# ALIGNING DISTRICT ENERGY AND BUILDING ENERGY EFFICIENCY

## BELGRADE

DISTRICT ENERGY IN CITIES INITIATIVE

Building Efficiency Accelerator

## A VIEW ON STRATEGIC INTEGRATIONS

SEPTEMBER 2018

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## BPIE WOULD ALSO LIKE TO THANK ALL THE EXPERTS INVOLVED IN THE WORKSHOP ORGANISED IN BELGRADE IN MARCH 2018.

This report was made as a part of the activities the Building Efficiency Accelerator (BEA) and District Energy in Cities (DES) Initiative implemented in the City of Belgrade. UN Environment is supporting the city's public authorities in promoting energy efficiency of buildings and associated energy systems, as one of the champion cities globally.

The BEA is a public-private collaboration that turns global expertise into action to accelerate local government implementation of building efficiency policies and programmes. The BEA is coordinated by World Resources Institute. UN Environment acts as the Global Environment Facility (GEF) Implementing Agency and provides targeted technical assistance, including support to Belgrade. buildingefficiencyaccelerator.org

The DES Initiative is a multi-stakeholder partnership coordinated by UN Environment, with financial support from the GEF, Denmark's development cooperation agency (DANIDA), and the Italian Ministry of Environment, Land and Sea. It supports local and national governments to build local know-how and implement enabling policies that will accelerate investment in modern – low-carbon and climate-resilient – district energy systems. districtenergyinitiative.org

The Buildings Performance Institute Europe (BPIE) is a European not-for-profit think-tank with a focus on independent analysis and knowledge dissemination, supporting evidence-based policy-making in the field of energy performance in buildings. It delivers policy analysis, policy advice and implementation support. www.bpie.eu

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# EXECUTIVE SUMMARY

This report supports the Building Efficiency Accelerator (BEA) and the District Energy in Cities Initiative, two initiatives under Sustainable Energy for All (SE4ALL). While the focus is on the City of Belgrade, the aim of this report is to support all public authorities and agencies developing and implementing integrated approaches to both energy efficiency in buildings and district energy supply. It provides guidance to decision-makers in Belgrade, while presenting universal recommendations to align district energy and energy efficiency in buildings.

Combining energy efficiency measures and district energy is often seen in the context of achieving deep decarbonisation in the most cost-effective manner. With high levels of energy demand savings on the building side through renovation, it can become more cost-effective to pursue sustainable energy supply options, like district energy based on renewable energy or excess heat, for the remaining energy demand.

There are many benefits for owners and occupants of buildings, district energy utilities and public authorities that can be gained from combining and integrating the approaches.

| BENEFITS OF AN INTEGRATED APPROACH FOR OWNERS/ OCCUPANTS OF BUILDINGS: |
|---|
| Supports move to consumption-based billing |
| Cost savings |
| Alleviation of energy poverty |
| Reduced sensitivity to fuel price increases |
| Increased comfort |
| Health benefits for occupants |
| Higher productivity and reduced absenteeism among occupants of commercial buildings |

| BENEFITS OF AN INTEGRATED APPROACH FOR PUBLIC AUTHORITIES (INCLUDING LOCAL MUNICIPALITIES AND REGIONAL/NATIONAL GOVERNMENTS): |
|---|
| Reduced energy bills for public buildings |
| Contributes to achieving decarbonisation goals and energy efficiency and renewable energy targets |
| Addresses air quality issues |
| Prevents increased electricity demand and/or air pollution issues as a result of switches from district heating to electric heating or individual stoves |
| Alleviates energy poverty |
| Economic benefits |
| Greater funding sources |
| Increased resilience |
| Reduced energy imports |

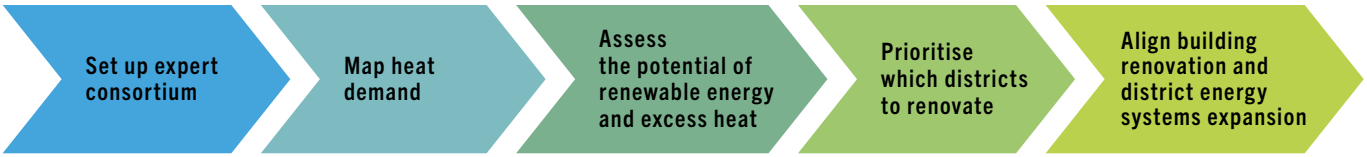
| BENEFITS OF AN INTEGRATED APPROACH FOR THE DISTRICT ENERGY UTILITY: |
|---|
| Builds customer base without additional cost of extra fuel or increasing generation capacity |
| Enables consumption-based billing (without the need for additional generation capacity or increase in bills) |
| Mitigates potential loss of customers/disconnection due to move to consumption-based billing and the resulting potentially higher energy bills |
| Reduces costs |
| Supports modernisation of the district energy system |
| Retains customers and attracts new customers by providing an energy service |
| Reduces heat losses |
| New business models |

Aligning district energy and energy efficiency is most effective if undertaken through a district approach. An integrated approach on the district level will allow for a more cost-effective and faster decarbonisation of the building stock. Renovation programmes often target single buildings in a fragmented way and do no exploit the synergies between reducing delivered energy demand and primary energy demand. Shifting the perspective to a district system approach would help to capture interdependencies between supply and demand, which are traditionally treated individually. Combining the approaches to energy efficiency in buildings and the heating system on a district level can effectively match the supply and needs and thus avoid unnecessary investments and lock-in effects.

The following recommendations provide areas of focus for policy-makers in Belgrade, as well as being applicable to many cities and regions wishing to develop and implement district energy and energy efficiency approaches.

## CREATE AND IMPLEMENT A VISION OF AN INTEGRATED DISTRICT APPROACH

### Recommendation 1: Map renovation potential and heat sources to provide an integrated district view



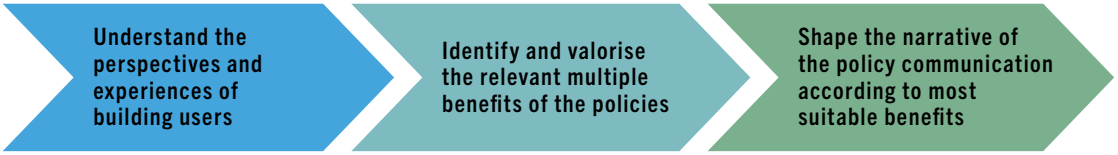

To align and create synergies between approaches to district energy and energy efficiency in buildings and tap the potential benefits and investment opportunities, it necessary to gain a true understanding of the potential for renovation and the future of the district energy system. As buildings are renovated they will become more efficient, reducing energy needs and the need for high temperature district heating supply. This will impact on the district energy system. Therefore, understanding where connections and reconnections would be most beneficial, considering the potential for renovation, is important to ensure it is planned strategically.

Mapping would support and stimulate an aggregated approach to renovating buildings at a district level. This would help to bring down costs of renovation, increase the leverage of public funding and build awareness. Aligning this aggregated approach with district energy systems would allow a truly integrated district approach to be taken.

### Recommendation 2: Harmonise and implement policies across all sectors


The City of Belgrade should set short-term three-year programmes and immediate one-year implementation plans to operationalise national plans and policies at city level. The three-year programme and one-year implementation plan should be embedded within the city's long-term renovation strategy as well as the national long-term renovation strategies. It is important to review the relevant policies in place (concerning both energy efficiency in buildings and district energy) and the policies needed to support the national policy agenda. From this the shorter-term programmes and plans can be established.

### Recommendation 3: Build and maintain political support through awareness raising



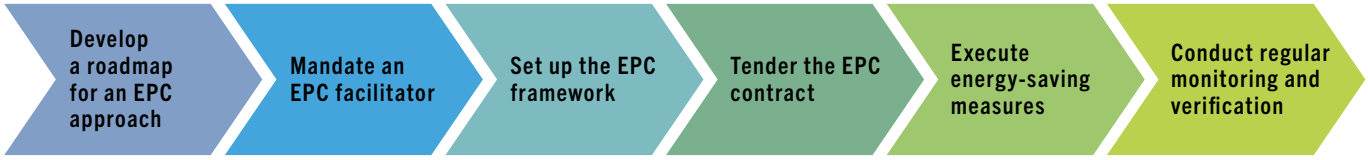

Wide political support for policies which align both district energy and energy efficiency is essential to prevent a stop-and-go approach to such policies. Political support is needed for energy efficiency and district energy policies to ensure they remain priorities and the supporting policy framework is maintained.

## SEIZE THE FINANCIAL OPPORTUNITIES

### Recommendation 4: Make the Energy Efficiency Fund operational


The City of Belgrade Budget Fund for Energy Efficiency (BEEF) has been created but it is not yet fully operational. Several steps are needed to full establish the Energy Efficiency Fund. Well-designed and established funds, such as Kredex Revolving Fund (see section *Financing examples*), can provide guidance and inspiration to the BEEF.

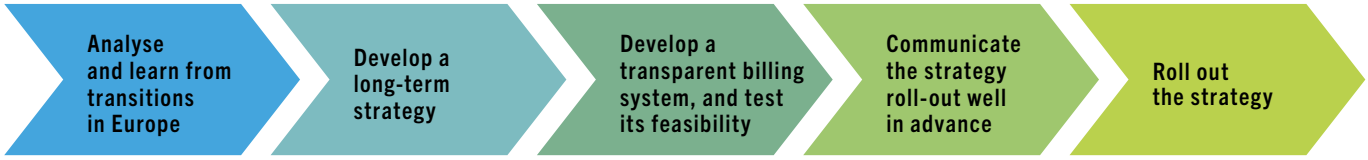
### Recommendation 5: Develop ESCO/MUSCO model




Energy performance contracts (EPCs) via an energy service company (ESCO) or multi-utility service companies (MUSCOs) are valuable business models which avoid the need for high initial upfront investment from city governments, such as the City of Belgrade (see section *Financing examples*). For cities, there are several elements to consider including selecting buildings/districts to focus on, identifying types of measures preferred and understanding the savings potential. Building a vision for an integrated district approach is therefore a prerequisite.

## DRIVE TRANSFORMATIONAL CHANGE WITHIN THE SECTOR

### Recommendation 6: Evolve towards consumption-based billing for all consumers




Consumption-based billing provides consumers with a better understanding of their energy consumption and encourages more energy-efficient practices. However, without improving the energy performance of district heating connected buildings, this shift could increase the energy bills of a significant number of households in district-heated buildings. Renovation of these buildings would not only mitigate this risk but should reduce energy bills as well as improve living conditions in terms of comfort. At the same time, the "freed and available" energy could be allocated to expanding the district heating system to provide heat to more buildings.

### Recommendation 7: Build up skills in the supply chain


For policies to be successful there needs to be sufficient expertise within the supply chain to support their implementation. Given the technical nature of energy efficiency in buildings and district energy, this is particularly important. One of the goals of the district energy utility in Belgrade is to attract greater numbers of younger employees. Education programmes, training and information on district energy and energy efficiency, and more professional networks promoting skills, play a key role here. The training and upskilling of existing workers in the supply chain is also needed.

