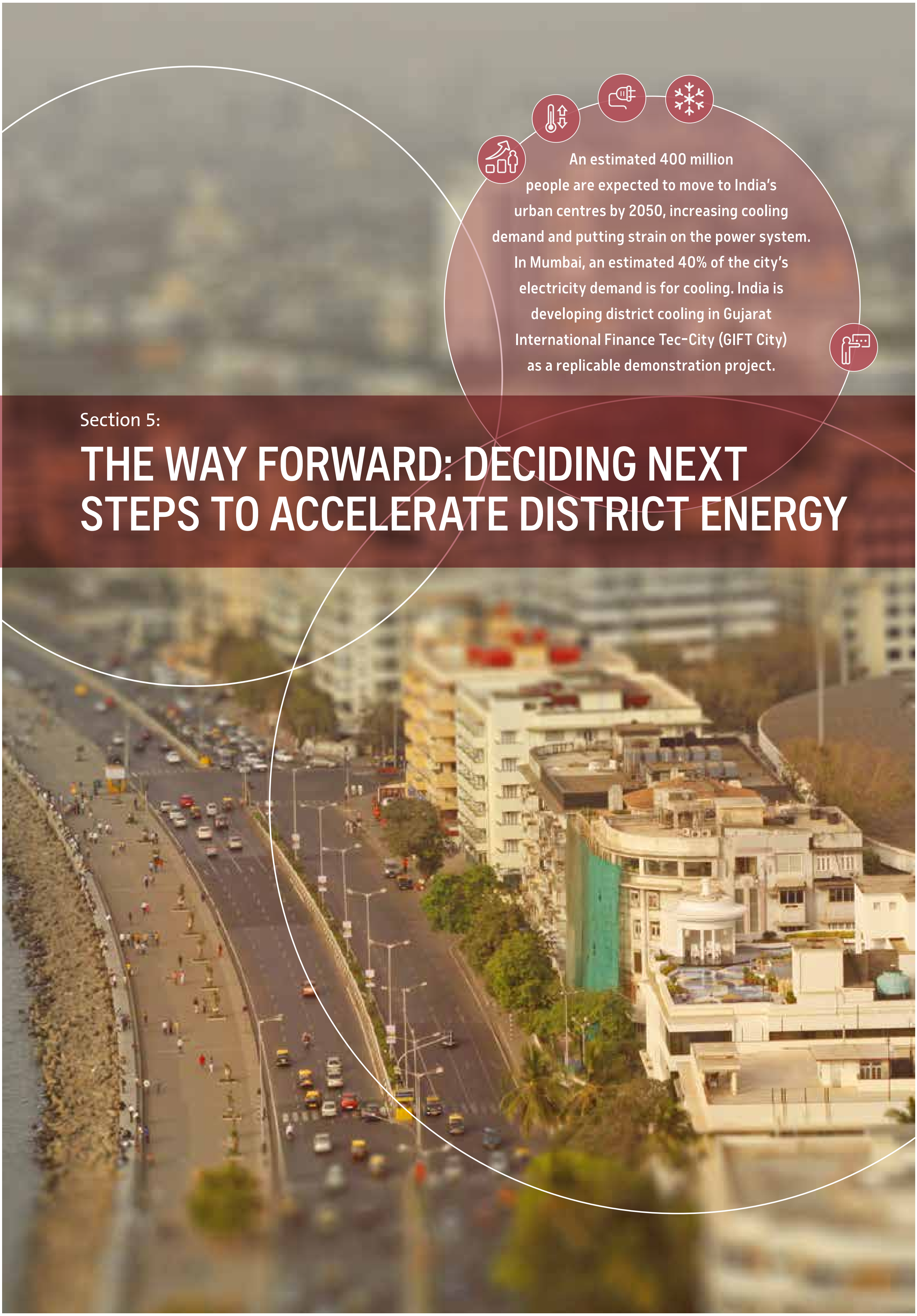


An estimated 400 million people are expected to move to India's urban centres by 2050, increasing cooling demand and putting strain on the power system. In Mumbai, an estimated 40% of the city's electricity demand is for cooling. India is developing district cooling in Gujarat International Finance Tec-City (GIFT City) as a replicable demonstration project.

Section 5:

THE WAY FORWARD: DECIDING NEXT STEPS TO ACCELERATE DISTRICT ENERGY

05

THIS SECTION LOOKS AT

KEY FINDINGS

The decision tree developed as an outcome of this publication will guide cities through the various stages in district energy development and highlight tools and best practices that could be considered based on their local conditions. This section provides an outline of the decision tree and key areas of intervention and action that will be available in the online tool accompanying this publication. This section also outlines a policy and investment road map that comprises 10 key steps to accelerate the development, modernization and scale-up of district energy in cities.

