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A common approach for sustainable heating strategies for partner cities

SUMMARY REPORT

May 2020

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Contents

1. Sustainable Heating: Implementation of Fossil-Free Technologies (SHIFFT)

SHIFFT is an Interreg 2 Seas project, running from 2019-2022, promoting cross-border cooperation between 4 European countries: The Netherlands, France, Belgium and The United Kingdom. It has been approved under the priority 'Low Carbon Technologies'.

Space and water heating represent a large fraction of overall energy consumption across the EU Member States, and around one third of carbon emissions. Dependence on fossil fuels has made the heat sector hard to decarbonise in at least three of the four Member States in the 2 Seas region. Further, between 65% and 80% of buildings across these four Member States that will exist in 2050 have already been built, often with fossil fuel heating systems and poor energy efficiency. There is an enormous potential to reduce CO_2 emissions in the sector by shifting to low carbon heating alternatives, but there remain many barriers to doing so.

The main objective of the SHIFFT project is to stimulate the adoption of low-carbon heating technologies in existing buildings. It will take multiple routes to achieving this through its three technical work packages (WP).

WP1 develops city strategies for four small to medium municipalities as well as producing general guidance for cities to make their own strategies for the move to low carbon heating. City strategies will be devised for the Belgian cities of Brugge and Mechelen, the Dutch city of Middelburg and the French city of Fourmies, with planning for each led by the cities as full partners in the project. These will inform a document offering guidance to other cities who want to devise their own strategy.

WP2 focuses on developing strategies for the fullest possible inclusion of communities in developing low carbon heating strategies at the local level. This co-creation process will inform the other WPs so that the views of building users are fully incorporated into decision making. We see it as essential to include communities to the fullest possible extent in decisions about the buildings in which they live, work and play. All relevant partners will be working to incorporate communities in this WP.

WP3 concerns delivery of exemplar community low carbon heating projects; one installation of low carbon heating technology will take place in each of the four INTERREG 2 Seas Member States, with each build led by one of our project partners: Places for People (UK), Fourmies (FR), and Woonpunt Mechelen (BE). We will aim to capture learning from these developments and pass it on to the widest possible selection of stakeholders in the sector.

Technical support is provided by two universities, the University of Exeter (UK), acting as project coordinator and Delft University of Technology (NL) and by environmental consultancy CD2E (FR). These organisations will support city and other partners as regards technology, policy and co-creation of projects with communities.

The specific and measurable objectives of SHIFFT are to assist in the development of city low carbon heating strategies, both within the project and by demonstrating routes to strategy development for other municipalities, to develop exemplar low carbon retrofit heating projects and to work with others to pass on the lesson learned within the project to maximise the value of the lessons learned.

SHIFFT targets local and regional authorities as a primary target group with the purpose of influencing communities, homeowners, districts, cities, energy consultants, energy service companies and SMEs to consider a wider set of heating solutions than is currently the case.

2. Introduction

This report provides a high level summary of a more detailed SHIFFT report which can be accessed via the SHIFFT project website: A Common Approach for Sustainable Heating Strategies.

The transition to sustainable heating for homes and community buildings is an immense, complex operation. It calls for thorough long-term planning and preparation by local authorities, distribution system operators, builders, homeowners, and communities. It requires robust, practical, tested tools and approaches for cities to mobilise, inform and facilitate local communities to make this change.

The common approach is designed to help cities develop a low carbon heating strategy. Its purpose is to help avoid replication of work and overcome some of the complexities in enabling a transition to low carbon heating in homes and community buildings. At a high level, we suggest that a sustainable heating strategy sets out a vision for how to decarbonise heating for a city, with clear goals and a plan for how to achieve these goals, including a roadmap. The common approach SHIFFT has developed is based on literature reviews, practical experience, and two partner workshops.

The common approach framework is based on a step-by-step process that considers barriers and opportunities across technologies, people and policy/regulation. The framework will assist in the process of identifying heat supply & demand, whilst identifying opportunities, actors, technologies, resources and barriers for decarbonising heat in a local area. The SHIFFT framework recognises the need for thorough long-term planning and preparation by local authorities, builders, households, communities and wider stakeholders and highlights best practice, tested tools and approaches so that cities can mobilise, inform and facilitate local communities in the transition to low carbon heat.

The step by step guidance within the common framework will help local authorities by providing guidance on technological choices for low carbon heating at different scales. It also sets out how to develop effective approaches with citizens and stakeholders, so that solutions are co-created in a transparent and meaningful way to gain consent for change. It then provides an overview of the key building blocks for creating a local heating policy, including creating a roadmap, zoning and the business case for a low carbon heat transition at city level. We have designed the common framework so that it can be developed and customised to suit local circumstances.

This summary report sets out the common approach and provides background information on technologies, social aspects and policies for low carbon heating. It covers existing high-level strategies; technology overviews; planning tools; citizen and stakeholder co-creation; and building blocks for heat policy. More detailed information on all these aspects is available within the full SHIFFT report on the common approach. That report also provides a wider introduction to SHIFFT and the partner cities; data on heating and cooling across the EU and 2 Seas regions; and a policy overview for sustainable heating in each of the 2 Seas Member States.

This edited summary is intended to give an overview of the SHIFFT common approach to develop a city or local authority level sustainable heating strategy and some of the existing resources that can help with this. Throughout this summary, links back to the more detailed information in the main report are highlighted in each heading – the full report can be accessed here: A Common Approach for Sustainable Heating Strategies. In addition to this resource, those with an interest in co-creation and working with citizens and communities, may be interested in this additional SHIFFT resource: State of the art report for co-creation approaches and practices.

3. The SHIFFT common approach for developing a sustainable heat strategy

3.1. The importance of heat decarbonisation and how to achieve it

3.1.1. Why does heating need to be decarbonised?

To tackle climate change, carbon emissions from our energy systems need to rapidly decrease across heat, power and transport. Global average temperatures have increased by over 1 degree Celsius since the industrial revolution and global greenhouse gas emissions continue to rise (IPCC, 2018). The UN Emissions Gap Report suggests that we need global reductions at a rate of 7.6% per year to stay below 1.5°C. In the EU greenhouse gas emissions have fallen to around 80% of 1990 levels (at an annual rate of around 1%) but since 2014 total emissions have roughly stayed level (Eurostat, 2019). The EU has progressively increasing targets to reduce GHG emissions, in line with the Paris Agreement, set out in the 2020 climate and energy package and the 2030 climate and energy framework. In 2019 the European Council endorsed an objective for the EU to become climate-neutral by 2050 (European Council, 2019). Meeting these goals will require a complete transformation of our energy systems.

Efforts to reduce carbon emissions within the energy system so far have mainly focussed on reducing emissions in the electricity sector, particularly cutting the use of coal-fired power stations, with less progress being made to reduce emissions associated with heat and transport. Across the EU, heating and cooling represents around half of all energy use, more than half of which is generated by burning gas and oil (Heat Roadmap Europe, 2017). Currently, EU households use 79% of energy for space and water heating and 84% of this energy demand is met through fossil fuels. Almost half the EU's buildings have individual boilers installed before 1992, with energy efficiency of 60% or less. Household CO_2 emissions for heating in the INTERREG 2 Seas region are around 90Mtonnes/yr.

Heat is largely a local issue, as it is often provided at the individual building level or through neighbourhood level schemes. There is enormous potential to reduce CO_2 emissions with wide-scale adoption of low carbon heating. But few structures currently use sustainable heating sources because there is a lack of awareness and knowledge among homeowners on the different technical options and advantages of sustainable heating. In addition, the initial investment costs for sustainable heating installations are high for individual homeowners. To help overcome these issues examples of sustainable heating in residential and community buildings are needed, alongside active engagement of homeowners and communities to raise awareness, remove barriers and create facilities (e.g. financing schemes, incentives) for the transition to sustainable heating. This process can be facilitated by the development of sustainable heating strategies at the city, municipality or local authority level.