# INTRODUCTION

This report supports the Building Efficiency Accelerator (BEA) and the District Energy in Cities Initiative, two initiatives under Sustainable Energy for All (SE4ALL). The SE4ALL Initiative was established by the former Secretary General of the United Nations Ban Ki-moon, to achieve universal energy access, improve energy efficiency and increase the use of renewable energy[1]. This report explores the synergies between aligning principles and approaches for improved efficiency in buildings, through the renovation of existing buildings, and district energy systems. Examples of policy and financing approaches to district energy and energy efficiency in buildings are investigated, as well as the current approach in Belgrade. Potential business models and financing streams are also examined. The research continues the work done in BPIE's recent "Renovating Belgrade" report [1], which outlines the renovation potential and approaches to increasing renovation activities in Belgrade, as well as the UN Environment Report "District Energy in Cities – Unlocking the Potential of Energy Efficiency and Renewable Energy" [2].

1 SE4ALL is the established delivery mechanism for the 7th Sustainable Development Goal (SDG 7): "*Ensure access to affordable, reliable, sustainable and modern energy for all*".

# CONTEXT

In 2016, 21.9 million $m^2$ of buildings in the city of Belgrade were heated through the district energy system, including more than 300,000 residential buildings [2]. It is the aim of the Belgrade district energy utility (Beogradske elektrane) to connect an additional (minimum) of 200,000 $m^2$ of buildings per year over the coming years, to add a total additional 3 million $m^2$ of residential apartments and business premises by 2025 [2]. Simultaneously, the long-term vision is to transition the current district energy system to a sustainable and modern "fourth generation" system[2], with a significant share of renewable energy in production and reduced water temperature in distribution [2]. The Belgrade energy heating utility aims to increase the share of heat from renewable energy sources from 0.75% (in 2016) to 7-15% by 2025 [2] [6].

Most of the district heating system in Belgrade was developed in the 1960s, and currently there is no cogeneration or use of excess heat from industry. Heat is supplied through natural gas and fuel oil boilers, as is typical of many third generation district energy systems. However, there is a digital control and management system, many parts of the distribution network are newer (constructed with pre-insulated pipes and pre-fabricated substations), and the supply and return temperatures of the system are relatively low.

In reality buildings are the largest final consumers of energy, particularly for heating and cooling, and the majority of the Serbian district heating network is supplied by gas, of which 71% is imported [3]. This makes Serbia vulnerable to gas disruption scenarios, including price fluctuations of energy imports.

Eurostat estimates that around 26% of the overall population in Serbia live in very low-quality dwellings with serious defects, such as leaking roofs, damp walls and rotting floors [3]. Consequently, one in six families are not able to keep their homes adequately warm and experience higher incidences of poor health and damp-induced illnesses and diseases. These energy poverty indicators[3] are among the worst in Europe and underline the need to improve the energy performance and quality of the building stock in Serbia.

Renovation of buildings and the district heating system effectively addresses these challenges as well as helping to achieve district energy goals. BPIE estimates that renovation of buildings in Belgrade could deliver energy savings up to 74% in terms of final energy demand for space heating by 2050, depending on the scenario [1], as well as reduce demand for imported gas and other fuels, deliver employment and tax benefits and boost the Serbian economy.

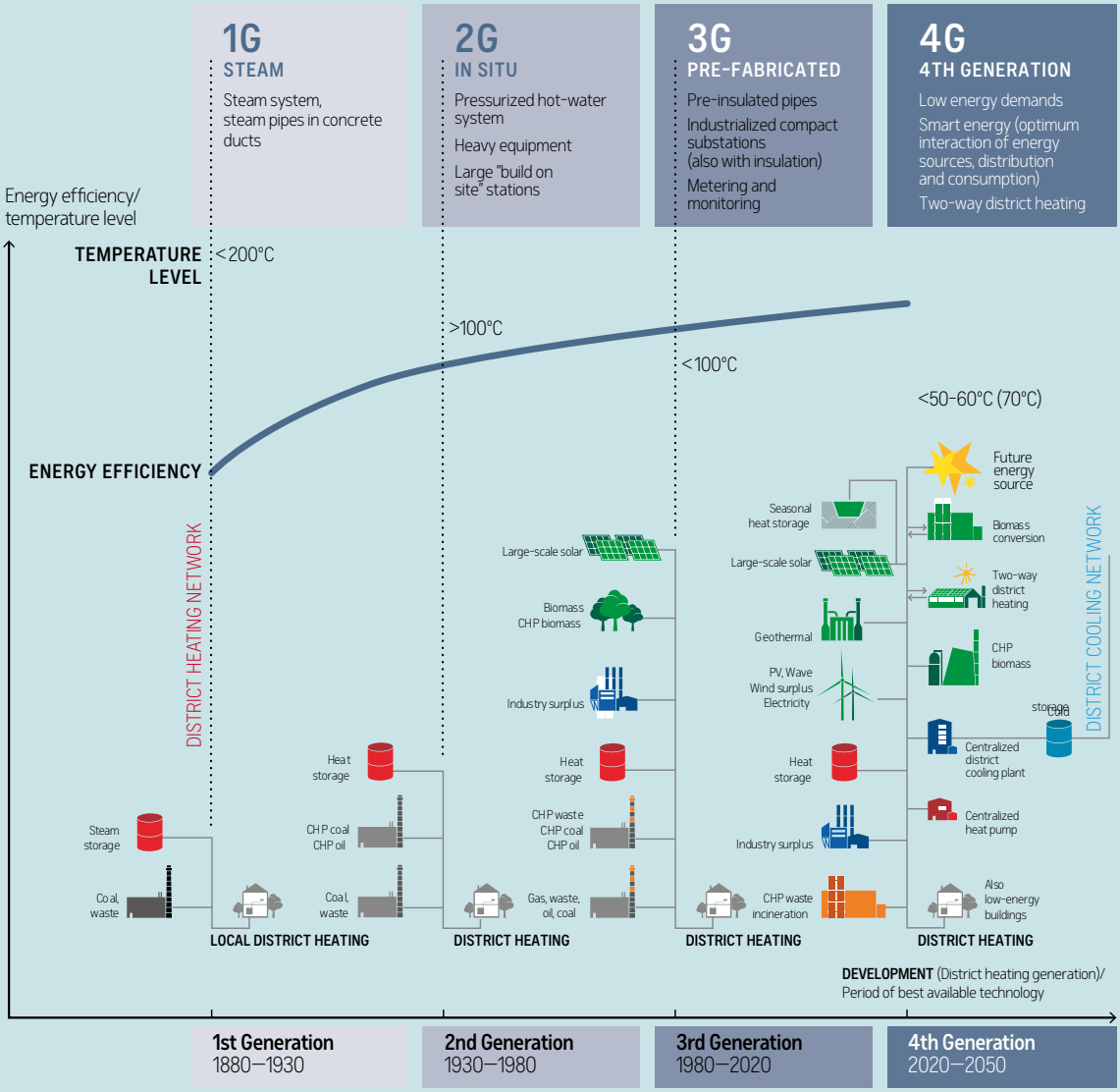
One of the recommendations of the Belgrade district energy utility's development strategy is for the City of Belgrade to establish a priority programme for renovation of the building stock, at least for buildings connected to the district energy system [2]. This would help the utility to achieve its aims of increased efficiency, increasing numbers of connections, moving to consumption-based billing, overall decarbonisation and a move towards fourth generation district heating. BPIE estimates that a renovation programme focused on renovating the buildings connected to the district heating system in Belgrade, which would renovate 100% of these buildings by 2050 (and 40% by 2030)[4], could reduce the energy consumption of the Belgrade building stock by 51.3 TWh between now and 2050 [1]. This would also help to foster the needed transition to billing based on actual energy consumption per household rather than billing by floor area. Consumption-based billing gives consumers a better understanding of their energy consumption and encourages more energy-efficient practices. There is concern that introduction of consumption-based billing in the existing (old) residential building stock, and particularly considering the number of buildings that are inefficient, would lead to significantly larger bills during the heating season. Consequently, many would request to be disconnected, which would reduce the efficiency of the system even further and could increase air pollution as a result of greater use of individual stoves and/or increase demand for electricity for heating. Renovation of these buildings would not only minimise this risk but should reduce energy bills.

At the same time, the capacity for heat provision that is freed up as buildings become more efficient could be allocated to expanding the district heating system to provide heat to more buildings, without the need for additional generation capacity. This would also allow for a better integration of renewable and recovered energy sources, instead of the current reliance on gas incinerated in heat-only boilers, and facilitate the provision of energy at lower temperatures, leading to higher efficiency. This could contribute to a reduction of heating bills, and the utility's ambition to connect a further 200,000 $m^2$ to a more efficient and renewable district heating network.

2 Figure 1 provides an explanation of the generations of district heating systems.

3 Defined by the European Union Statistics on Income and Living Conditions.

4 It should be noted that the depth of renovation may vary in the buildings renovated, specifically in historic or special architectural buildings.




**Fourth generation district heating (4DH)**

*Figure 1: Different generations of district heating (Source: [4].)*

Fourth generation district heating (4DH) systems are defined as integrated, coherent and efficient technical and institutional concepts, which use smart thermal grids as part of a move towards 100% renewable energy systems. Figure 1 shows the different generations of district heating as they have developed historically; their respective temperatures, and the different types of energy sources that can be used to supply the district heating system. The first district heating systems, developed at the end of the 19th century, were based on heat only (coal) boilers and steam. Second generation concepts saw slightly better building quality and an increased use of combined heat and power. Steam systems developed to pressurised hot water systems, but still using rather high temperatures. As the system transitions towards third generation, more types of (increasingly sustainable) heat sources are used and typically the thermal quality of both the distribution pipes and the building increases. This results in lower temperatures in the distribution grid, and lower losses overall.

In fourth generation district energy, fossil fuels are phased out of the system and replaced by renewable and recovered energy sources. This is, in part, made possible by the lower energy demands of buildings, and the low temperatures in the network, allowing for the integration of lower-grade heat sources such as low-temperature geothermal, highly efficient centralised large-scale heat pumps, and excess heat from industries. In order to manage, balance and optimise the efficient use of these sources, different types of storage are also applied.

The different generations of district energy are not distinct, clear-cut categories, but rather represent evolutions in district heating systems. For example, a city can have part of the district energy system based on steam, high-temperature cogeneration – even though the quality of the building stock is relatively high, and renewables such as geothermal or solar thermal are used around the more peripheral areas. Similarly, a district energy system can supply energy from a large variety of different, low-temperature and renewable energy sources through a highly efficient distribution system to very well-insulated houses – but not have bidirectional district heating, or a district cooling system. Similarly, different areas of the district heating system may look very different, depending on the building stock, temperatures, sources and configurations. For these reasons, transitioning towards a more modern generation of district heating is a process of incremental development, rather than a completely new system.

# PRINCIPLES

## COMBINING THE BENEFITS

In the past measures to improve energy efficiency in buildings and district energy systems were rarely considered in tandem. This was likely due to the traditional supply-side versus demand-side split in terms of responsibility in local and national administration, as well as the nature of their ownership and the infrastructure role. District heating is a decentralised infrastructure system that involves coordination between energy provision, distribution and the multiple customers. Buildings typically each have individual owners and represent the least centralised elements of the system, making it challenging for local authorities and municipalities to address.

However, when it happens, the combination of energy-efficiency measures and district energy is often seen in the context of achieving deep decarbonisation in the most cost-effective manner. With high levels of energy demand savings on the building side through renovation, it can become more cost-effective to pursue sustainable energy supply options, like district energy based on renewable energy or excess heat, for the remaining energy demand.

**Balancing investment in improvements to building energy efficiency and a district energy approach – Rotterdam, Netherlands**

In Rotterdam, the returns on investments in improvements to building energy efficiency (i.e. renovation of buildings) to specific energy performance levels and investments for a district energy approach were compared. It showed that as buildings become more efficient, it becomes more cost-effective to pursue district energy, as shown in figure 2. Specifically, when improving a building's energy performance from the G level of certification to the E level, building-level efficiency measures are more cost-effective than district energy. Once that level is reached district energy was found to be more cost-effective than moving from the E level to higher levels [5].