THE DECISION TREE IS SPLIT INTO FOUR BROAD AREAS:

WHY? Why district energy, what is the energy demand and what are the next-available technology costs for district energy deployment?

WHEN? When should district energy be developed, and what are the catalysts that take district energy from vision to reality?

WHAT? What steps need to be taken to begin development of a district energy strategy in the city?

HOW? How can the city foster and develop district energy? How can incentives, policy frameworks, business models and tariff structures best serve district energy in the city?

5.1 WHY?

Diverse cities are exploring district energy as a solution for achieving numerous policy objectives. This section explores the two primary variables for why a city would consider turning to district energy: heating and cooling demand, and costs. Section 5.2 then discusses when a city may take the decision to act on district energy, based on a number of policy drivers.

5.1.1 HEATING AND COOLING DEMAND

Increasing demand for heating and cooling increases the infrastructure and capital budgeting requirements at the city level and nationally. All cities have several pockets of free and local energy sources for heat and cooling that district energy can utilize. District energy has the ability to connect waste energy and to utilize primary energy as efficiently as possible.

If the city has high levels of heat and/or cooling demand, and this demand is distributed such that some areas have significantly high density of demand, then this demand may be best served with district energy. If demand is not high or very few areas of high demand exist in the city, then ambitions for district energy may be smaller.

5.1.2 COSTS OF ALTERNATIVE FUELS AND TECHNOLOGIES FOR HEATING AND COOLING

The current technologies used to produce heat and/or cooling in a city will affect the cost-competitiveness of district energy. For example, natural gas imports from a volatile international market can make electricity and gas bills expensive and uncertain. Rather than a combination of individual gas boilers and gas-fired power stations, gas CHP in combination with district energy (and any waste sources of heat that this district energy can also connect) can reduce a city's gas imports, insulating it to an extent from volatile gas prices. Furthermore, centralized gas production of heat is far easier to fuel switch than individual gas boilers.

If the city is using a high proportion of (cheap or valuable) electricity to meet heating or cooling demand, then district energy is an opportunity to avoid power infrastructure investment (such as power stations and transmission grid) and can alleviate grid demand, particularly at times of stress on the grid. For example, district cooling can significantly reduce the peak electricity load of a city. At peak load, the most expensive power plants will be running, and district cooling can reduce the need for such plants. This is a significant problem in extremely hot cities that have high levels of electricity consumption from air conditioning.

Alternatively, not using electricity for cooling and heating can reduce electricity's cost to users and allow it to be used for more valuable activities such as improving access to electricity in rural areas, exporting to other countries at a higher price or powering industry. In Oslo, despite large local hydro resources, the city decided that it would prefer to use the hydropower to create aluminium rather than heat and cool using electricity.

District energy can allow the production of heat outside of individual homes and in a cleaner, more efficient way, improving local air quality and emissions.

Individual air-conditioning units (top) and gas boilers (bottom) are just two of the technologies that district energy can replace.

5.2 WHEN?

"We celebrated 100 years of district energy at the Toronto University, and the conclusion we came to was that if you own buildings and pay the bills for energy, then you would come up with this solution 100 years ago as they did. The policy challenge for us is how to translate that model to the rest of the city. The way that we have done it is to take multiple approaches – such as mapping potentials and leading by example through demonstrations – that enable us to be ready and nimble to act when it is the right opportunity. The multiple benefits of district energy mean that it can emerge as a solution to multiple crises." *Fernando Carou, City of Toronto, 2014*

As seen in this publication, the drivers of district energy have evolved over time based on the status of the technology in a city and on the economic development of the city as a whole. In *consolidated* cities, these drivers often have evolved, from air quality and energy independence to renewable energy integration and primary energy efficiency. In *refurbishment* cities, the historical drivers (affordability and access of cheap heat to the population) remain, but energy independence and efficiency are also driving modernization. For *emerging* cities, the drivers relate to the energy efficiency improvements and energy independence that district energy can provide relative to status quo heating and cooling technologies, as well as the environmental and economic benefits that this provides.

Interviews with local governments and stakeholders suggest that cities have often identified district energy as a key solution for these drivers, but have waited for the opportune time to act. This has usually been when a clear champion has emerged and/or when external events have catalyzed the urgency to act. In most cases, an external catalyst has mobilized the support required for district energy build-up or modernization or has led to district energy systems emerging as the response to the event.