3.1.2. What is a sustainable heating strategy?

The transition to sustainable heating for homes and community buildings is an immense, complex operation that calls for thorough long-term planning and preparation by a wide range of stakeholders..

Sustainable heating (and cooling) involves reducing the energy demand for heating (and cooling), whilst shifting the energy supply for the remaining demand away from fossil fuels to carbon neutral sources, provided through renewable energy sources. Within the SHIFFT project we think a sustainable heating strategy should set out a high-level vision for how a transition in heat can be achieved, with clear goals and a plan on how to achieve these goals, including a roadmap. Drawing on a literature review and informed by practical experience, over two expert stakeholder workshops, the SHIFFT project composed a list of key components for sustainable heating strategies. They should:

- offer a clear goal (e.g. carbon- neutrality by 2050) with sub-goals and timeframe (e.g. 2025, 2035);
- develop a roadmap to achieve these goals;

- be co-created by citizens, technical experts, politicians and other stakeholders, so that the strategy developed will be socially legitimate;
- indicate techno-economic feasibility of sustainable heating technologies and solutions and describe under which conditions these technologies are feasible;
- not stand alone but be embedded in other local policies (e.g. climate plan, spatial planning, building regulation);
- build on and feed into heating policy at regional, national and international level (i.e. EU);
- support and steer sustainable heating projects on a district and building level;
- avoid simply allocating the costs to other domains (e.g. air quality, energy poverty);
- be customised to local conditions;
- be in line with legal and institutional requirements.

To help shape the development of locally based sustainable heating strategies SHIFFT has developed a common approach for creating a sustainable heating strategy, this provides a framework of key areas to develop, as set out below.

3.2. A common approach for sustainable heating strategies

The common approach to develop a city level sustainable heating strategy is summarised in Figure 1 below. It comprises of seven steps to develop, evaluate, and implement a sustainable heating strategy, with three cross-cutting themes that run across each step:

- Technology - e.g. choice of technologies, how to select and apply them and at what scale;
- People - e.g. how to engage stakeholders and communities to co-create acceptable low carbon heating solutions;
- Policy - e.g. how to assess, develop and apply policies to support low carbon heating.

It is proposed that this approach is used to support the development of strategies for the four SHIFFT partner cities of Bruges, Fourmies, Mechelen, and Middelburg. The rest of this chapter walks through each step of the common approach.

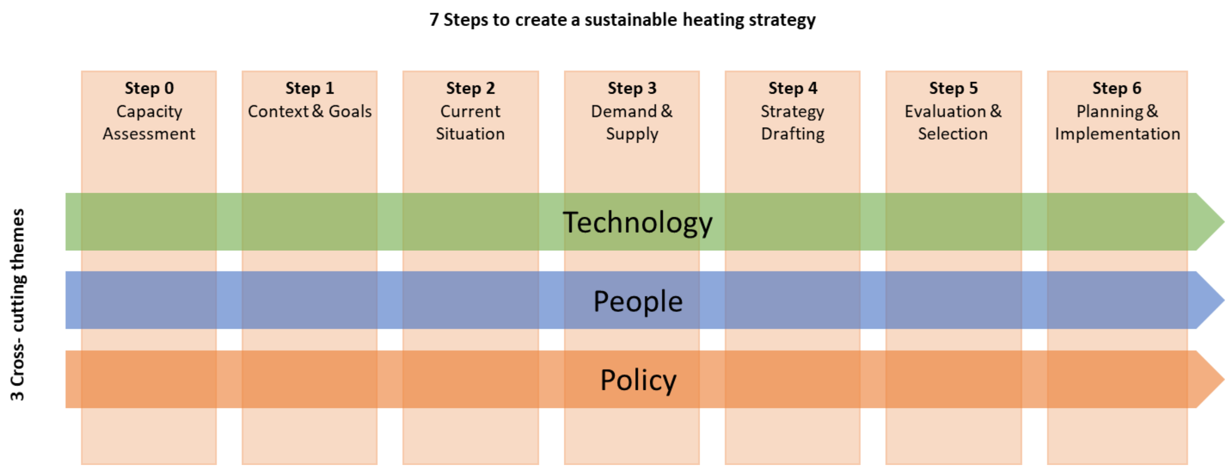


Figure 1. High-level overview of the draft SHIFFT common approach

3.2.1. Step 0 Capacity assessment, getting a team together (Page 19 in full report)

The opening step should begin with approval from an elected official, to ensure a democratic mandate for the whole process. The aim of this step is as an internal capacity check – the goals being to:

- establish that the municipal government institutions have the political will, the personnel, governing capacity and some financial resources to commit to the process of devising a strategy;
- carry out a review of relevant initiatives that the municipality is already working on;
- identify relevant expertise within the municipal organisation and form a team;
- identify some obvious stakeholders within the local government organisation.

3.2.2. Step 1 Context, boundary conditions, setting goals (Pages 19 – 21 in full report)

In Step 1 the goal is to develop a draft vision of what a sustainable heating strategy for your municipality/jurisdiction will look like, ahead of working out the practical steps for achieving this vision. A key enabler of action is setting out from the start what your ambitions and goals will be in respect to a local sustainable heating strategy. In simple terms this is about defining what you want to do and the timeframe over which you want to do it. This step should build on the capacity assessment and create some clear milestones, these could be for specific years or you could work to short (e.g. 2025), medium (e.g. 2030) and long-term goals (e.g. 2040). To help with this you might want to consider what ambitions your municipality or jurisdiction has (or would like) in terms of greenhouse gas emissions – do you want to be in line with or ahead of regional, national or EU climate policy goals? Visioning and goal setting should also happen in a deliberative setting with policy makers, stakeholders and politicians involved.

Technology

Low carbon heat technologies (and those to help reduce energy demand) are central to the delivery of a sustainable heat strategy. The resources in section 4.1 and 4.2 can help with this step, there are several things to consider:

- What goals do you want to set? e.g. what percentage or amount of heat would like to be supplied through low carbon sources and by when?
- What is the market/supply chain for heat in your area/region? Who can you work with/consult e.g. are there local or regional firms; which technologies are available and how are they currently supported?
- What boundaries will it be most appropriate to work within – i.e. should it be a city-wide approach, or split down into districts, neighbourhoods, etc?
- Look at existing strategies and tools to help inform your thinking.

People

Heating is a fundamental aspect of the human need for shelter in our climates, and therefore a significant social, cultural, economic, and psychological phenomenon as much as technological. Heating reaches far into people's homes and private lives, not just workplaces or leisure contexts, involving everyday habits and negotiations between building occupants and family members. Heat is a cultural service that cannot only be seen through the lens of economic efficiencies and return on investments. Providing heat is a key aspect of social life (e.g. entertaining guests) and seasonal cultural practices (e.g. wintertime cosiness). In the transition to sustainable heating, homeowners and local communities therefore form essential parts of the system.

Enabling a large-scale shift towards sustainable heating therefore must actively involve local people. The first stage of this is an external stakeholder assessment and putting in place a citizen and stakeholder engagement strategy. Section 4.4. of this report provides resources that can help with engagement and detailed information on co-creating a sustainable heating strategy with local citizens; there is also a more detailed SHIFFT state of the art report on co-creation available from the SHIFFT website. This engagement process needs to begin early in the project, before ideas are firmed up, and be maintained as the strategy develops. It is emphasised that it is essential to work with people in your municipality/jurisdiction to develop common and shared:

- Objectives – what are you collectively trying to achieve in terms of the shift to sustainable heating, and why does this need to happen?
- Narratives – How are you going to achieve these objectives? What will it look like in practice? What will it cost? What are the next steps?
- Refer to the resources provided on how to find, engage, and embed citizen and stakeholder co-creation into the development of your sustainable heating strategy.
- This engagement should be viewed as part of an ongoing process.