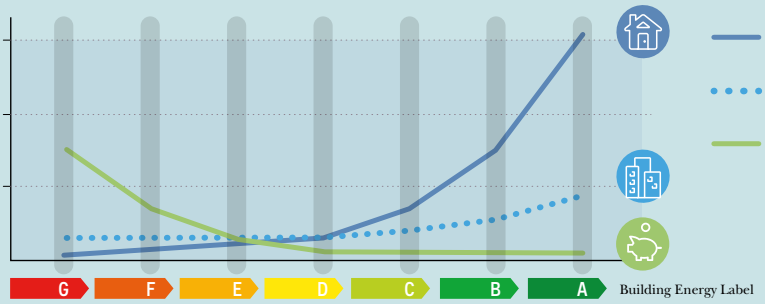



*Figure 2 – Return on investment in Rotterdam from building-level efficiency improvements versus a district energy approach (Source: [5])*

This approach attempts to balance the required investment with the risk of lock-in to lower levels of energy performance while also considering the supply side. The long-term goal should be to decarbonise the urban building stock cost-effectively, which requires both reaching high levels of energy performance in buildings and taking advantage of the possible energy supply options at district level.

There are many benefits for owners and occupants of buildings, district energy utilities and public authorities that can be gained from combining and integrating the approaches.

As new buildings are built to a better standard or older buildings renovated to a higher level, the overall energy demand falls. The same service can be provided with less generation capacity required on the district heating side. This enables expansion of the district heating system, making it possible to serve more end-users without increasing the generation capacity. Additionally, better thermal insulation of buildings reduces the peak energy demand[5], allowing for a reduction in peak generation capacity, which in turn increases the overall utilisation factor of the installed capacity. Furthermore, the improved building performance allows for a reduction in the supply temperature. This increases efficiency since it prevents losses in the distribution network, and opens up possibilities for the use of a much wider range of supply options, such as waste heat from unconventional (urban) sources; much more efficient use of large-scale heat pumps; heat from renewable geothermal and solar thermal sources; and heat which has been kept in seasonal storages. Without improvements in the energy efficiency of the building stock, it becomes less feasible to move towards a fourth generation district heating system, and be able to capture all the primary energy savings and renewable energy types that come with it.

5 The maximum amount of energy ever required during one time period, typically one hour.

| BENEFITS OF AN INTEGRATED APPROACH FOR OWNERS/OCCUPANTS OF BUILDINGS: | |
|---|---|
| Supports move to consumption-based billing | Without improving the energy performance of district heating-connected buildings, moving to consumption-based billing could increase the energy bills of some of the residents in district-heated buildings. |
| Cost savings<br>Linked to alleviation of energy poverty<br>Reduced sensitivity to fuel price increases | After renovation of existing buildings, energy bills will be lower due to reduced energy consumption and better operation of the system. Insulation from energy price spikes and greater long-term certainty on heating and cooling bills because price is less reliant on fossil fuel prices. |
| Increased comfort | Renovation of existing buildings or highly efficient new buildings should address comfort issues by preventing draughts and damp in buildings. |
| Health benefits for occupants | Linked to improved comfort, as well as reduced (indoor and outdoor) air pollution from use of individual stoves or burning of wood. |
| Higher productivity and reduced absenteeism among occupants of commercial buildings | More comfortable and efficient buildings are proven to improve the productivity of the building occupants. |

| BENEFITS OF AN INTEGRATED APPROACH FOR PUBLIC AUTHORITIES (INCLUDING LOCAL MUNICIPALITIES AND REGIONAL/ NATIONAL GOVERNMENTS): | |
|---|---|
| Reduced energy bills for public buildings | Energy bills will be lower due to reduced energy consumption and better operation of the system as a result of renovation. |
| Contributes to achieving decarbonisation goals and energy efficiency and renewable energy targets | Improved energy efficiency and lower greenhouse gas emissions due to lower energy consumption and more options to integrate low-carbon sources. Further decarbonisation will be achieved by moving to fourth generation district heating and the use of renewable energy rather than fossil fuel, which is facilitated by more efficient buildings. |
| Addresses air quality issues | Reduced energy consumption means less fuel will need to be used; in addition, the shift to fourth generation district heating will replace fossil fuels with renewable energy. Many cities started district energy networks to address air pollution. Greater use of district heating would replace individual heating, which, especially if based on fuel combustion (solid, liquid and gaseous), contributes to in- and outdoor particulates, as in Belgrade. |
| Prevents increased electricity demand and/or air pollution issues as a result of switches from district heating to electric heating or individual stoves | There is a concern that in response to bills or other issues, consumers disconnect from district heating and switch to electric heating, thus increasing demand for electricity, or individual stoves which could cause air pollution. If energy bills can be reduced via renovation and an improved district energy system fewer consumers may decide to switch. |
| Alleviates energy poverty | Renovating buildings can help to reduce energy bills, and connection to district heating can replace less efficient heating systems. |
| Economic benefits | Job creation through renovation, installation and operation of district energy, and increased reliance on local energy sources (local forest residues, landfill gas, renewables, excess heat). Local wealth retention through reduced imports, greater use of local resources and more efficient primary energy consumption. Potential dividends to the local government via city ownership model or public-private partnership model of district energy, |
| Greater funding sources | Taking a district approach opens up new sources of capital for improving performance of a community's existing building stock and the district energy system. |
| Reduced energy imports and increased resilience | Efficiency and district energy can mitigate the risks and challenges associated with relying on big infrastructure, which includes regional-scale failures, especially in areas prone to natural disasters (e.g., earthquakes, volcanoes). District-level (renewable) thermal energy and CHP plants can introduce a diversity of energy supply sources and mitigate the impact of disasters, making communities more resilient.<br><br>The ability of district heating to reduce electricity demand during peak periods and reduce stress on national or regional power grids (through energy sharing and thermal storage) also increases the reliability of power. Reduced dependence on fuel imports, use of local sources and fuel switching also increases energy security and resilience to fuel price shocks. |

| BENEFITS OF AN INTEGRATED APPROACH FOR THE DISTRICT ENERGY UTILITY: | |
|---|---|
| Builds customer base without additional cost of extra fuel or increasing generation capacity<br><br>Enables consumption-based billing (without the need for additional generation capacity or increase in bills)<br><br>Mitigates potential loss of customers/disconnection due to move to consumption-based billing and the resulting potentially higher energy bills | Reducing the energy consumption of existing buildings connected to the system through renovation could enable the energy previously supplied to those buildings to be redistributed to new customers.<br><br>Without improving the energy performance of district heating-connected buildings, moving to consumption-based billing could increase the energy bills of some residents and cause them to disconnect from the DH system. |
| Reduces costs | Fuel costs would be lower due to reduced demand |
| Supports modernisation of the district energy system | As part of the shift to fourth generation district energy (renewable energy and lower temperatures) it would be logical to ensure the system is sized to the energy demand of buildings after renovation. |
| Retains customers and attracts new customers by providing an energy service | District energy system operators (or others in the market) could take on a holistic role offering both energy-efficiency measures and deep renovation of existing buildings and supply of heat. |
| Reduces heat losses | When reduced heat demand is in tandem with reduced temperatures, heat losses can also be reduced. |
| New business models | Operators can get involved in new business models, for example partnering with the power utility who would benefit from the deferred or reduced cost of<br>upgrades in gas and electricity<br>distribution networks as users switch<br>to district energy, and/or reduced transmission losses as electricity is generated closer to<br>where it is being used. |

## TAKING A DISTRICT APPROACH

Aligning district energy and energy efficiency is most effective if undertaken through a district approach. An integrated approach on the district level will allow for a more cost-effective and faster decarbonisation of the building stock. Renovation programmes often target single buildings in a fragmented way and do no exploit the synergies between reducing delivered energy demand and primary energy demand. Shifting the perspective to a district system approach would help to capture interdependencies between supply and demand, which are traditionally treated individually. Combining the approaches to energy efficiency in buildings and the heating system on a district level can effectively match the supply and needs and thus avoid unnecessary investments and lock-in effects.

## Albertslund, Denmark

The Albertslund South area, just outside Copenhagen, is undergoing large renovations, and the beginning of an overall transition towards fourth generation district heating. Albertslund was developed as a futuristic suburb of Copenhagen in the 1960s, with a high level of social housing, concrete and badly insulated buildings. In 2007, during the run-up to the UN climate conference in Copenhagen (COP15), there was a combined ambition to contribute towards the Danish climate goals in Albertslund, while also renewing the district, fixing leaks and mould, and addressing difficulties in attracting new tenants and growing social problems. As the municipal tax revenues were relatively low, one of the ambitions was to develop the area to a point where higher tax revenues would become reality.

With a broad coalition of partners, including the municipality, utility companies, housing associations, heat suppliers, industrial partners, academic partners and the Danish Energy Agency, the project was able to take advantage of some local subsidies and apply for various sources of funding. Since the buildings in Albertslund were largely representative of the types of buildings built in Denmark before 1971, the project was able to serve as a test-case for the renovation of other neighbourhoods. The project has involved a variety of experimental approaches, where similar buildings were retrofitted to different standards, provided with different supply technologies, and monitored. Based on the evaluation, they decided to move towards highly insulated, retrofitted buildings and a low-temperature district heating system (50°C supply). In conjunction with this, the municipality has made a "low-temperature readiness assessment" of the different neighbourhoods, and a neighbourhood-based renovation plan for both the buildings and the district heating system.


*Figure 3: District renovation plans in Albertslund South [7]*

## HEAT MAPPING PROVIDES ACCESS TO RENEWABLE AND EXCESS HEAT

Mapping potential heat sources can help to identify new sources of heat, such as renewable energy and excess heat, and support their integration, as well as provide better links between supply and demand. Without a district energy approach, these types of energy are often not considered. Excess heat from industry, power generation or even 'unconventional' urban sources like hospitals, data centres and metro systems can be recovered through a district energy approach, and used in the district heating system. Without a district energy perspective, these types of energy are lost. Similarly, the use of renewable thermal energy sources like geothermal energy, large-scale solar thermal energy or the efficient use of large-scale heat pumps is not possible without a district energy system to distribute these decarbonised sources of heat to the buildings. However, these types of renewable thermal energy are most effective in buildings with district and internal distribution systems designed to operate with lower supply temperatures, so work best with energy-efficient buildings [8].

In addition, demand and supply matching on a temporal scale is also facilitated by high energy performance of buildings. The possibility of coupling district heating network expansion with building renovation may help district heating systems to continue to operate with sufficient utilisation factors of the baseload plants [4]. Cost-effectiveness for the district heating company can be ensured through a high utilisation of baseload capacity, which is easier in districts where the heating network can be expanded to counterbalance the energy savings [9].

Thermal mapping of building energy performance can also be used to target a joint renovation and expansion of district heating plan. This was the case in Paris, where in 2007 the Paris Climate Action Plan announced the ongoing development of a study providing details of 96,000 residences in Paris, including wall thickness, age, solar gains, building materials and an expected analysis of each building's thermal performance. These studies were designed to help identify the optimal areas for energy efficiency improvements, and could be used to direct network development and highlight inefficiencies.