When the intent to develop district energy has been established, cities will need to identify what actions and steps need to be taken to respond to these catalysts. The following sections of the decision tree – 'What?' and 'How?' – outline how the decision tree will guide local authorities to take the necessary actions considering their resources, context and jurisdiction to act.

ACROSS THE 45 CHAMPION CITIES, CATALYSTS FOR DISTRICT ENERGY INCLUDED:

CATALYST	EXAMPLES
Fuel poverty	Case study 3.2 on **London** See online case study on **Vilnius**
Reduction in electricity consumption at peak	Case study 3.12 on **Port Louis**
Energy intensity targets	**Hong Kong** in table 2.2
Air emissions	Case study 3.7 on **Anshan**
Extreme weather events or natural disasters	Earthquake in **Christchurch** See section 2.3.3
Waste management	Case study 3.3 on **Bergen** **St. Paul** in table 1.1
Geopolitical events affecting energy prices	**Växjö** in section 1.4.2 See online case study on **Velenje** **Copenhagen** in table 1.4
Public works	Case study 3.5 on **Toronto**
New-area development or redevelopment	Case study 3.6 on **Dubai**
Industrial activity	Case study 2.15 on **Rotterdam**
Urgent maintenance on existing systems	Case study 2.5 on **Botosani**
HVAC cycle	See online case study on **Seattle**
Availability of international finance and capacity-building programmes	Case study 4.4 on **Yerevan**
Energy efficiency in buildings	**Amsterdam** in table 2.2
100% renewables targets	**Frankfurt** in table 2.2

For additional discussion, see section 1.6.

5.3 WHAT?

5.3.1 DEVELOP AN ENERGY STRATEGY AND DISTRICT ENERGY-RELATED GOALS OR TARGETS

As discussed in section 2.2.1, an energy strategy with a clear articulation of the benefits of district energy is critical to providing a coherent vision around which to mobilize diverse stakeholders.

Cities first need to develop a holistic study of their energy use and energy needs in order to understand how best to realize socio-economic or environmental objectives. Such a holistic study must include a heat and cooling assessment to answer questions such as: How much electricity is used for cooling, and when is it used? How much gas, oil and wood is used for heating (and not cooking)? (see section 2.2.1).

This assessment can identify potential energy technology pathways to achieve city objectives by identifying a technology's impact on air quality and CO_2; electricity grid constraints; fossil fuel dependency; and energy affordability. For many cities, a technology pathway that includes district energy will be the cheapest solution with highest impact.

Such assessment also will allow a city to develop an energy strategy that explicitly speaks to the role of district energy in addressing policy objectives such as: How much can gas imports be reduced by 2020? How can a city's peak electricity demand be reduced? How much can heating's contribution to CO_2 emissions be reduced by 2020? Based on this energy strategy, district energy-related goals or targets can be set that are associated with the benefits. This target can evolve as the city progresses in district energy.

In a new market, the step between a broad energy strategy, such as emission reductions, to a city-wide district energy-related goal or target is often achieved over time and with learning by the city. As targets and strategies evolve over time, experiences from, for example, demonstration projects, can provide lessons and showcase benefits that can be incorporated into the energy strategy (see energy mapping below).

To develop an energy strategy and district energy-related goal or target, a city needs to have the capacity to complete a heat and cooling assessment – i.e., to collect and analyse data on its heat/cooling demands, density, resources, etc. This requires some coordination of stakeholders but is not as intensive as energy mapping (see below). Such an assessment could benefit from international/national funding and assistance, particularly for developing country cities. It could lead to better understanding of basic energy metrics in the city (annual gas consumption per capita; approximate numbers of air conditioners; heating degree days, etc.).

Through a city-twinning programme, a city with similar metrics can be identified, lessons on energy strategy development in that city (such as methodologies, generalizations etc.) can be shared, and development best practices can be identified. Twinning between cities – matching champion ones with learning ones – will be a key component of the new district energy initiative.

5.3.2 ENGAGE IN ENERGY MAPPING

A key best practice is to build on the city's heat/cooling assessment and on the stakeholder engagement and institutional coordination developed in this process to develop a detailed heat/cooling map of the city. As discussed in section 2.2.2, the first step is to collect spatial data on areas of dense heat or cool demand, local energy assets such as excess waste heat, renewable heat, free cooling and distribution infrastructure. This will enable the identification of individual projects, future interconnection potential, future growth in the city and required policy interventions. Where a city is unable to develop city-wide energy mapping due to a lack of funds, mapping can focus on high-potential areas such as the Central Business District (CBD) or zones/areas of new development.