Policies and Regulation

An effective sustainable heating strategy should link to other relevant policies. This could include direct links to key policies, policy instruments and policy tools around climate change and energy, but also other policies that could be of relevance in the municipality. It is recommended that a review is carried out to identify relevant links vertically i.e. to EU, national, regional policies and horizontally i.e. locally across other relevant policy areas. Resources to support this step are available in Annex 1 of the full report and sections 4.4 and 4.5.

- Vertical analysis – a summary of EU, national and regional level energy and climate policy is available in Annex 1; it is also recommended to speak to local energy information centres to access their knowledge and understanding.
- Horizontal analysis – work with colleagues in other policy areas to identify potential links to other key local policies, such as those relating to climate, energy, housing, health, social care, the environmental, jobs, regeneration, others.
- Create visions of a carbon free future. How does your city look like in the future when the sustainable heating transition has succeeded? What are its implications to buildings, infrastructure and local residents?
- Set goals (main goal and sub goals) that should be achieved in order to let your vision become reality.

3.2.3. Step 2 Current Situation (Pages 21 – 23 in full report)

The goal in Step 2 is to create an accessible and transparent energy baseline for your local area. Collating good local data to establish the current situation for energy supply and demand for heating is vital. This step of the strategy development will help you understand the current situation and therefore what will need to be done in order to realise your goals. It will also help identify what might be suitable at different levels, e.g. building, neighbourhood, city level solutions. As well as data on energy, other key sources of information will be important.

Technology

To build the baseline there are some key areas of data that will help understand the current situation and therefore what some of the options for sustainable heating might be. Make use of national, regional and local statistics, as well as your own municipality's data. Also, identify which organisations or experts can provide data to help establish the baseline; this could include information from energy companies, energy regulators, and energy information centres. The resources in Annex 1 of the full report and sections 4.2 and 4.3 can help with this step.

- Energy Supply Chain
  - What is the current demand for energy in your municipality? And how is this demand across end-use, i.e. heating, power, cooking; and sectors i.e. domestic, tertiary, industry?
  - How is energy currently supplied, i.e. what is the current percentage of supply from renewables, gas, oil, coal, biomass, and electricity?
  - How is that energy delivered, i.e. are there local networks for electricity, gas, heat?
  - Is it possible to estimate the carbon impact from the current supply chain?
- Local Mapping
  - What is the age of the building stock and what types of households do you have? E.g. percentage of homes: by build year; by tenure e.g. owned, rented; by type e.g. detached, semi-detached, flats, etc; and occupancy e.g. families, single households, etc.
  - How do different sectors map your local area – i.e. where are homes, industry, tertiary?
  - Where are the energy sources in the local area? This can include heat, gas networks, as well as any renewable sources or other local energy producers.
- Missing Data
  - What data is missing and who could help provide it?
  - What can be done when data is not available?

People

External stakeholders from across the energy sector, municipality and wider society will play a key role in helping establish the current situation. This could include access to data, knowledge, as well as insights into local preferences. See section 4.4 for resources, and consider:

- Co-benefits – what are the benefits outside lowering carbon emissions in enabling this shift for citizens, the municipality, the region, country and global climate? E.g. increased comfort, air quality, health, social cohesion, wellbeing, or in terms of business and job creation.
- Drivers and barriers – what might encourage people to make changes or reduce heat consumption, and what do they feel is stopping them doing so or dissuading them from acting?
- How can the wider public be engaged to help understand barriers, drivers, preferences, and solutions? How to build this into any consultations, co-creation events?

Policies and Regulations

Building on the analysis in Step 1, consider in detail which policies could support the development and implementation of a sustainable heat strategy. Consider also how a heat strategy could help other departments or colleagues deliver their priorities. The resources in sections 4.1 and 4.5 can help with this step. Some examples are given below:

- Buildings & planning – are there building codes for new build and/or renovations that can encourage the installation of energy efficiency improvements and low carbon heat? Can heat zones be developed for new and existing developments?
- Health & social care – are there goals to reduce fuel poverty or poor housing to improve people's lives? Is advice or financial support available for citizens to keep warm and healthy? Look for relevant issues in local health and social care policy that can be of relevance to your local sustainable heating strategy.

- Energy & carbon – are there polices to reduce carbon emissions, increase the share of renewable energy, improve energy efficiency and how can these policies best support sustainable heat?
- Economy & jobs – can the supply chain or industry for sustainable heat and energy efficiency be developed locally? Does the sustainable heating strategy envision business and job creation locally? Also look for relevant issues in local economic policy that can be of use to your local sustainable heating strategy.
- Environment – are there clean air or other policies that could link to a sustainable heating strategy? How can local environmental policy contribute to sustainable heating strategy? Perhaps via clean air policy and environmental permit systems regulating buildings and operation of industrial processes (that produce heat).
- Policy gaps – are there opportunities to address policy gaps to enable the development of sustainable heat in your local area, across different policy areas and other policy domains? Who could you work with to address these?

3.2.4. Step 3 Demand Reduction & Supply Potential (Pages 23 – 24 in full report)

Step 3 in developing a sustainable heat strategy for your municipality or jurisdiction involves consideration of what the potential is for both reducing heat energy demand and supplying heat sustainably. This will give an early indication of what might be possible at the household, neighbourhood, district, and city level. It might also show where there are some quick wins or where more research or consultation might be needed. This step should build on the previous steps and by the end of it you should have a draft outline on the way forward to build upon.

Technology

Working from the baseline data from Step 2 and shaped by your goals in Step 1, calculate the potential to reduce demand and based on that, what an ambitious target for reduction should be and what also what heat can be supplied from sustainable sources. This could start at the building level and work up or be developed through a district by district approach. The resources in section 4.2 and 4.3 can help with this step; consider:

- What scale of action is appropriate and how to assess the potential of different approaches? – e.g. reduce, reuse, generate sustainably.
- Which technologies might be most appropriate at different scales?
- The technological potential will depend on the view of stakeholders and citizens – make sure the knowledge gathered from citizens, feeds into the technology analysis.

People

The potential to reduce demand and switch to low carbon heat will also be directly influenced by the willingness, preferences and ultimately the consent of local citizens. It will be important to build information on these aspects into your work with these stakeholders and it may be necessary to carry out ongoing consultation and co-creation events as possible options become clearer. Section 4.4 provides resources, and to help with this:

- Check with people on their preferences for the different options available.
- See if a common approach can be found for the most optimal solutions. Where are the opportunities and risks, and where might further consultation and engagement be needed?
- Co-creating a platform where a wider set of people can share their experiences and views of heating, comfort and sustainable alternatives can help broaden participation and input.

Policies and Regulation

Having understood the potential technology and stakeholder options at different scales for reducing demand and supplying heat sustainably, consider what policies and/or regulation might be needed to enable these options to be delivered. The resources in section 4.5 will help with this analysis but also consider:

- Can the potential options be delivered within existing policy frameworks, or will new policies need to be developed?
- If new policies are needed, can you demonstrate that there is stakeholder and citizen support for measures you want to take? If yes, is there the political and departmental support to enable this to happen? If not, how can this developed?
- Use the case studies and tools provided to help identify other localities that have taken a similar approach to the one you wish to develop.