Heat maps can help a local government identify potential projects that could be developed, how they can be best expanded and connected in the future, and how this ties into other infrastructure development. Through mapping a city can also understand how to best apply its land-use authority to encourage district energy and building efficiency integration as well as to develop tailored incentives in different zones. In several cities around the world, from Tokyo and Singapore to Vancouver and London, the city creates specific clauses in building developers' planning permission that requires connection to district heating or cooling in urban development zones that have been identified through mapping as having high district energy potential. Different data and layers of analysis can be added depending on policy goals and objectives. For example, present and future building density and use type; socio-economic indicators to identify fuel-poor areas that could benefit from connection; or building stock (size, construction date, density) to determine an opportune time, if applicable, to connect to an expanding modern district heating network.

## AGGREGATION OF DEMAND IS A KEY CHALLENGE FOR ENERGY EFFICIENCY INVESTMENTS

A critical challenge arises from the fact that many attractive energy efficiency investments such as housing renovation are of small size and broadly distributed across large numbers of buildings where energy cost and usage has not been a primary or strategic concern. The district level is a perfect scale to aggregate small investments with the support of local and regional authorities (see for example the case "Taking a district approach – Valladolid, Spain"), and other intermediaries such as trade federations, banks, utilities and other businesses with retail customers [10].

## Taking a district approach – Valladolid, Spain

The EU-funded project R2CITIES aims "to develop and demonstrate an open and easily replicable strategy for designing, constructing, and managing large scale district renovation projects for achieving nearly zero energy cities" [11]. While this example does not address connection to the district energy system, where such as system is in place, this is an example of a district approach to energy efficiency.

One of their demonstration cases is the Cuatro de Marzo district in Valladolid. Cuatro de Marzo is a compact residential district close to the city centre. The buildings in the area were built during the 1950s and they suffer from inadequate construction quality and ageing problems. The district has common problems directly related with heating losses, discomfort and very high energy consumption. The planned energy efficiency improvements for the district include:

- reduced thermal consumption (insulation and shadings improvements, ICT implementation);
- reduced electrical consumption (occupancy sensors in common areas, more efficient lighting equipment and detailed billing);
- reduced CO2 emissions by means of renewable energy systems (solar PV and solar thermal).

The restoration project in the district will be promoted by the Valladolid Municipality and apartment owners are encouraged to join the "retrofitting urban plan". It is planned that a total of 800 homeowners will join the retrofitting plan and it is expected that 300 dwellings will be refurbished [11].

Economies of scale combined with innovation in the construction sector allow for reduced costs in the renovation process, as demonstrated by the Dutch Energiesprong project, where the cost of a net zero energy renovation of a terraced house reduced from €130,000 for the first pilot project in 2010 to €65,000. [12]

As with other types of utilities, the revenue from the aggregation of customers paying for heating, cooling and hot water systems enables access to capital, such as municipal bonds, state and federal grants, or private project finance investors, which is usually unavailable to individual building owners. The aggregation of energy demand and the customer service model established for district energy can serve as the foundation for other clean energy needs and resource and infrastructure services and projects such as water management, wastewater recycling, decentralised renewable energy projects, etc. A city can create new tools to finance energy performance improvements to entire neighbourhoods in one phase of work. This local utility approach to energy system development also gives communities the option, should they want it, of taking greater ownership of local infrastructure assets and providing long-term operating revenues back to the community. In any case, the system owner, whether a community-based or a privately owned utility, can leverage long-term financing to cover the upfront capital costs with a rate structure that pays off the financing over time. [13]

## URBAN REGENERATION FOSTERS SOCIETAL BENEFITS

A district approach to building renovation can ignite an urban regeneration of neighbourhoods with social problems, and in many cases reverse a negative trend (see for example the case "Integrating a district approach to deliver urban regeneration – Mühlenberg, Germany"). Reducing energy poverty, which arises when the costs of heating and other energy use take too big a proportion of household income, has proven to be an effective way to improve air quality, reduce social problems and improve the quality of life in a district. A renovated district has a bigger potential to attract new tenants and businesses.

### Integrating a district approach to deliver urban regeneration – Mühlenberg, Germany

KfW, a German government-owned development bank, supports municipalities across Germany to develop urban district concepts[6] [14]. The idea is to develop strategies to boost energy efficiency in certain neighbourhoods, with the objective to support overarching climate goals. The integrated concept gathers information about the actual state of the district and potential savings, as well as recommendations for implementation, with special consideration of energy renovation of the buildings, optimisation of heat supply and the use of renewable energies.

Mühlenberg is a district in Hannover and one of five energy district concepts developed by the city. The district is easily recognisable by its many high-rise buildings; 50% of the gross floor area consists of apartment buildings with flat roofs from the 1970s. Before renovation, these buildings have a relatively high heating energy consumption of about 180 kWh/m²/year. Most of these buildings are now in a dire need of refurbishment. The energy district concept aims not only to improve the quality of the building stock but to alleviate some of the socio-economic problems the district is facing [15].

The concept identifies the following "strategic challenges" which must be mastered to fully exploit the energy-saving potential and achieve the long-term ambitions of a climate neutral building stock:

- *Convince housing associations*: One of the central tasks will be to present convincing business cases and through dialogue to overcome the scepticism of the housing industry in terms of cost-effectiveness and actual savings of high-quality energy renovation.
- *Activate private homeowners*: As part of a strategy that focuses on the district, measures are also needed to activate the private owners to further boost energy renovations.
- *Ensure social compatibility*: The district has a high importance as part of the social housing supply in the city of Hannover. The rise in rent ought to be limited in order not to have a negative effect on living conditions [15].

The holistic strategy for Mühlenberg covers four broad topics: (i) energy renovation of the building stock, (ii) optimisation of the district's energy supply, (iii) increase of renewable energies, and (iv) climate-friendly mobility [15].

**Energy renovation of the building stock and optimisation of energy supply**

The initial situation was analysed based on the district's energy consumption data. The building stock was divided into clusters and each cluster was given the number of buildings supplied with the respective energy sources. In the case of Mühlenberg, the majority of buildings are heated by gas. Based on the analysis of energy supply and demand, it is possible to draw some inferences on how it can be improved. In Mühlenberg, only a small share of the buildings are supplied by individual heating systems and the proportion of buildings with floor heating is low. Most of the existing buildings are connected to a common heating system.

One of the findings is the option to exploit the potentials of renewing the energy supply technology in connection with the renovation of the buildings. It was concluded that replacement of the existing individual heating systems by combined heat and power plants can be cost-effectively implemented in combination with other investments in the buildings [15].

6 KfW Programme 432 "Energetische Stadtsanierung" supports municipalities with up to 65% of the eligible cost. The grant can be combined with other subsidies.

## SHIFTING FROM A FRAGMENTED TO AN EXTENDED DISTRICT APPROACH

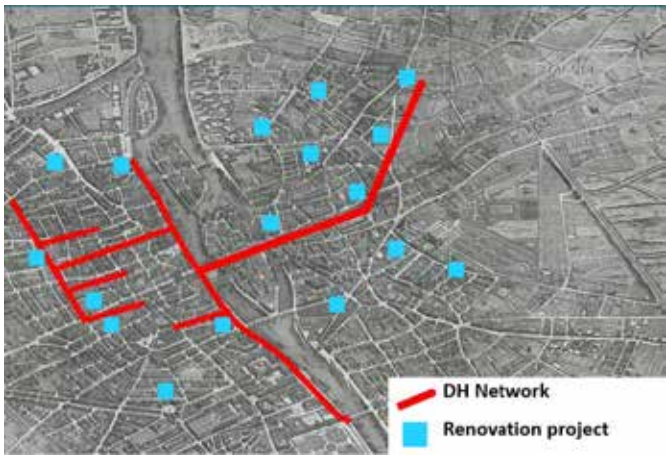



*Figure 4a: visualisation of a conventional approach with fragmented renovation (source: BPIE own elaboration)*

The district approach can beneficially be extended over time, as illustrated in Figure 4a, Figure 4b and Figure 4c. The conventional approach with outspread renovation projects (Figure 4a) does not bring any direct benefits to the district heating system; it can even make it more difficult to predict future heating demand.

A district approach where buildings and the heating network are upgraded in tandem according a harmonised and comprehensive strategy generates synergies leading to multiple benefits.

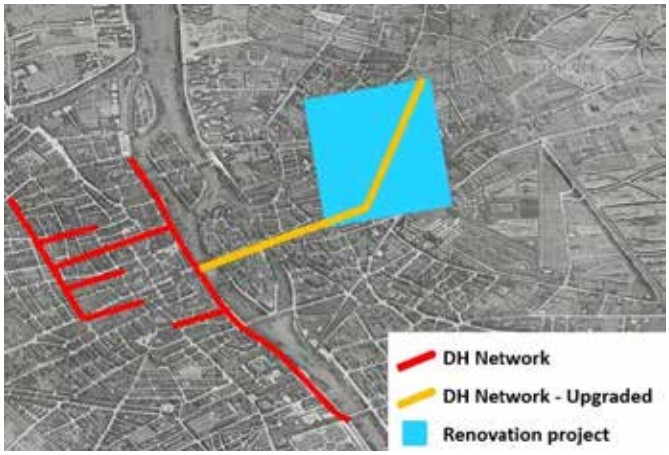



*Figure 4b: visualisation of an initial district approach, combining building and district energy system renovation (source: BPIE own elaboration)*

Aligning a district approach is an evolving process, starting with a basic initial approach (Figure 4b) progressing towards an extended approach (Figure 4c) that combines efficient buildings with a sustainable district energy system.

In the initial district approach, a strategy is developed and implemented whereby renovation works are aggregated, e.g. block by block, in the same district while the district energy system undergoes an upgrade. Through economies of scale, bundling renovations implies lower investment costs, but also allows the district energy system to become more efficient through reduced peak demand and supply temperature, thus reducing the energy bills even more.

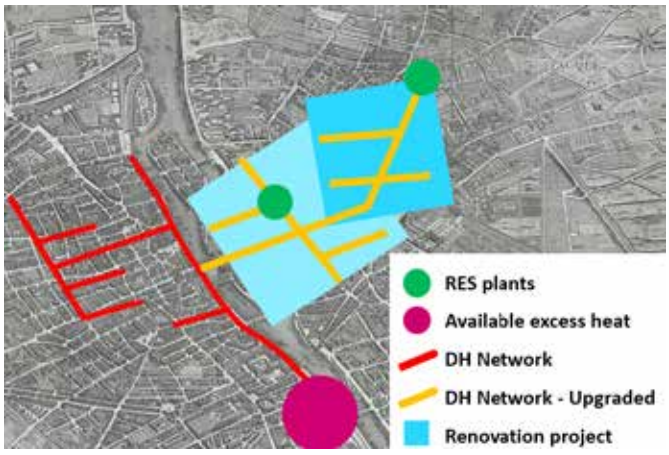



*Figure 4c: visualisation of an extended district approach (source: BPIE own elaboration)*

To further evolve towards an exhaustive sustainable district, the districts targeted for renovation further expand, while the district energy system increases the share of heat from renewable energy or excess sources.

# POLICY APPROACHES

Different policy approaches need to be considered, which integrate improving the energy efficiency of buildings and the district energy system. These include:

- Minimum building energy efficiency requirements that consider district energy
- Subsidies for new and retrofitted buildings connected to district heating
- Requiring compatibility and/or connection of all new buildings, and those undergoing deep renovation, to the district energy system
- Green building standards and labels that account for primary energy efficiency savings.

The following sets out some examples of how these approaches have been taken in different cities and regions.