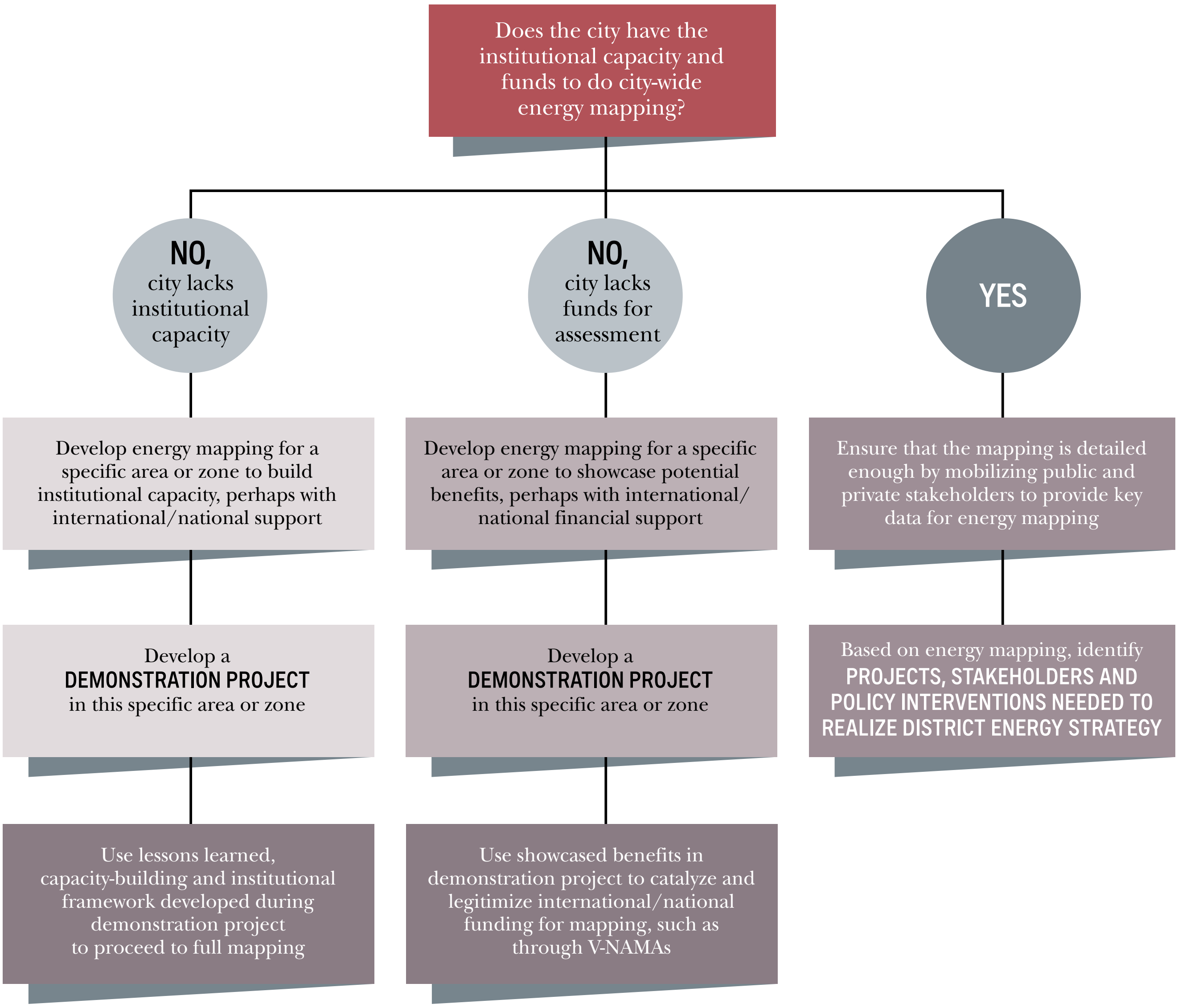
Best practice is to begin to develop an institutional structure for multi-stakeholder coordination (see section 2.5) and to use data input from stakeholders, such as the distribution utility, public buildings, housing associations, etc. Where the institutional capacity or funding does not exist to carry out a thorough energy mapping, a city can explore the following options:

- Develop a public-private partnership in planning, coordination and project development. Mobilize private partners on the basis of the potential benefits and the objective to scale up district energy to help with strategy development and capacity-building (see section 2.4 on Sonderborg's ProjectZero).
- Identify the most economically viable areas in the city that have high heat or cooling demand, such as commercial districts or new developments. Develop an energy map for these specific areas in collaboration with any private sector actors, and assess potential benefits from district energy deployment in those specific areas. Such potential

benefits can legitimize – and facilitate funding for – the demonstration project (see case study 3.12 on Port Louis).