3.2.5. Step 4 Formulation of Strategy Options & Indicators (Pages 24 – 26 in full report)

In Step 4 the goal is to formulate a range of specific strategy options that can be compared. These draw on the understanding of the current situation, potential future heat scenarios, policy best practice, and the overall goals from earlier steps. Formulating a range of options is important to ensure that different possibilities are compared and considered, it also allows preferences to be understood.

Technology

Each option should include detail on several elements, section 4.2 provides resources:

- Sustainable Heat Technologies
  - The optimal combination of technologies should be identified
  - An appropriate level of detail these technologies should be mapped onto the locality
  - The costs of the various heating systems should be estimated where possible.
- Key Performance Indicators (KPIs)
  - KPIs are qualitative or quantitative measures used to monitor progress against a specific goal and, collectively, the whole strategy. These measures may pertain to carbon emissions, energy use, renewably generated energy, autonomy, or impact on material use or space.
  - The selection of KPIs will depend on the goals and sub-goals adopted in each strategy.
  - The precise method for measuring each KPI should be specified.
- Targets
  - Key milestones should be outlined over the short, medium, and long term. These should be measurable in terms of the KPIs you have identified.
  - It should be established whether the strategy will achieve reductions in carbon emissions from heat in line with the goals you have outlined in Step 1. Given the climate benefits of cutting emissions quicker, it may be worth considering options which achieve rapid initial reductions in carbon emissions.

People

Stakeholders play an important role in this step in collectively determining the options to be formulated. The options used will depend on local context and the stakeholders, as such they will vary from case to case, but in scoping out possible strategies you can consider:

- Priorities such as rapid decarbonisation, low cost to consumers, or minimal disruption.
- Technical characteristics such as maximum energy efficiency or electrifying heating.

- Socio-political dynamics such as facilitating community energy, public ownership, or bottom-up implementation.
- It is also possible to formulate scenarios which transition certain areas or demographics earlier or later in the process.

Once the range of strategy options has been decided on, the formulation of the options themselves may well be delegated to expert stakeholders or partners. Linked to policy, a process of stakeholder engagement throughout the strategy's lifetime must also be devised and built into each strategy option.

Given how heating affects the lives of ordinary people, citizens can provide valuable input to developing citizen-based approaches within these strategies. Consider:

- How can the heating strategy best involve citizens? How can citizens be meaningfully involved in choices about their city or region as well as their neighbourhood and home?
- How can local government best organise and support these initiatives?

Policy

For each strategy option, policy initiatives to implement the specified technologies and achieve the milestones need to be specified or devised. Policy instruments can be drawn down from best practice or examples in other municipalities (e.g. using grants to subsidise installation of sustainable heating systems) – section 4.5 provides resources. Where no best practice exists, policy can be devised for a particular purpose. The policy instruments specified are likely to include a range of measures such as:

- Policy to stimulate the deployment of sustainable heating and energy efficiency measures.
- Regulation to enforce standards of energy efficiency or carbon emissions reduction.
- Pilot projects or zones, to test processes for deployment and to demonstrate the benefits of the sustainable heating.
- Partnership initiatives to encourage private, public and community organisations to contribute as well as to facilitate information exchange.

The advantages and disadvantages, as well as incidental co-benefits of each policy instrument should be explored. These might be related to a policy's likely popularity, cost, inclusivity, ease of implementation, or risk of misuse. Additionally, the policy instruments may relate to or build on existing programmes and strategies, these should be highlighted. There may also be co-benefits of a policy for the wider community, housing, local health, the local economy, energy security, energy poverty or health. The precise method of evaluation might be a formal process such as cost-benefit analysis.

Crucially, all policy instruments should be practically feasible, financially viable, and, insofar as possible, proven to be effective. It is also important to be nimble, design in a reflexive process for feedback and review of policy; this should be established from the outset so that changes can be made, or the policy extended in the future.

In some cases, it may be useful to identify policy which would be necessary or facilitative but is beyond the power of the local government.

3.2.6. Step 5 Evaluation & selection (Pages 26 – 27 in full report)

The aim in Step 5 is for the stakeholders and technical experts to evaluate and express their preferences for the range of local sustainable heating strategy options established in the previous step. Helping stakeholders' express their preferences is key to ensuring people have a voice and helps understand which options will be popular and why. This process involves evaluating the strategy options according to how they adhere to the overall goals established in Step 1 as well as how they fare against KPIs you have chosen. Other socio-political and economic criteria such as public acceptability and cost-benefit analysis can be used to examine other important dynamics.

The optimal outcome from this stage is the selection of one preferred strategy option, however, it may be more complex, showing a range of preferences which need to be analysed. In this more complex case, the analysis can inform political decision-makers who, in any case, make the ultimate decision. The outcome may be a justified selection of one strategy option, or it could be a modified amalgamation of different strategy options.

Technology

In this step you need to calculate how each strategy option fares against your KPIs and compare each of the options to the current situation. Quantitative KPIs for each strategy option can be calculated using the methodologies identified in Step 4, section 4.2 provides resources. Repeating these calculations for each option at specified time intervals (e.g. 2025, 2030, 2040) can provide a picture of how each strategy would likely progress over time. These calculations are then fed into the evaluation of the strategy options and the collective decision-making process. For qualitative KPIs, evaluation may be carried out by experts or by stakeholders themselves.

In each case, the current state of affairs (from Step 2) can provide a useful baseline against which to compare the performance of the different strategy options.

People

Stakeholders' views are important in the evaluation and selection of the sustainable heating strategy. All stakeholders who have been involved in the process should be consulted on the strategy options which have been formulated in order to produce a clear understanding of preferences. The pros and cons of the various options can be discussed and shared to allow people to understand how others feel about the available options. Section 4.4 provides resources on gathering preferences. The aim is an agreed approach/s to deliver.

Whilst the measurements of some of the quantitative evaluation criteria are objective and can be carried out, the relative importance given to the different criteria is subjective, and people with different views will therefore prefer different options. Therefore, the evaluation by stakeholders will elicit responses to qualitative criteria as well as priorities among the quantitative criteria.

Policy

Each strategy option will have a different mixture of policy instruments and in each case these tools and their outcomes should be evaluated, and preferences elicited and recorded. Appropriate criteria need to be applied to each policy or set of policies. The criteria used to evaluate policy instruments will depend on the type of policy and the local priorities. Some example criteria to consider are:

- Stimulating policy (e.g. grants, loans) - consider issues such as: value for money; risks of use; appropriate target demographic or sector; public acceptability; practical feasibility
- Direction Setting
- Regulation – consider the ease with which it can be enforced; effectiveness at achieving desired outcomes; public acceptability; practical feasibility
- Demonstrating value for money; and appropriateness
- Facilitating

3.2.7. Step 6 Commitment, planning, and implementation (Pages 27 – 28)

Step 6 involves local government adopting a sustainable heating strategy, and the subsequent planning needed to implement it. The adoption of a strategy is primarily a political decision-making process. The planning involves the local government administration establishing a delivery team who will then set out how the various elements of the strategy will be implemented, including the various policies, public engagement processes, and monitoring.

Technology

Proposed initial plans should be developed in order to be discussed with stakeholders. These plans will be based on the technology pathway/s chosen and may involve pilot or demonstration projects or changes to public procurement of heating technology. Many of the policies (such as those involving mapping or technical feasibility assessments) may require technical support, at least at the beginning.

Data collection processes need to be in place going forward to allow for the KPIs to be monitored. Establishing whose responsibility this is and that there is capacity and monitoring in place is important.

People

The strategy should be co-implemented with citizens, their views and input to decisions are still important. Citizens' involvement in decision-making throughout the implementation phase empowers them to be part of the heating transition and minimise any disillusionment. By monitoring the adoption of new technologies as well as how the transition is affecting different groups, the municipality can keep track of progress and, where necessary, adjust its communication approach or incentives. There could be a role for 'heat champions' and 'energy ambassadors' here.