## MINIMUM BUILDING ENERGY EFFICIENCY REQUIREMENTS THAT CONSIDER DISTRICT ENERGY SUPPLY – MILAN, ITALY

Milan uses its building codes to promote an integrated approach to building efficiency and district energy. The building code stipulates specific minimum energy efficiency requirements for new and retrofitted buildings and is higher than national standards. These energy efficiency requirements do not only look at the building but also the supply of heat and hot water and so can be met by connecting to the district heating network in combination with other building efficiency measures. As such, buildings are being encouraged through the city's building code to connect to district heating. A prerequisite to meeting the standards of the building code is for a building not to have a diesel boiler, promoting a switch to sustainable heating in new and retrofitted buildings. The building code also allows new buildings to exceed standard building size requirements in planning conditions if they meet higher energy efficiency levels than the minimum. This is effectively a density bonus for developers in the city that are developing high-efficiency buildings, and further encourages connection to district heating. By taking an integrated approach that encourages both efficient, low-carbon district heating and renovation and high building standards, Milan can both plan for higher-value buildings and reduce primary energy effectively.

## SUBSIDIES FOR NEW AND RETROFITTED BUILDINGS CONNECTED TO DISTRICT HEATING AND RELATED AWARENESS RAISING – MILAN, ITALY

Milan provides a reduction in infrastructure charges for new and retrofitted buildings that respect standards concerning energy efficiency and/or renewable energy sources, including connection to district heating. District heating does not represent a compulsory requirement for the reduced infrastructure charge, but can represent one of the elements that allow the achievement of the fixed standards. The absence of diesel oil as a fuel in heating is a pre-condition to benefit from the incentives provided by the infrastructure charge reduction measure. In addition, Milan previously provided incentives for district heating in the form of a direct subsidy to buildings to switch from diesel oil boilers to district heating to overcome initial capital costs. However, the payback period of this switch is today so low at 4-5 years that the city no longer provides incentives as building owners will switch anyway. [16]

In order to promote this opportunity to building owners, Milan has a municipality-run energy helpdesk that provides technical and financial information on energy issues to end-users and residents. Energy experts are available according to a fixed schedule in the institutional offices of the city's districts, to address any questions and to provide information on potential interventions, available incentives and financing instruments on renewables, district heating, fuel switching and energy efficiency in buildings.

In Milan, many existing buildings already have a centralised heating system. In these cases, besides substituting the existing boiler with a heat exchanger and the connection to the network, no other significant infrastructural works are needed.

Energy suppliers offer retrofitting through energy service contracts. However, communication is a key ingredient to obtaining the energy service agreements. The current building owners need to be educated on the benefits and reliability of being a customer of a district energy system, and a municipal helpdesk can contribute to the knowledge and information being made available to the citizens.

## ENERGY EFFICIENCY STANDARDS AND LABELS CONSIDERING PRIMARY ENERGY SAVINGS – GERMANY/FINLAND/ABU DHABI/US

Accounting methods used to develop efficiency ratings, labels and standards for buildings are usually based on energy consumption within the building. They rarely account for the ways that electricity and heat are produced, or for the use of non-renewable energy, creating a disincentive to use district energy and contradicting energy targets for its deployment. In Finland and Germany, building codes set primary energy efficiency standards for new buildings, and different sources of heat have different coefficients. The higher the coefficient, the more difficult it is to achieve the standards, as the primary energy efficiency is lower. Both countries require that a certain share of the energy used come from renewable sources. District heating based on CHP/excess heat and/or renewable energy is automatically considered to fulfil this criterion.

The energy-saving ordinance in Germany aims to reduce the primary energy demand of buildings to save resources and lower greenhouse gas emissions. Insulation, efficient systems and primary energy sources can fulfil the obligations. The system therefore reflects the efficiency benefits of modern district energy. The Pearl Rating System used in Abu Dhabi is another example of coherent energy efficiency accounting in design, planning and implementation.

The US Green Building Council has released an updated guideline on district energy that enables buildings connecting to district energy to earn credits for efficiency improvements, renewable energy supplies and refrigerants (in the case of district cooling) as a result of district energy. They can also earn a credit ("innovation point") related to "green heat" supply to buildings under the Leadership in Energy and Environmental Design (LEED) rating system. By considering both final and primary energy in the accounting methods, the efficiency gains at district level are more explicit and can be rewarded correspondingly.

## NATIONALLY QUANTIFYING AN INTEGRATED APPROACH – HEAT ROADMAP EUROPE

In the 1970s, the international oil crises sparked a development towards energy planning in Denmark, which until then had largely been demand-driven and overwhelmingly dependent on oil. Energy planning paid large attention to the energy savings in the built environment, and efficient heating technologies (such as district heating, combined with cogeneration) played a large part in reducing the dependency on (foreign) oil in the immediate aftermath of the oil crises [17].

This national policy approach of explicitly combining the potential for improved building standards and the potential for renewable and sustainable energy sources, particularly in the district energy sector, played a large part in the development of the Heat Roadmap Europe methodology. This project series aims to develop strategies which cost-efficiently decarbonise the heating and cooling sector, combining increased thermal efficiency of the built environment and industrial processes, and the supply of sustainable energy via efficient district heating, heat pumps, and the use of renewables.

Heat Roadmap Europe has focused both on the European level and on 15 different countries in Europe, including Croatia. One of its key findings is that in terms of primary energy and $CO_2$ savings, the potential for greater efficiency is similar on the building side, and on the supply side (see figure 5). This kind of approach shows that energy efficiency is needed both in terms of the thermal efficiency of the built environment, and the implementation of (efficient) district energy approaches.

By quantifying this on a national level, the results show the scale at which energy efficiency potentials can contribute to the national energy system, and provide impetus for national and supra-national frameworks to incentivise district approaches.

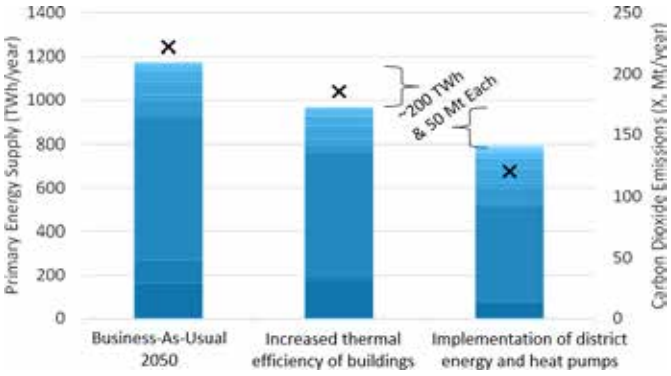



*Figure 5: Potential impact of increased energy efficiency in buildings, district energy and heat pumps [8]*

# THE SITUATION IN BELGRADE

## NATIONAL APPROACH

Serbia's approach to renovation and district heating is set out in its Third National Energy Efficiency Action Plan (for the period to 2018) [18] and National Energy Sector Development Strategy [19].

The National Energy Sector Development Strategy includes several measures related to improving the energy efficiency in district heating systems, such as continued modernisation (including reduction of distribution losses and introducing measuring end-users' heat consumption and billing) and expansion of the existing district heating system. In recent years several projects for reconstruction and modernisation have been implemented.

Over a period of years, a total of €101.42 million of investment has been provided, as part of a cooperation between KfW (the German government-owned development bank) and the Serbian Ministry of Mining and Energy, to the Programme for Rehabilitation of District Heating Systems in 22 municipalities in Serbia. As a result of these loans, 40.4 km of district heating pipeline has been reconstructed or replaced, 960 stations for consumer heat exchanged, 59 km of pipes replaced with new pre-insulated pipes, 11 km of new pipelines constructed, 2,700 heat meters installed, 6 heat-only boilers modernised, and 7 new ones constructed.

The National Law on Efficient Use of Energy also requires introduction of metering and billing of actual consumption of heat at the level of the heat station. For the case of connecting new buildings to the district heating network, it is investors who are required to install devices that measure the consumed heat. If technical conditions allow and it is economically advantageous for buildings already connected to the district heating system to transfer to consumption-based billing, at the request of the apartment owner the distributor must provide an offer for installation of heat-measuring devices. However, it is up to apartment owners to cover the costs of the devices for controlled regulation of the consumed heat on each radiator.

This relates to Serbia's commitments as a member of the Energy Community and an EU candidate country, for which Serbia has started the process of transposing EU regulations, such as the Energy Performance of Buildings Directive (2010/31/EU) and the Energy Efficiency Directive (2012/27/EU) into national law.

In relation to renovation of buildings, the Law on Planning and Construction defined for the first time in law the term "energy performance of a building", alongside an obligation for energy performance certificates for buildings. Underpinning this are the rulebooks on energy efficiency in buildings (explaining the general procedures and principles for calculation with the list of applicable standards) [20] and on conditions, content and method of issuing energy performance certificates [21].

Adoption of regulations started in 2011 and became obligatory from 2012. Rulebooks currently only address the building envelope, heating system and hot water preparation, but are currently under revision and will include cooling, ventilation and lighting as part of the revision process.

Maximum energy performance values of new buildings and for existing buildings undergoing renovation are defined by the "Rulebook on energy efficiency in buildings" [20]. Specific values of maximum allowed energy need for heating are defined for each building type. Table 1 gives threshold values for energy performance indicators per building type. [22]

*Table 1 – Energy performance indicators for new and refurbished buildings per building type (Source: [22])*

| Building use | Energy performance indicator threshold for new buildings (kWh/m² per annum) | Energy performance indicator threshold for renovated buildings (kWh/m² per annum) |
|---|---|---|
| Office and administration | 55 | 65 |
| Education and culture | 65 | 75 |
| Healthcare | 100 | 120 |
| Hotels and restaurants | 90 | 100 |
| Trades and services | 80 | 90 |
| Sports | 70 | 80 |

The Law on Housing and Maintenance of Buildings adopted in 2016 made a significant change for the residential sector. For the first time, improvement of energy efficiency was declared to be a matter of public interest; thus, the national government can now provide state budget funds for this purpose in the residential sector. This enabled the creation of funds such as the City of Belgrade Budget Fund for Energy Efficiency.

According to the Energy Community Secretariat [23], Serbia achieved progress towards transposition and implementation of the energy efficiency acquis with the adoption of the Third Energy Efficiency Action Plan, but additional secondary legislation mainly linked to the buildings acquis is still missing and should be adopted without delay. It also recommends that the priority for Serbia in the forthcoming period is the transposition of the Energy Efficiency Directive, which would include development of a national renovation strategy and implementation of consumption-based billing.

## CITY APPROACH

To date, district heating reconstruction and modernisation in Belgrade has been supported by loans from the European Bank for Reconstruction and Development (EBRD), technical and financial aid from the Swedish International Development Cooperation Agency (SIDA) and KfW, and national (Public Investment Management Office) and city resources. An investment of more than €100 million covered replacement of old pipelines and pipe fittings, and reconstruction and modernisation of heat plants and 8,500 substations. The implemented modernisation increased the production efficiency from 0.78% to 0.88%.

The development strategy of the Belgrade district energy utility "Beogradske elektrane" sets out clear goals and targets, with an outlook to 2025. This includes connecting an additional 200,000 $m^2$ per year (which would primarily be new buildings) in the coming years, with an additional 3 million $m^2$ of residential apartments and business premises connected by 2025. The long-term vision is to transition from the current system to become fourth generation with a significant share of renewable energy in production, reduced water temperature in the distribution system and greater coverage of Belgrade [2].