- Consider seeking funding for demonstration projects at the national or international level, such as through V-NAMAs (see section 4.3), development bank grants and EU structural funds (see section 2.3), as long as the potential benefits for the project (CO_2 mitigation; demand reduction, etc.) are highlighted (see case study 4.4 on Yerevan).
- Use the experience from a demonstration project, and the benefits showcased, to leverage further finance for full energy mapping in the city.
- Use demonstration projects to develop the institutional frameworks and capacity-building that are vital for the development of energy mapping. The city can then scale up capacity and institutional frameworks in a stepwise manner, using lessons from the demonstration project (see case study 3.1 on Vancouver).

FIGURE 5.1 Assessing pathways to energy mapping in expansion cities



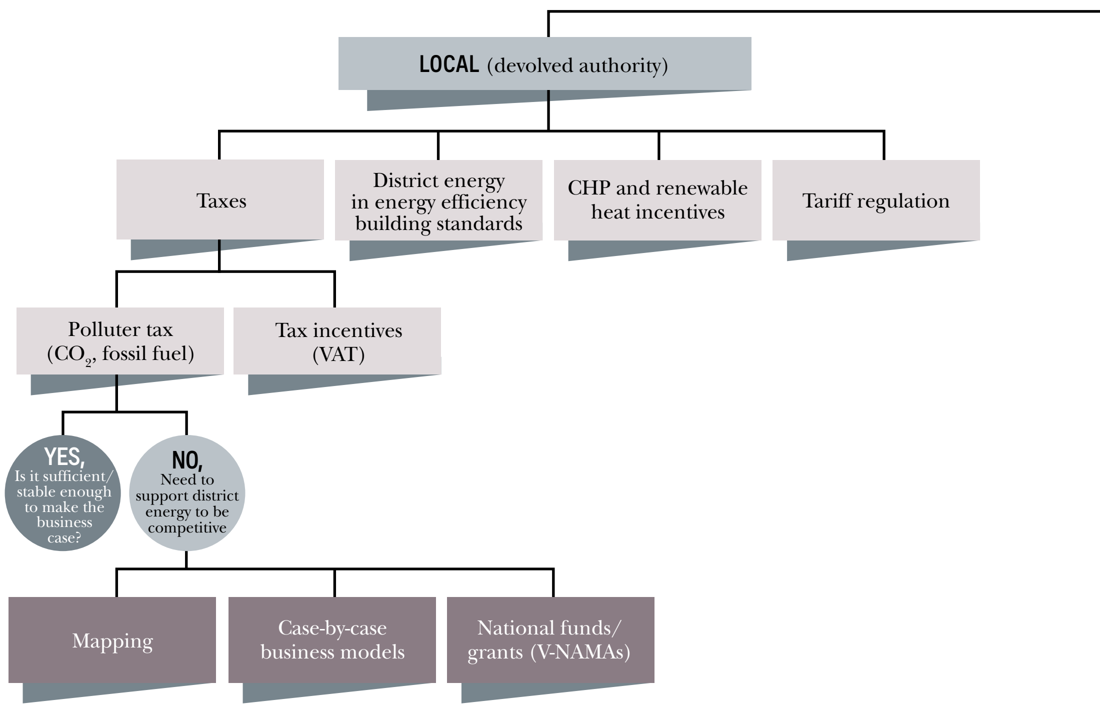
5.4 HOW?

This section provides insight into how the online decision tree will guide a local authority through the different options for developing district energy, utilizing the policy tools available to the city as planner and regulator, facilitator, provider and consumer, coordinator and advocate. Some of these policy options are made available through the national regulatory and policy framework and are influenced by the extent to which responsibility is devolved to the local authority.

From the 45 champion cities surveyed, a clear recommended first step was to assess what incentives exist at the national level to internalize the benefits of district energy and level the playing field. From the cities surveyed, the four national policies with the greatest impact are: incentives for CHP and renewables (see section 4.2); national regulation on tariffs (see section 4.2.3); incorporation of district energy into building efficiency standards (see section 4.1); and polluter taxes (see section 4.2). The decision tree in figure 5.2 explores the potential variations of such polluter taxes (for example, taxes on CO_2, fossil fuels or pollutants such as SO_2, NO_X or particulates) and how they can enable district energy. The use of polluter taxes has been a key best practice in Nordic countries such as Denmark, Finland and Sweden in achieving high levels of district energy.