Co-creating the sustainable heat strategy with a relatively small, but representative, group of stakeholders is just the beginning; for the implementation to be inclusive these engagement and co-creation strategies need to be embedded in policy development and deployment. This will require a broader public engagement strategy.

Policy

Once the municipality or local government has adopted a strategy; the details of the policy needs to be put into action. Initial planning involves identifying the resource, personnel, and partners that the policy will require. Some areas to consider are:

- For areas of policy building on existing strategies
  - Which existing strategies are these?
  - What sort of collaboration with other policy teams is needed?
  - Who will be responsible for developing and implementing this policy?
- For new policy areas, replicating best practice
  - What is the most appropriate policy example to replicate? Why?
  - How does the best practice relate locally? Does it need altering?
  - Are there other municipalities who could assist with expertise or experience?
- Devising new policy
  - What similar policy (in the local government or elsewhere) can be drawn down on?
  - Should the policy be piloted initially?

Processes for ongoing monitoring and revision of all policies should be established from the outset.

4. Inventory of current challenges and approaches to sustainable heating

This chapter considers a headline summary of implementation challenges from three different viewpoints (technical-financial, governance and societal point of view) and more importantly, ways to overcome these.

4.1. Existing high-level strategies and approaches to achieve sustainable heating

After the oil crises of the 1970s and the emergence of societal environmental awareness, many strategies and approaches have been developed to achieve increased sustainability in the built environment. This section describes a few of them, in terms of their relevance to the SHIFFT perspective of sustainable heating and cooling in the built environment.

4.1.1. NSS: New Stepped Strategy (pages 30/31 in full report)

The New Stepped Strategy (NSS) (Van Den Dobbelsteen, 2008) is a simple step-by-step approach to achieving full sustainability efficiently, and has its roots in the Trias Energetica (Duijvestein K., 1997) and (Lysen, 1996). It is usually summarised as reduce, reuse and generate sustainably, although for practical purposes the analysis phase is also included, as an important preparatory step:

0. Analyse the present
1. Reduce energy demand
2. Reuse existing waste flows
3. Generate the remaining demand sustainably

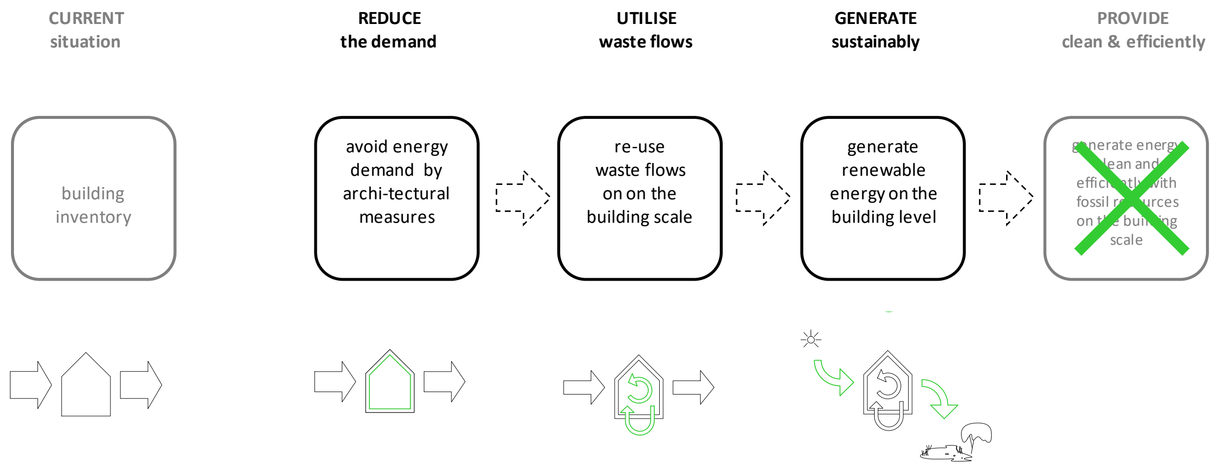


Figure 2. NSS: New Stepped Strategy (Van Den Dobbelsteen, 2008)

4.1.2. REAP: Rotterdam Energy Approach and Planning (page 32 in full report)

Developed from the NSS, Rotterdam Energy Approach and Planning (REAP), introduces a spatial component to the steps in the NSS. The reason behind this is that different measures work on different levels (for example insulating an individual home vs. capturing waste heat from a sewage treatment facility that can provide thousands of them), but they can all influence on the shape of the future energy system. REAP helps identify the different measures and their effects at these different scales. This helps transcend boundaries between stakeholders and find the best solutions for each area in a city that complement each other.

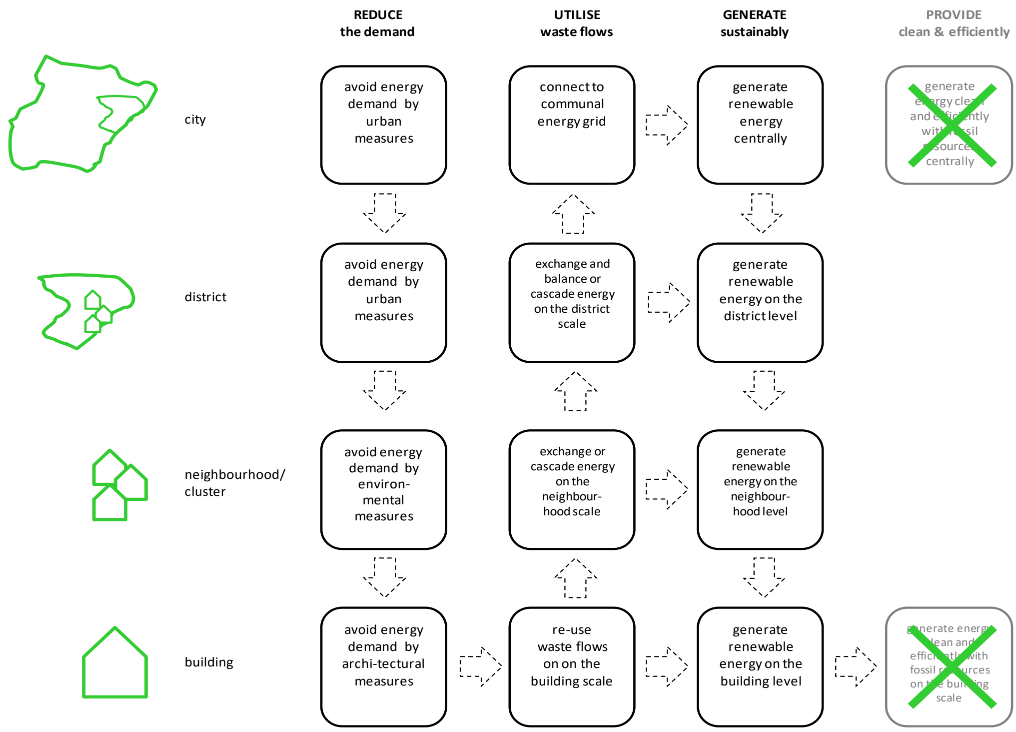


Figure 3. REAP: Rotterdam Energy Approach & Planning (Tilllie, N. et al 2009)

4.1.3. The City-zen Energy Transition Methodology (pages 33/34 in full report)

In the City-zen project the transition to renewable energy was considered, with a focus on refurbishment and the role of citizens. Products included demonstrators, games for stakeholder involvement and awareness and the City-zen Roadshow.