The requirement to implement consumption-based billing is a challenge in Belgrade since currently only about 8% of total residential buildings have consumption-based billing and these are mainly new buildings. However, the percentage of business premises with consumption-based billing is significantly higher, about 85%. Consumption-based billing typically involves splitting the fee for heating into a fixed part or connection fee (to cover distribution investment, operation and maintenance, which are not dependant on the amount of heat generated or consumed) and a variable cost, to cover the cost of generating heat. The primary issue with fixed payment is that it does not incentivise energy savings on the customers' side; in addition, some are paying too much, and some are paying too little. There is concern that introduction of consumption-based billing in the existing (old) residential building stock, and particularly considering the number of buildings that are inefficient, would lead to significantly lower charges for some, and larger bills for others during the heating season. Consequently, those with the most inefficient buildings and control systems would see their payments rise, and could request to be disconnected. This would likely increase air pollution as a result of greater use of individual stoves and/or increase demand for electricity for heating. It would also make the district heating distribution system less efficient as the coverage falls, and heat demand density would be lower.

However, the move to consumption-based billing also increases the feasibility of energy renovations for individual consumers, since the demand reductions are mirrored in a fee reduction. This is especially the case for those consumers who are currently using proportionally more than they are paying for, and would be most negatively affected by a shift to variable costs.

The development strategy explicitly states that a "precondition for successful transition to consumption-based billing is the improvement of the insulation and energy efficiency of the buildings, primarily for most energy inefficient buildings". The Belgrade district energy utility also acknowledges its essential role and responsibility for improving energy efficiency in buildings within Belgrade. This includes:

- continuously educating its customers on district heating energy efficiency and on improving the energy efficiency of all buildings, and to be available to the customers at any time for the necessary consulting assistance on optimal ways to reduce heat consumption, while maintaining the same comfort in the apartments;
- regularly informing its customers (for example, on heating bills) about their consumption, their consumption in relation to average consumption of similar buildings in Belgrade and potential measures to improve the energy efficiency of their buildings or apartments;
- raising the energy efficiency of its own heat sources, distribution network and substations to provide an example of best practice to the public;
- improving the energy insulation and energy efficiency of all its office buildings in line with what it expects from its users; and
- reporting on the state of insulation of buildings, including analysing the average consumption of buildings connected to Belgrade district energy system, to produce a list of the those that consume the most heat. These buildings could then be the focus of future funds for improving their energy performance. This could also help the City of Belgrade to establish its own priority programme for reconstruction of building stock, and particularly buildings connected to the district energy system.

# FINANCING APPROACHES

## BUSINESS MODELS

The following business models could be opportunities to align and fund approaches to improving the energy efficiency of buildings and district energy.

### SERVICE-BASED ENERGY PERFORMANCE CONTRACTING

Energy performance contracting is a form of service contract in which the contractor pledges that a specified amount of energy will be saved throughout the project period. An energy service company (ESCO) is the commercial or non-profit business that designs, plans, funds and implements the energy reducing project. Under an energy services agreement the contractor provides a performance guarantee, while the end-user makes a fixed monthly payment to pay back the investment. Depending on the resources of the ESCO and on the market demand, the ESCO may finance the project (building renovation, district heating expansion, etc.) itself or help secure funding by providing performance guarantees.

The energy performance contracting model implies that the contractor's compensation is directly linked to the performance of the project over time, creating an incentive for energy savings. These services include installation of energy-efficient equipment, renovation, maintenance and operation, facility management, and the supply of energy.

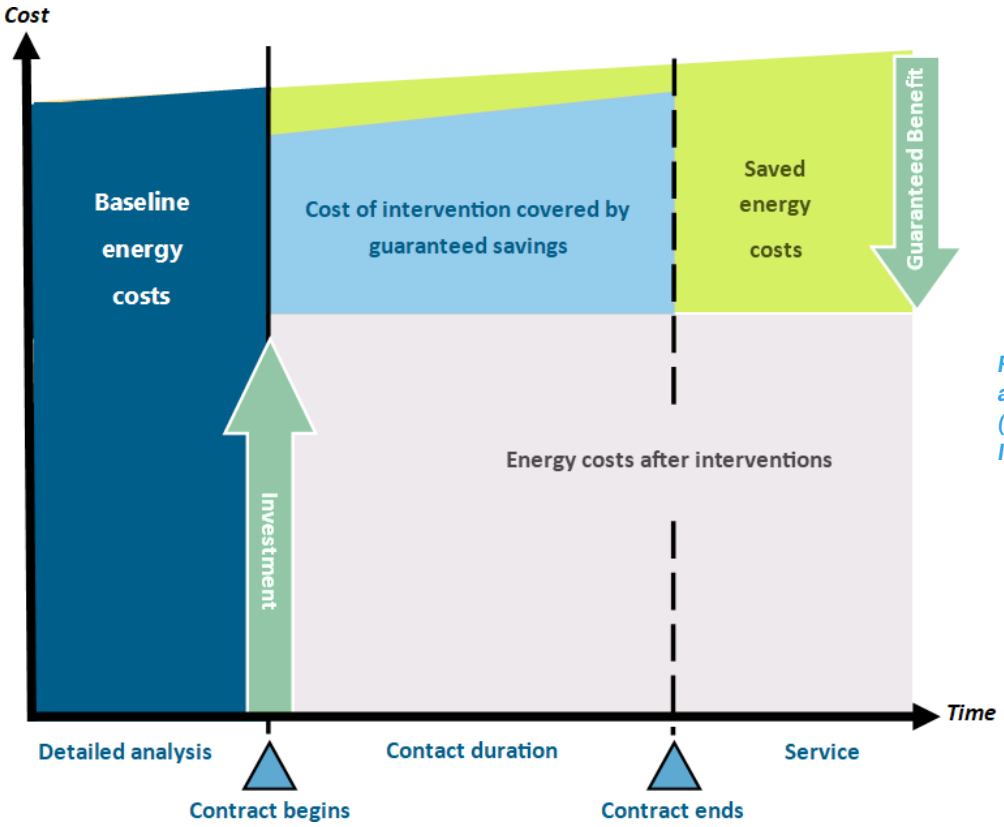



*Figure 6: Business model of an energy service company (BPIE own figure, adapted from Institute of Building Efficiency)*

Multi-utility service companies (MUSCOs) can combine demand-side and supply-side services, for example by managing the district energy system and providing a renovation programme and energy efficiency measures to reduce energy demand. This model could be particularly relevant for large and commercial buildings (e.g. hospitals, schools, shopping centres, etc.).

Regular monitoring and verification is essential to ensure that savings are realised. This will be agreed between the city or owner and the ESCO/MUSCO. The International Performance Measurement and Verification Protocol (IPMVP) is commonly used and internationally recognised. It defines standard terms and best practice recommendations for quantification of energy savings [24].

**ESCO design – Thurrock, UK**

In 2010 Delap & Waller, on behalf of the Carbon Trust for Thurrock Council, produced a study evaluating the feasibility of the renewable energy targets in new residential and non-residential buildings. The holistic approach included both building stock retrofit and an optimisation of the district energy system.

A central topic of the action plan was to design an ESCO. It was concluded that the establishment of district energy networks required support from Thurrock Council, and that the council should develop its own ESCO by partnering with an experienced operator. A combination of an energy supply ESCO and a local retrofitting company was described as the best option as it could set up an effective 'pay-as-you-save' scheme [25].

**The study outlines some first steps to be undertaken for setting up an ESCO partnership:**

1. Apply for funding through the European Investment Bank (EIB), in order to be able to employ an experienced company to develop a business plan for the ESCO and a tender package for an experienced district energy network partner and retrofit contractor.
2. Negotiate with the reputable companies on the tender list or go to tender to find suitable ESCO partners.
3. Develop the first district energy network for publicly owned buildings in an area of high density and campaign/market the scheme to attract other connections and extend the network.
4. Offer a 'pay as you save' retrofitting service to those buildings connected to the network using the network's billing system to make repayments for the costs of retrofitting simple to collect (on bill financing). This incentivises retrofitting, thus helping to achieve the carbon reduction target, and allows the network to expand while minimising the energy required to operate the network.
5. Market the services of the ESCO to enable the development of a series of district energy networks with existing building owners and new building developers.
6. Market the ESCO retrofitting service to all building owners and use government programmes to incentivise retrofitting and provide innovative financing options for retrofitting [25].

If a service-based approach is offered by the district energy utility, it may help to prevent customers disconnecting from district heating and attract new customers by providing a complete high-quality service. In addition, this could be seen as modernisation and help to spur interest in the company and attract new generations to work for the utility – this would support the goal of the district energy utility in Belgrade to attract greater numbers of younger employees.

**ESCO–district energy utility partnership – Seattle, US**

In 2011, Seattle Steam (the district energy utility in Seattle, US) joined a public-private coalition to encourage downtown building owners and managers to make energy efficiency improvements aimed to cut energy costs, increase profits, and strengthen Seattle's local economy. Seattle Steam partnered with a local energy service company to offer an energy savings programme directly to district energy customers. Through the programme, customers reduced their energy consumption by up to 29%.

The programme is structured into three phases undertaken by the ESCO in conjunction with Seattle Steam. Phase I provides a qualitative analysis of the building's energy saving potential. Seattle Steam customers and the ESCO have the ability to access individual building steam data as far back as 1991 through an online portal. The portal helps customers monitor and evaluate energy savings as they implement energy-efficient improvements. Seattle Steam uses the data to identify any operation inefficiencies that may occur as well as for analysis for budgeting, forecasting, demand and usage.

If potential savings are identified, Phase II is initiated. This focuses on a quantitative analysis of the building's historical energy bills, an existing equipment audit (may include metering stations, pressure reduction valves, hydronic distribution network, air handlers, condensate return etc.), and a detailed list of energy- and cost-saving measures, capital costs and payback periods. Properties that advance to Phase III can access grant funds and low-interest loans to finance building-side energy efficiency upgrades.

Seattle Steam offers Phase III customers on-bill financing that allows them to pay back the loans over time through their monthly utility invoices. In most cases, the energy savings account for the entire upgrade cost, so building owners do not see an increase in their monthly utility bills. Typically, the loan is paid off in five to seven years, at which point the building owner sees a substantial reduction in the monthly energy bill.

Seattle Steam recognises the environmental and economic value to the district system in ensuring customer building efficiency, and this innovative programme facilitates efficiency improvements that otherwise might not be realised. From a business development perspective, Seattle Steam's in-house ESCO programme lowers customer's utility bills once the loan for efficiency upgrades has been paid off, allowing the system to retain existing customers with competitive rates [5].

# FINANCING PROGRAMMES

The following are potential EU and regional financing schemes which are available and could be relevant in Belgrade for funding both renovation and improvements to district energy systems.

## INSTRUMENT FOR PRE-ACCESSION ASSISTANCE

The Instrument for Pre-accession Assistance (IPA) is used to support reforms in the countries looking to join the European Union [26]. It provides financial and technical assistance to enable countries to prepare for participation in the EU. For 2014-2020, €11.7 billion will be distributed by the instrument [27].

When a country joins the EU, it must comply with the "acquis communautaire", including EU Directives such as the Energy Performance of Buildings Directive (EPBD) and the Energy Efficiency Directive (EED). The EPBD and EED require national renovation strategies and renovation of public buildings (Article 5 EED), as well as assessment of the potential for efficient district heating and cooling (Article 14 EED) and ensuring meters and billing are in place to reflect actual heat consumption (Article 9-11 EED). Therefore, the IPA could be used to help to comply with these requirements and in doing so be used to align approaches to renovation and district heating in Belgrade, as Serbia has already started the process of embedding these directives into national law.