Polluter taxes may not be as strong in other national frameworks, where such taxes are not stable enough or at a sufficient level to internalize the socio-economic and environmental benefits of district energy. As such, local authorities will need to explore other national policies and incentives. This could include assessing projects on a case-by-case basis and

FIGURE 5.2 Assessing options in expansion cities to develop district energy based on the national and local regulatory framework



working with the different stakeholders who stand to benefit from district energy systems (such as other, non-energy utilities) in order to internalize the benefits in the business model and create a level playing field. Such an approach may not accelerate district energy to the same level as in the Nordic countries, or not as quickly, but will provide proof of concept. For example, the lack of polluter taxes on industry in the harbour in Rotterdam means (in combination with high guarantee on supply) that the business case is not strong enough without local authority development.

A mapping exercise in the city can enable a local authority to demonstrate benefits that are not realized because of insufficient polluter taxes. Such benefits are critical to the leveraging of finance from national or international funds. With regard to the benefit associated with CO_2 reduction, V-NAMAs may be an appropriate tool for a city's request for financing district energy, as V-NAMAs need to be linked to demonstrable benefits (see case study 4.5 on V-NAMAs in South Africa, and section 4.3).

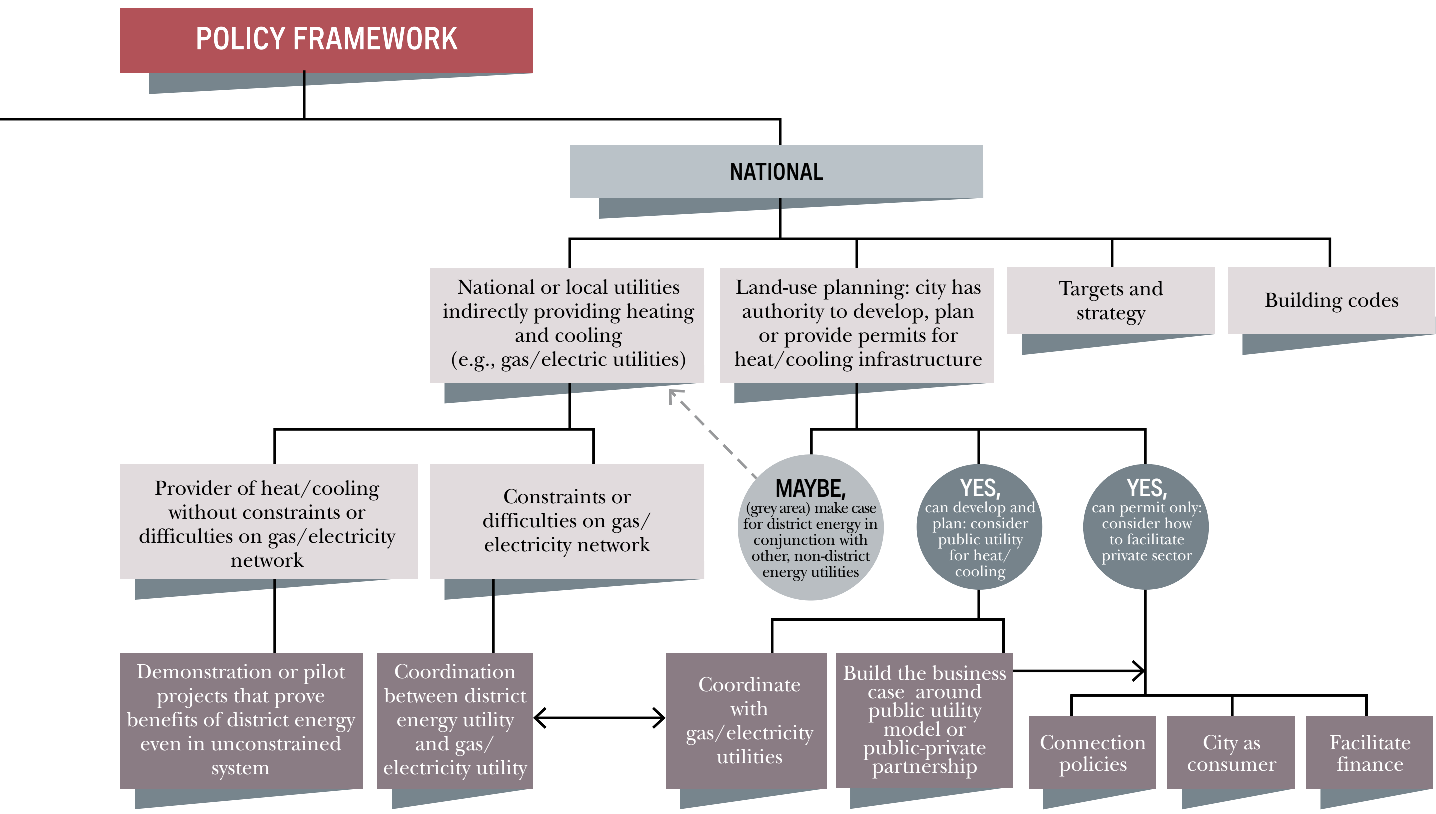
In parallel to looking at the national framework, a city will have to assess whether integrating district energy into land-use and infrastructure planning, as identified as a best practice, is a viable option going forward. Heating and cooling infrastructure, unlike electricity and gas which are based on national or regional infrastructure, are best placed to be handled at the local level. There is often a grey area regarding how cities can intervene in its planning and permitting.