One central element to the City-zen project was the City-zen Urban Energy Transition Methodology. The core of this approach is similar to the NSS in the sense that the present is considered, and measures are then defined. However, with City-zen the focus is on taking into account the time (years or decades) that a complete transition takes, and identifying early no regret measures as well as high impact but long term ones, and monitoring progress, staying on track towards the set goal.

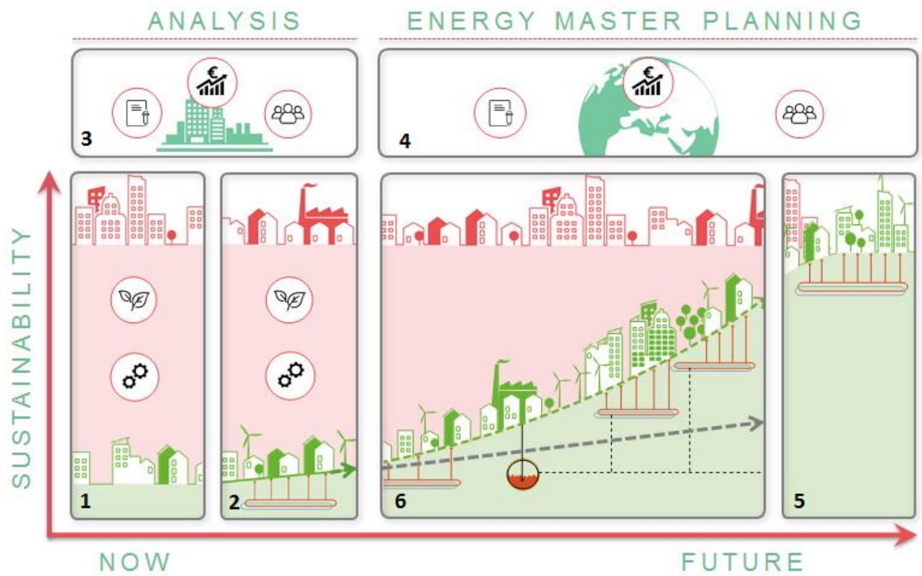


Figure 4. The City-zen Urban Energy Transition Methodology (Broersma S. et al , 2018)

The City-zen approach consists of six steps, the first three are the analysis stage and the second three are Energy Master Planning:

1. **Basic energy analysis** - EPM to map and quantify demand, reduction and supply opportunities
2. **Current planning and trends** - involves making an inventory of these and assessing their impact
3. **Societal & stakeholder analysis** - considers the political, legal & economic environment of the city
4. **Scenarios for the future** - defines scenarios for the future which helps identify resilient measures
5. **Sustainable city vision with goals and principles** - end goals and key principles are defined
6. **The roadmap** - combines all these measures over time and ends with the goals set in the vision.

4.1.4. SUI: Smart Urban Isles

The 'Smart Urban Isle' (SUI) project is a JPI Urban Europe project. A 'smart Urban Isle' is defined as 'an area around a (public) building that locally balances the energy as much as possible, resulting in minimized import and export of energy from outside this area'. The aim of the SUI project was to develop energy systems for urban areas that locally balance the energy as much as possible, thereby considering both building measures and neighbourhood energy solutions. Within the SUI project, a systematic step-by-step approach was developed that supports the design or development phase, i.e. the generation of various energy system configurations for neighbourhoods. Following this approach can lead to various innovative neighbourhood energy configurations. After this concept development approach, further optimization of the promising concepts can be carried out. The SUI approach consists of five steps, as shown in Table 1.

Table 1. SUI Guidelines for developing locally balanced neighbourhood energy concepts (S.C. Jansen et al 2018)

Steps	Goal	Results
1. SUI description & KPI's a. Site description b. Buildings c. Context d. KPI's	to define the project area, site characteristics, describe buildings and infrastructure and select Key Performance Indicators (KPI's).	1.1 Site characteristics 1.2 Overview of existing and 1.3 planned buildings & infrastructure 1.4 Context and boundaries 1.5 Selected KPI's
2. Energy status quo: a. Existing energy infrastructure b. Energy demand c. Current energy supply	to provide an overview of the status quo of the current energy system. For new buildings a reference situation based on requirements can be defined.	1.1 Existing energy infrastructure 1.2 Current energy demand 1.3 Current local renewable energy supply
3. SUI concept potentials a. SUI Bioclimatic improvement potential b. SUI energy exchange c. SUI renewables potential	to determine all energy potentials: potential reduction of the demand, exchange between different functions and renewable supply using different technologies.	3.1 Quantified demand for various building solutions 3.2 Potential energy exchange 3.3 Energy potential of local resources
4. SUI concept development a. Connecting demand and supply potentials b. Heating and cooling options c. Electricity supply options	to develop energy configurations that meet the demand with maximised use of local energy potential, in order to evaluate the preferred option in step 5.	4.1 Schemes of the different energy configurations that can meet the demand 4.2 Energy balances of the configurations
5. Evaluation & selection	to quantify the performance and evaluate the KPI's for the different solutions developed in step 4	5.1 KPI's of each concept 5.2 Selection of 1 or 2 promising SUI solutions for further development

4.1.5. The Smart Energy Cities strategy (pages 35/36 in full report)

The Smart Energy Cities strategy was developed to accelerate the energy transition of Dutch districts and neighbourhoods. The strategy consists of two routes: a social approach (green) and a technical/financial innovations (blue). Both routes are equally important and dealt with simultaneously.

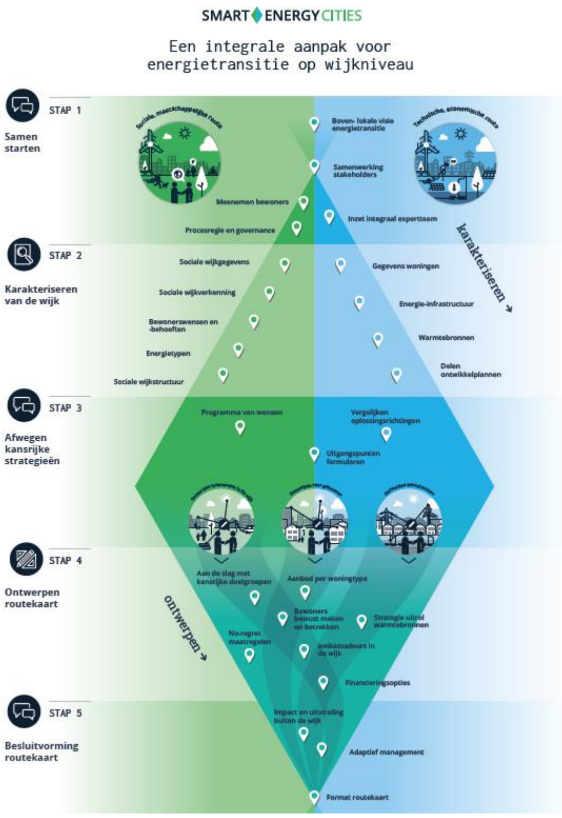


Figure 5. The Smart Energy Cities model (smartenergycities.nl)

The strategy consists of five steps, each including both routes and results in an integrated and adaptable roadmap:

- Step 1: **Start together** – map the stakeholders, local ambitions and actively involve the citizens.
- Step 2: **Characteristics of the district / neighbourhood**: social characteristics of the neighbourhoodand its citizens (2.1) and the technical characteristics (2.2) of the project area.
- Step 3: **Weigh promising strategies** – use the insights of the social and technical analysis to define guidelines and possible heat strategies (alternatives).
- Step 4: **Design the roadmap**
- Step 5: **Decision making roadmap**: implementation program with short-term interventions and therefore required investments.