For the 2014-2020 period it is planned that the IPA will be used to contribute to reconstruction of the district heating system/ boilers for the use of renewable energy sources. It will also be used to rehabilitate and upgrade the heating distribution system, and to rehabilitate four public buildings in Belgrade. [28]

## WESTERN BALKANS INVESTMENT FRAMEWORK

The Western Balkans Investment Framework (WBIF)[7] has two main objectives: pooling grants, loans and expertise to finance priority investment projects; and strengthening coherence and synergies among donors to increase the positive impact and visibility of investments in the Western Balkans [28]. To date, the WBIF has contributed €22.6 million to three energy efficiency related projects in buildings [27]. WBIF provided €1.3 million for technical assistance under the "Energy Efficiency in Public Buildings" project in Serbia, which is also funded by KfW and the involved municipalities [18]. It also contributed to the "Programme for Rehabilitation of District Heating Systems in Serbia" [29].

7 More information can be found at: *https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/pdf/western-balkans-conference/wbif-a4-def_en.pdf*

## GREEN FOR GROWTH FUND

The Green for Growth Fund (GGF) was initiated in 2009 by the EIB and KfW to enhance energy efficiency and foster renewable energies in South-East Europe, in the form of a public-private partnership with a layered risk/return structure. As of March 2015, the committed volume amounts to €185.6 million. GGF's investments seek to achieve a 20% reduction in energy consumption and/or a 20% reduction in $CO_2$ emissions, by:

(i) Refinancing financial institutions (local commercial banks, non-bank financial institutions such as microfinance institutions and leasing companies, and other selected financial institutions) providing loans to households, businesses, municipalities and the public sector for energy efficiency measures or renewable energy projects. Investments through financial institutions constitute the majority of GGF's investments.

(ii) Providing direct financing to non-financial institutions (companies, ESCOs, renewable energy companies or projects, small-scale renewable energy and energy efficiency service and supply companies).

## EU FINANCING – ELENA (EUROPEAN LOCAL ENERGY ASSISTANCE)

ELENA (European Local ENergy Assistance) supports projects including retrofitting, integrating renewable energy in public and private buildings, and energy-efficient district heating and cooling networks. It can cover up to 90% of the technical support costs of preparing the investment for implementation and financing of projects. This includes feasibility and market studies, programme structuring, energy audits and tendering procedure preparation. Assistance in creating solid business and technical plans helps to attract funding from private banks and other sources, including the EIB.

## WESTERN BALKANS SUSTAINABLE FINANCING FACILITY(WEBSEFF)

WeBSEFF is a financing facility under which the EBRD provides credit lines to partner banks in the Western Balkans to lend on to businesses and municipalities wanting to invest in energy efficiency and small-scale renewable energy projects. WeBSEFF is part of the EBRD's Sustainable Energy Financing Facility (SEFF) family. To date, SEFFs have made available €2 billion for financing projects through more than 80 participating local financing institutions in 20 countries worldwide. So far, WeBSEFF has supported projects on energy efficiency in Serbia with a total value of €1.5 million through UniCredit Bank Serbia.

## FINANCING EXAMPLES

The following examples demonstrate how financing programmes have been used to fund both improving the energy efficiency of buildings and improvements to district energy systems.

### BOTOSANI, ROMANIA

During the 1990s and early 2000s, Romania's district heating sector suffered from lack of investment, which led to reductions in operational efficiency and reliability of heat supply. Combined with the rising cost of natural gas, this caused serious affordability constraints for end-users, resulting in disconnections from the network, which further reduced operational efficiencies. By the mid-2000s, the annual heat losses topped 50%. The poor financial state of the district heating sector meant that long-term commercial financing needed to modernise these utilities was not available. The Romanian Regional Operational Programme (supported by EU Structural Funds) provided greatly needed financial support to upgrade district heating systems across Romania. However, several municipalities, including Botosani, struggled to secure their share of co-financing, as access to commercial financing was scarce.

The International Finance Corporation's (IFC) Subnational Finance group helped Botosani to secure the municipality's co-financing requirement. As a result of the project, a state-of-the-art CHP plant and two heat-only boilers were installed (replacing an oversized and inefficient heat capacity), and 6.5 km of transmission and 14.3 km of distribution in the district heating network were replaced. The second phase of the project financed replacement of an additional 3.7 km of distribution pipes, as well as an energy efficiency improvement programme for residential buildings. The total project cost was €45.7 million, with the IFC providing a loan of ~ €8 million. In addition to financial support, the IFC provided advisory services to the Botosani district heating utility to identify technical measures to reduce costs (largely changes in operational modes) and cost-structure review [5].

### VILNIUS, LITHUANIA

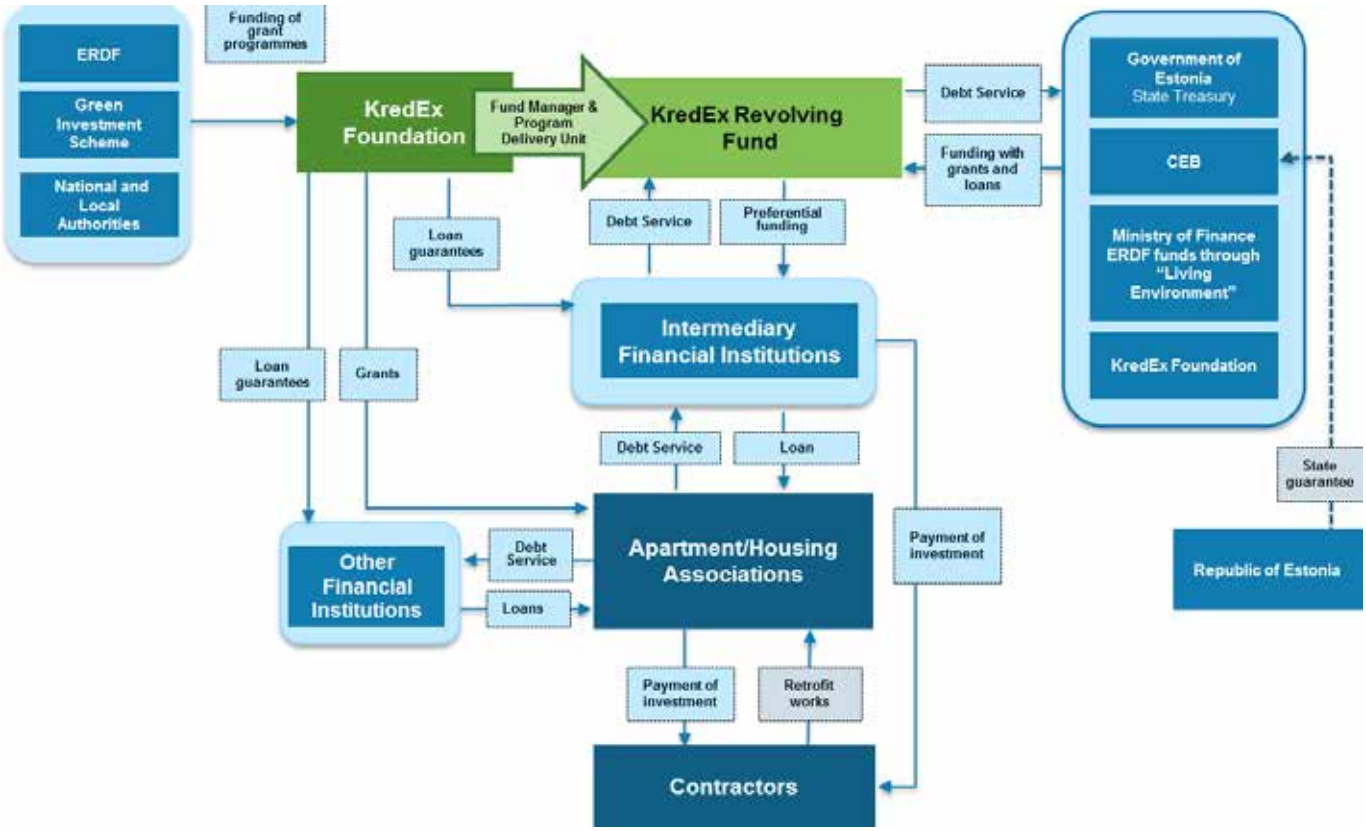
The World Bank provided a US$6.5 million grant from the Global Environment Facility (GEF) to finance the Vilnius Heat Demand Management Project in Lithuania. The project aimed to reduce greenhouse gas emissions from the district heating system by implementing energy efficiency investments in the city's residential buildings. This included co-financing Vilnius Energija's (the district energy utility) demand management programme and creating a revolving financial facility – Energy Conservation Programme Commercial Fund – to support investments aimed at reducing heat losses from the residential building stock [30]. The demand management programme included introducing measures such as thermostatically controlled radiator valves, heat meters, and building-envelope improvements to reduce energy losses. [31]

Vilniaus Energija established an Energy Efficiency Fund of €5.8 million, which covered 75% of residents' individual heat-metering costs. These systems were installed in 188 multi-apartment buildings in Vilnius.

## ESTONIA

The Kredex Revolving Fund in Estonia is fundamentally a lending institution. Through its financial intermediaries Swedbank and SEB, it provides financial products such as preferential loans and loan guarantees for renovation of apartment buildings. This covers the necessary upfront investment, which housing associations are able to repay as heating bills are reduced. The fund also acts as an intermediary for reconstruction grants and grants for efficiency audits, evaluations and project design documents, and as a promoter of energy efficiency. It has put considerable effort into promoting a more efficient use of energy and raising energy efficiency awareness in Estonia.

*Figure 7: Kredex Revolving Fund operational and funding model (Source: [32])*



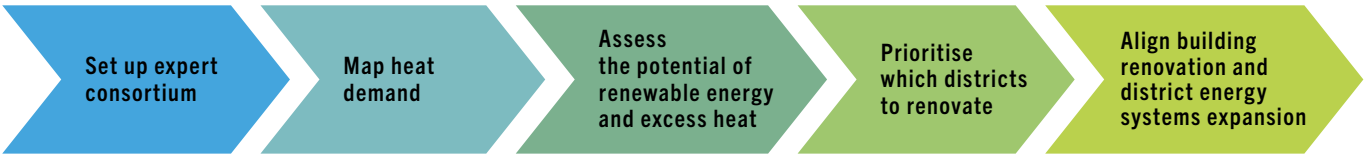
# CONCLUSIONS AND RECOMMENDATIONS TO ALIGN DISTRICT ENERGY AND BUILDING ENERGY EFFICIENCY DEVELOPMENTS IN BELGRADE

The following recommendations are distilled from discussions with experts and stakeholders about the local challenges at the workshop on this topic in Belgrade in March 2018. Stakeholders and experts included Belgrade District Heating Utility, National Ministry of Mining and Energy, City of Belgrade, Association for Sustainable Development, GIZ, Regional Agency for Development and EU Integration, Serbia Green Building Council, Secretariat for Urban Planning and Construction, Secretariat for Environmental Protection, RES Foundation, University of Belgrade, BPIE and UN Environment. They build further on the examples and approaches discussed in the previous chapters.

These recommendations provide areas of focus for policy-makers in Belgrade, as well as being applicable to other cities and regions wishing to develop and implement district energy and energy efficiency approaches.