Cities will often need to collaborate with national or regional utilities that are indirectly responsible for heating and cooling (such as those providing electricity for air conditioning). This collaboration will be dependent on how heating and cooling currently affects their business model, such as leading to grid constraints and blackouts on a national network for air conditioning. In several cases, identifying how district energy can relieve constraints on the electricity grid or the burden of replacing/installing new gas infrastructure has led to fruitful collaboration (e.g., Vancouver's collaboration with BC Hydro; see also case studies 3.12 on Port Louis and 2.11 on Rotterdam.)

If the city's role as planner of energy infrastructure is clearer, then the city can consider developing district energy as a utility or encouraging it through its various roles. One of these key roles, as shown in the decision tree, is through connection policies to reduce load risk for a district energy project. One such connection policy could be mandatory connections.

If a city decides to create a mandatory connection policy, it is important to guarantee that it is the most cost-effective choice for the consumer, either through transparency on prices and profits of utilities (e.g., the non-profit heat utility model in Denmark); through tariff regulation to be cheaper than the next-available fuel; or by putting the onus on the developer to prove that it is not cost-effective through city planning tools (e.g., London, Tokyo) or through national licensing schemes (e.g., case study 4.2 on Norway). It is important to consider the criteria against which these cost assessments are made. In the EU, these assessments must account for a full economic cost-benefit analysis of modern district energy systems.

The full decision tree is available online along with the case studies of the 45 champion cities.



5.5 KEY STEPS IN DEVELOPING A DISTRICT ENERGY SYSTEM

The decision tree will highlight the decision-making considerations under 10 key steps to support the development of a policy and investment road map for district energy systems (see figure 5.3). These steps can be taken individually or packaged to meet specific city conditions and needs. The existing policy actions in a city and the degree of experience in developing district energy systems will inform which steps are applicable in a city. The decision tree will help a city navigate the options and tools that are available, based on their local conditions, to address each area of action. In this context, development of a district energy system comprises new systems or systems in need of upgrade or retrofit.

Capacity-building is a cross-cutting area of action that is implicit within each step. Through the public-private partnership model of the District Energy in Cities Initiative, tailored support using the 10 key steps is intended to be provided to the cities/countries. Twinning between cities – matching mentor ones with learning ones – will be one of the key components of the new district energy initiative to transfer and scale up lessons learned and best practices.

FIGURE 5.3 Key steps in developing a district energy system

1.	**ASSESS** existing energy and climate policy objectives, strategies and targets, and identify catalysts
2.	**STRENGTHEN** or develop the institutional multi-stakeholder coordination framework
3.	**INTEGRATE** district energy into national and/or local energy strategy and planning
4.	**MAP** local energy demand and evaluate local energy resources
5.	**DETERMINE** relevant policy design considerations
6.	**CARRY OUT** project pre-feasibility and viability
7.	**DEVELOP** business plan
8.	**ANALYSE** procurement options
9.	**FACILITATE** finance
10.	**SET** measurable, reportable and verifiable project indicators

5.6 CONCLUDING REMARKS: OVERCOMING KEY CHALLENGES AND CAPTURING OPPORTUNITIES

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. The following is a summary of some of the main barriers common to cities, and the lessons learned from their experiences.

- **INADEQUATE MUNICIPAL CONTROL OVER THE ENERGY SECTOR:** 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 Greater London Authority, Seoul, and Tokyo.

- **INADEQUATE CAPACITY AND PUBLIC ACCEPTANCE:** Raising awareness and technical understanding of district energy applications and their multiple benefits is critical in order for city authorities to engage with the market as an "intelligent client" – managing feasibility analyses, developing appropriate policies, engaging with stakeholders, developing business models and ensuring public acceptance – all of which are critical to build the trust of potential users. Examples include Milan's designated "help desks" and Frankfurt's Energy Agen-cy; partnering with the private sector to leverage their expertise (e.g., Anshan); and developing demonstration projects (e.g., Vancouver).