The Smart Energy Cities approach is comparable to the City-zen Urban Energy Transition Methodology, including similar steps in a slightly different order. However, the Smart Energy Cities approach elaborates more on the social aspects of the energy transition and provides guidelines on how to deal with citizen participation. Within City-zen strategy, on the other hand, more attention is paid to goal setting (step 5: Sustainable city vision with goals and principles).

4.2. Heating and cooling: technology overview

This section describes technical principles, concepts and terms relevant to the transition to renewable heating and cooling. The section is structured according to the SHIFFT common approach for sustainable heat strategies and provides more information on the technology pillar of the approach.

4.2.1. CONTEXT: The energy supply chain, from demand to (renewable) production (pages 37/38)

For understanding and evaluating energy systems, the energy flows can be determined on three different levels of the energy supply chain: **Energy demand** (the heat to be delivered to, or extracted from, a conditioned space to maintain the intended temperature conditions during a given period of time); **final energy** (the energy consumed by end users); and **primary energy** (energy that has not been subjected to any conversion or transformation process). The energy chain for heating starts with the net heat demand, which eventually needs to be supplied with renewable resources. In-between we need technical components to convert, store and distribute the energy into the right form, at the right time, and at the right place. The energy chain is shown in Figure 6.

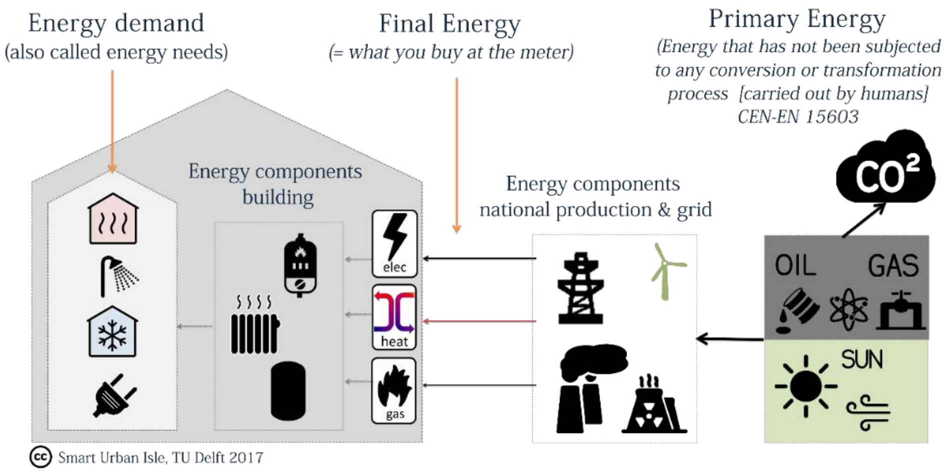


Figure 6. The Energy Chain (Smart Urban Isle, TU Delft 2017)

4.2.2. CURRENT SITUATION: how to calculate current energy demand (pages 38/39)

When identifying the current energy 'use', it must be clear which level of the energy chain is presented (demand, final energy or primary energy). Often, some conversion between these is necessary.

For existing neighbourhoods, the final energy consumption can often be obtained from the grid operators. If no measured final energy data are available, national reference numbers can be used, preferably based on building characteristics such as year of construction, energy performance certificate or energy label, in line with the European Energy Performance of Buildings Directive. Also, energy performance calculation methods can be used to estimate energy consumption, but it must be noted that significant differences can occur between calculated and actual energy performance.

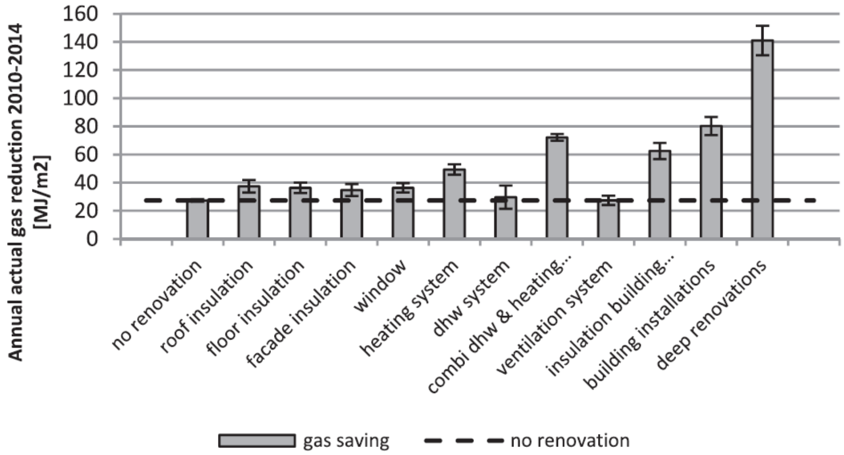
After determining the final energy consumption, the division between the different energy types - heating, hot water, cooking, cooling, lighting and other electricity use – should be determined.

Finally, as most real data is provided based on 'final energy' consumption, this number must be converted to energy demand or needs. The energy needs are the basis for the energy saving potentials as well as the new to be developed (building) energy system. In the next section this is shown for the case study.

4.2.3. DEMAND REDUCTION: Energy demand reduction potential (pages 39/40 in full report)

To enable 100% renewable energy supply, the reduction of the energy demand is an essential component. This can be achieved through via different routes:

- **Energy efficient design** - can minimise energy demand for heating and cooling through a range of measures, such as: building shape; orientation; properties of the building envelope including glazing types; shading systems and passive measures such as nocturnal ventilation. Many of these can also be applied to renovations.
- **Actual energy demand reduction versus calculated energy demand reduction** – the level of energy demand achieved can vary depending on the measures taken, see Figure 7.
- **Temperature level for heating** – the level of heat needed is a function of the insulation value, air tightness and ventilation system of a building. Often, the temperature of the heating system can be lowered after renovation and lower temperature heating using renewable resources can then more easily be used.



Average energy saving (corrected for degree days) per thermal renovation measure (including confidence interview 0.05) dashed line is actual difference in gas reduction between 2010-2014 for non-renovated houses.

Figure 7. Average energy saving from different measures (van den Brom, Meijer and Visscher, 2019)

4.2.4. SUPPLY POTENTIAL: (renewable) energy resources (pages 40/41)

When the present and expected future energy demand are known, both in quantity and temperature level, these can be matched to the locally and regionally available renewable and residual resources.

Renewable sources can be used indefinitely, provided the technology that harvests them is maintained over time. Common examples are solar thermal, geothermal and biomass. Renewable thermal sources can be divided into a few main categories – Table 2.

Table 2. Renewable thermal sources comparison

Primary resource	Primary conversion technology	Resulting energy carrier	notes
Sun	PV, solar thermal	Heat	Fluctuating supply
Air	Heat pump / direct	Heat / cold	Fluctuating supply
Water	Heat pump / direct	Heat / cold	Fluctuating supply
Geothermal	Heat pump / direct	Heat	Constant supply, underground must be suitable
Biomass	Combustion (CHP)	Heat (/electricity -> cold)	Can be stored, requires storage, availability varies

Residual sources

Waste heat from residual sources can also be used for space heating, domestic hot water or other functions by exchanging and cascading. The latter is the most common and uses waste heat from one process to supply another that requires heating to a lower temperature than the main heat load. Table 3 provides examples.