## POLICY DEVELOPMENTS – CREATE AND IMPLEMENT A VISION OF AN INTEGRATED DISTRICT APPROACH

### Recommendation 1: Map renovation potential and heat sources to provide an integrated district view




To align and create synergies between approaches to district energy and energy efficiency in buildings and tap the potential benefits and investment opportunities, it is necessary to gain a true understanding of the potential for renovation and the future of the district energy system. As buildings are renovated they will become more efficient, reducing energy needs and the need for high temperature district heating supply. This will impact on the district energy system. Therefore, understanding where connections and reconnections would be most beneficial, considering the potential for renovation, is important to ensure it is planned strategically. The assessment should take account of where energy needs are high, the potential for local and low-carbon heat sources, and where air pollution from use of stoves is an issue which could be addressed by connection to district energy. Mapping heat demands, as undertaken for example by the Heat Roadmap Europe project, identifies areas with a high potential to implement district heating, apply tailored land-use planning policies and incentives, reduce heat demand and temperatures, expand district heating, or establish frameworks for individualised supply options. A consortium of technical partners, combining expertise on buildings, district heating and urban planning, should be established to support and carry out this mapping exercise.

Assessing the potential of using renewable energy and excess heat as a source of heat for the district energy system will show how efficient and sustainable the system could be. This could form the basis of what the district energy system could and should look like in the future, how it can be best expanded, and how this expansion can tie in with other infrastructure development. For example, an assessment should be made of the sources that could replace gas and oil boilers in the short, medium, and long term to enable a move away from reliance on fossil fuel boilers. In addition, this will allow for an assessment of how renewable energy can be integrated, and how much excess heat can be used. Based on this, the primary energy savings and the many other benefits of doing this can be calculated and quantified.

It is important to understand the impact of renovation on the operation of the district energy system. Mapping where loads and temperatures can best be reduced, and the effect of load and temperature reduction, is necessary to maximise the synergies and guarantee investments happen in the most suitable locations. The existing National Typology of Residential Buildings in Serbia [33] could be scaled up to include more building types. This would help to provide more information on energy demand, and the possible reduction in energy demand that could be delivered by renovation.

Mapping would support and stimulate an aggregated approach to renovating buildings at a district level. This would help to bring down costs of renovation, increase the leverage of public funding and build awareness. Aligning this aggregated approach with district energy systems would allow a truly integrated district approach to be taken.

## Recommendation 2: Harmonise and implement policies across all sectors


The City of Belgrade should set short-term three-year programmes and immediate one-year implementation plans to operationalise national plans and policies at city level. The three-year programme and one-year implementation plan should be embedded within the city's long-term renovation strategy as well as the national long-term renovation strategies. It is important to review the relevant policies in place (concerning both energy efficiency in buildings and district energy) and the policies needed to support the national policy agenda. From this the shorter-term programmes and plans can be established. This will ensure a harmonised approach is taken, which means policies can be designed to be complementary and ensure they are implemented in the most effective way. These plans, as well as setting out the specific policy approaches and actions, should be used to define responsibilities at both political and administrative level. By taking a holistic view of both district energy and energy efficiency policies an integrated approach can be established.

## Recommendation 3: Build and maintain political support through awareness raising


Wide political support for policies which align both district energy and energy efficiency is essential to prevent a stop-and-go approach to such policies. Political support is needed for energy efficiency and district energy policies to ensure they remain priorities and the supporting policy framework is maintained.

Understanding the perspectives and experiences of building users can unearth drivers for policies and political support. For example, in a survey presented in the study Healthy Homes Barometer 2016 [34], 14,000 Europeans from 14 countries were asked the reason for renovating their homes. Improving overall wellbeing at home was indicated as more important than reducing energy costs. In the Dutch Energiesprong project, what building occupants liked most about their renovated net zero energy homes was the deeper windowsills, the new kitchen and the fact that the house no longer looked like social housing.

These multiple benefits can help to increase the political "attractiveness" of these policies. Energy renovations, for example, address many important topics: tackling social issues (such as energy poverty) and health issues, creating jobs, reducing air pollution, as well as reducing greenhouse gas emissions. It is important to clearly identify and valorise these benefits, which go beyond monetary savings, by engaging research institutes and think-tanks, many of which are exploring this topic at the macro-economic level.

Increasing public awareness of district energy and energy efficiency and their benefits is an important step. Setting up a survey with different end-users can help to build understanding of their needs and expectations. By understanding what they value most, policies – and more importantly the narrative around policies – can be tailored to these values. The narrative of policy communications should include the benefits which are considered the most important to the audience. Real-life examples can help to showcase the benefits and engage the broader public. Renovation of public buildings can provide such a showcase. Heat mapping can also be used as a tool to visually showcase projects and benefits in different neighbourhoods.

Conducting a thermal diagnosis to improve thermal performance of buildings would also help consumers understand how installing new insulation, removing oil boilers, installing double-glazed windows, and switching to district heating can help to achieve economic, social and environmental goals. Raising awareness on how owners of buildings can come together (e.g. owner associations) to reduce the energy demand of their heating systems, which could involve connecting to a district heat network, could also facilitate community support for building efficiency renovations.

## FINANCIAL DEVELOPMENTS – SEIZE THE FINANCIAL OPPORTUNITIES

### Recommendation 4: Make the Energy Efficiency Fund operational


The City of Belgrade Budget Fund for Energy Efficiency (BEEF) has been created but it is not yet fully operational. Several steps are needed to fully establish the Energy Efficiency Fund. Well-designed and established funds, such as Kredex Revolving Fund (see section Financing examples), can provide guidance and inspiration to the BEEF. To establish this, a formal separate entity might be necessary, and the operational capacity of the fund needs to be considered.

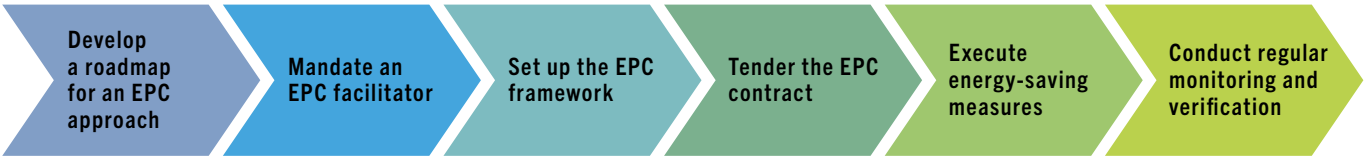
By pooling funding from different financing sources, such as funds from the City of Belgrade's budget, financial investors and funds, commercial banks and other donors (including international donor agencies and intergovernmental agreements), the BEEF can focus on large projects including both improving the district energy system and the state of the building stock. This would help the city of Belgrade to achieve its goals of:

- reducing greenhouse gas emissions
- reducing the energy use per unit of habitable area
- reducing the energy expenditures of the City of Belgrade
- improving the indoor living and working conditions
- increasing the energy security of the City of Belgrade and Republic of Serbia as a whole.

A long-term goal for a city could be to establish an entity to manage a revolving fund bundling smaller energy efficiency projects and provide technical, legal and financial support to foster the development of a local ESCO market.

While in its initial phases the BEEF will focus on renovation of public buildings (including schools, universities, hospitals, administrative buildings, cultural facilities), these buildings have the potential to become showcase projects. Taking a district approach looking at such buildings as part of their surrounding energy system can begin to explore and exploit the synergies between energy efficiency and district energy.

### Recommendation 5: Develop ESCO/MUSCO model




Energy performance contracts (EPCs) via an ESCO or MUSCO are valuable business models which avoid the need for high initial upfront investment from city governments, such as the City of Belgrade. For cities, there are several elements to consider, including selecting buildings/districts to focus on, identifying types of measures preferred and understanding the savings potential. Building a vision for an integrated district approach is therefore a prerequisite.

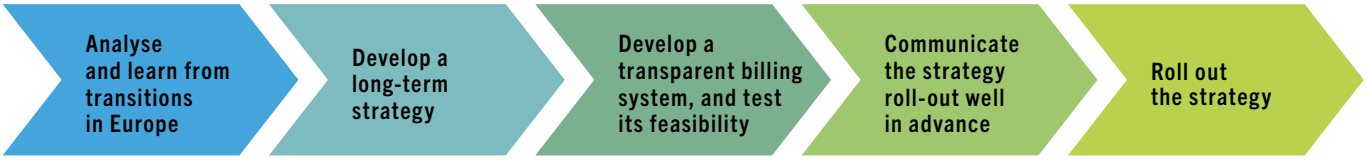
Based on this vision, a roadmap for developing the EPC approach should be set out. It is important to have a clear strategy and understanding of each building/project involved, to avoid changes to their use, sale or demolishing during the contract. In addition, good communication between the ESCO and the building user is essential.

Implementing EPCs is complex, both on a technical and a legal level. In a city with limited ESCO experience, it is recommended to mandate an EPC facilitator who provides know-how and experience to support an EPC project and acts as a mediator between client/city and the ESCO. A facilitator can support setting up the framework contract and tendering.

Once the contract is in place and energy-saving measures implemented, ongoing monitoring and verification of the results is vital to ensure the project is delivering as planned.

## SECTORIAL DEVELOPMENTS – DRIVE TRANSFORMATIONAL CHANGE WITHIN THE SECTOR

### Recommendation 6: Evolve towards consumption-based billing for all consumers




Consumption-based billing provides consumers with a better understanding of their energy consumption and encourages more energy-efficient practices. However, without improving the energy performance of district heating connected buildings, this shift could increase the energy bills of a significant number of households in district-heated buildings. Renovation of these buildings would not only mitigate this risk but should also reduce energy bills as well as improve living conditions in terms of comfort. At the same time, the "freed and available" energy could be allocated to expanding the district heating system to provide heat to more buildings.

Analysing the experiences of other countries (such as Croatia, Romania, Poland, Lithuania, Czech Republic) where this transition has already happened or is under way can help to develop the approach needed in Belgrade. Such a transition is not a short-term fix but requires a long-term strategy, differentiating between new and existing buildings, considering and including renovation measures, and implementing support schemes. The strategy should consider its impacts on the current regulatory system, levels of consumer trust and issues of privatisation. Testing the feasibility of the suggested billing system in a sample of consumers is an important step before wider roll-out.

Having a transparent billing system (including details on the balance between consumption-based and fixed fees) can help build understanding and buy-in from consumers. In addition, it is vital to communicate and build awareness of the roll-out in advance. This should include promoting the multiple benefits (linked to recommendation 3 on awareness raising). Rolling out the strategy and switch to consumption-based billing should be done in stages, first on a voluntary basis for consumers, then semi-voluntary and finally making it mandatory.

### Recommendation 7: Build up skills in the supply chain


For policies to be successful there needs to be sufficient expertise within the supply chain to support their implementation. Given the technical nature of energy efficiency in buildings and district energy, this is particularly important. One of the goals of the district energy utility in Belgrade is to attract greater numbers of younger employees. Education programmes, training and information on district energy and energy efficiency, and more professional networks promoting skills, play a key role here. The training and upskilling of existing workers in the supply chain is also needed.

Upskilling the supply chain is needed on a national level since the workforce is not limited to the boundaries of the municipality. Therefore, it is important to approach this initiative within a national context and as a collaboration between local and national public authorities.

The first step to strategically building up skills is to set up qualification platforms which gather stakeholders from across the supply chain to help identify needs and priorities. This should feed into establishing a skills roadmap or strategy to plan out how to introduce new and upgrade existing qualification and training schemes. This can include updating or introducing regulatory frameworks, quality labels, self-control management procedures, and training programmes. The ultimate goal is to stimulate the development of initiatives to improve the quality of the works, taking into account the pros and cons of previous experience, with specific attention to boundary conditions and allowing effective compliance. Successful initiatives across Europe, such as the BUILD UP Skills Initiative, could be used as inspiration [35] [36].

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