■ **COORDINATION AND COOPERATION BETWEEN MULTIPLE STAKEHOLDERS AND INTERESTS:** A strong – often public – champion is required to develop a customer base and to ensure a rules-based permitting process. Local governments can establish a coordination structure to ensure integrated, holistic planning and/or develop energy maps to visually communicate opportunities, bring together the different partners for business development and inform the planning process. Amsterdam used energy mapping to establish cooperation among various industrial partners on the exchange of energy and use of excess waste heat from data centres.

■ **HIGH COST OF FEASIBILITY STUDIES:** 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.

■ **DE-RISKING CAPITAL INVESTMENT:** 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., Łódź; Velenje) 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). To reduce risk and project cost, smaller systems can be interconnected over time as a city-wide system, as exemplified in Copenhagen. This allows the system to be built out as load is connected (as has occurred in Dubai with district cooling), reducing the risk of not being able to connect sufficient demand. Local governments can also provide loan guarantees, as in Aberdeen; leverage international finance, as in Botosani; or develop a revolving fund to reduce the costs of finance, particularly for projects that have high public benefit, as in Toronto.

■ **PUTTING A PRICE ON WASTE HEAT:** The integration of publicly or privately owned waste heat can be achieved through heat tariffs that reflect the cost to connect and the ability to guarantee supply. This is similar to the development of feed-in tariffs for renewable electricity generation – a variable waste heat supply should have its consumption maximized but may be able to only predict and not guarantee heat.

■ **REGULATING TARIFFS TO ENSURE CUSTOMER PROTECTION:** Tariff regulation is an important aspect of district energy that can ensure consumer protection in a naturally monopolistic market. In some cases, the local governments may have control over tariffs set by the private sector through concession agreements. Tariffs can be 1) regulated so that district energy is priced at the alternative technology costs, or 2) effectively indirectly regulated by controlling the profits of district energy companies or the costs that they can pass on to consumers.

■ **EXISTING MARKET STRUCTURE AND DISTORTIONS:** 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, the Oslo Climate and Energy Fund).

■ **MULTI-LEVEL GOVERNANCE AND NATIONAL REGULATIONS:** 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 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. Insufficient multi-stakeholder involvement and coordination is another challenge to address. Devolution as part of broad national strategies can encounter difficulties in developing countries due to 1) the delay in building up local capacity and 2) the delay in devolving financial sources (e.g., fiscal revenue). This can limit the speed and efficiency of development under devolution.

■ **ENERGY MARKET INFLUENCE ON DESIGN OF BUSINESS MODELS:** The energy market in a country and the degree of liberalization, privatization and regulation shape the business model for district energy. In many developing countries, utilities are publicly owned and may be responsible for producing, transmitting and distributing electricity. Incorporating national utilities into the business model – such as through full or partial ownership – is key to realizing the macro-economic benefits of district energy.

The economic, social and environmental benefits of district energy systems have not always been fully accounted for in technology comparisons. 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, but they do need financial, fiscal or policy support to bring them on to an even playing field with other technologies.

5.7 FURTHER AREAS OF RESEARCH

As a stand-alone report, this publication is intended to accelerate district energy and to launch the Global District Energy in Cities Initiative. Significant areas of research still need to be addressed, however, particularly with regard to district cooling and how it relates to energy efficiency, energy access and renewable energy. The following areas of research would be particularly beneficial to district energy going forward:

- Exploring the impact of cooling demand at the city and national level and the comparative benefits of district cooling against national power system upgrades and developments.
- Understanding the extent to which district cooling could allow a greater focus on access to electricity in a country by reducing strain on the national power system.
- Improving data collection and analysis methodologies for countries and cities looking to understand cooling demand, and developing best practice guidelines.
- Elaborating national energy policies and market structures that enable the national benefits of district cooling to be captured in the business model.
- Developing cost data and guidelines to enable cities to compare district energy against competitive technologies.
- Designing replicable national policies that can attract finance and expertise for refurbishment of district heating systems to become modern and efficient.
- Evaluating the ability of district energy, in particular CHP and CCHP technologies, to provide balancing for power systems and to enable higher levels of variable renewable generation.
- Demonstrating the importance for district energy development of vertically integrated structures between city, regional and national authorities.
- Quantifying the multiple benefits of district energy in the context of various nexus dimensions such as resource use, water, land use, and health.