Table 3. Examples of residual thermal energy sources

Residual thermal source	Primary conversion technology	Resulting energy carrier	Notes
Subways	Heat pump	Heat	Uses heat exchangers in ventilation shafts
Data centres	Heat pump	Heat	Relatively constant supply
Parking garages	Heat pump	Heat	Uses forced ventilation exhaust in closed facilities
Supermarkets, ice rinks, refrigerated storage facilities	Heat pump	Heat	Residual heat from (product) cooling/freezing
WWTPs	Heat pump	Heat	Residual heat from purification process
Sewage networks	Heat pump	Heat	Residual as well as environmental heat
Heavy industry	Direct	Heat	Steel plants, aluminium smelters
Light industry	Heat pump / direct	Heat	Paper mills, large bakeries
LNG terminals	Direct	Cold	Residual heat from the existing fossil fuel infrastructure

4.2.5. STRATEGY OPTIONS: Energy System Technologies (pages 41-45 in full report)

Sustainable energy system technologies can be used to match the future demand with the local energy potentials and includes technologies related to distribution, conversion and storage of energy. In step 4 of the SHIFFT common approach an optimal combination of these technologies should be identified. The databases for the SUI Technology Matrix, SUI Technology Inventory and the City-zen Catalogue of Measures (CoM) all provide an extensive overview of these technologies.

Figure 8 from the SUI project gives an overview of alternative heat solutions for the built environment: heating without the use of fossil fuels. The diagram makes a distinction between individual systems and collective heat systems (district heat networks). The energy carrier electricity can for example be used for individual heat systems: heat pumps, infrared and electrical heaters. The technology matrix of the SUI project is a tool that visualizes which technologies and sources should be further considered and which should not, given the local conditions. More details about these technologies can be found in the SUI Technology Inventory: an overview of different technologies, products, manufacturers and services.

Both SUI and City-zen make the distinction between four sustainable heat systems: green gas (biogas), biomass, hot water (district heating) and electricity. The CoM provides relevant information about a wide range of possible energy measures at both technical and strategic level. An overview of the technologies included in the CoM are shown in Figure 9 and a detailed table is available in the full SHIFFT report on pages 44/45 which sets out technology options in relation to distribution, generation, conversion, storage and systems.

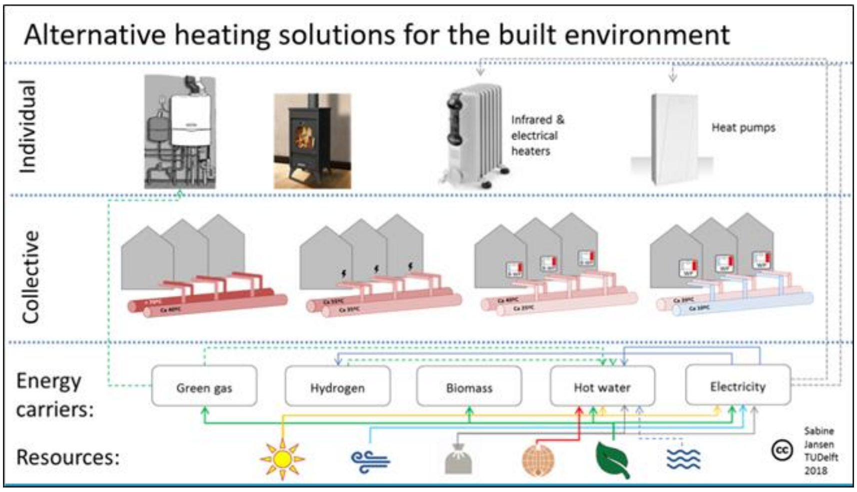


Figure 8. Alternative heating solutions for the built environment, SUI Project (Jansen, S.C., et al, 2018)

Figure 9 shows the four main sustainable heat systems divided into individual and collective systems. On the left the individual systems biomass (I), biogas (I) and all-electric heating (II) and on the right, collective heat networks. Horizontally, the diagram is divided into four temperature levels: from high temperature till very low temperature heating. The scheme visualizes which heat systems are effective at which temperature and thus the required energy labels and building installations (for heating, cooling and domestic hot water). The black icons represent the different energy technologies that can be used to supply the energy required in the selected heat system (Broersma S., 2018).

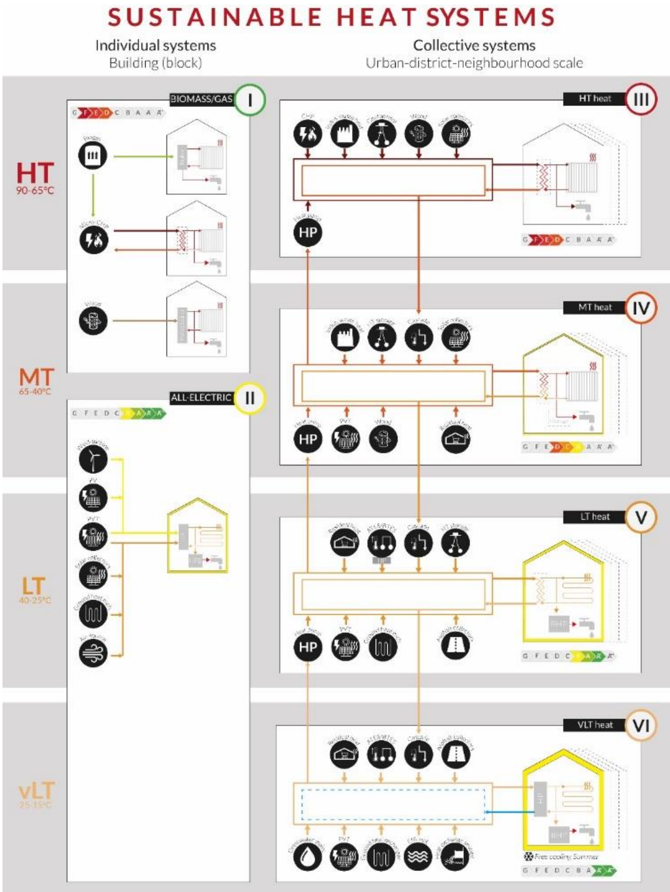


Figure 9. Sustainable heat systems diagram city-zen [Broersma et al. 2018]

4.2.6. INDICATORS: Evaluating impact (pages 45 – 49 in full report)

We recommend the use of Key Performance Indicators (KPIs) within Step 4 of the common approach, based on the goals and sub-goals adopted. The sustainability ambition of the municipality is established within the first step of the common approach framework, 'Context, boundary conditions, setting goals'. There can be confusion about the different definitions of sustainability goals, so below are some definitions of sustainability goals and the related KPIs.

(Net) zero carbon, carbon neutral, climate neutral

Over a year the (net) GHG-emissions are zero (KPI). Carbon emissions may be compensated, for example by carbon trading (CO_2 certificates), CO_2 storage and CO_2 uptake by forests. Since the goal of becoming (net) zero carbon or carbon neutral is related to climate change mitigation it can also be called climate neutral. In total the released CO_2 equivalents should be equal to the amount of CO_2 compensation (Broersma et al 2018).

(Net) zero energy, energy neutral

The amount of energy used within the system is equal to the amount of renewable energy produced over a year (KPI). The use of fossil fuels is still allowed but should be compensated by on-site renewable energy production. Therefore, energy neutral does not mean the system must be fossil free. Where more energy is produced then used within the same system over a year, the system can be called energy positive. The performance of the system is measured in terms of the on-site energy production compared to the energy usage/demand (both expressed in kWh or GJ) (Broersma et al 2018).

Fossil free

Being completely fossil free means operating with zero fossil fuels; fossil resources aren't allowed anywhere within the system. Compensation of carbon emissions is not allowed. The system can be called circular on its energy performance, but not for other flows such as water, material and food. KPI: the amount of fossil fuels (expressed in kWh, GJ or m^3) used within the system is zero (Broersma et al 2018).

Circular

Circularity is often only connected to the use of products: focusing on reusing, recycling and reprocessing materials. However, circularity can also include energy, water and nutrient cycles. A circular system reuses all waste flows and resource with only the input of renewable energy. A circular system functions by itself; it is self-sufficient. It is difficult to measure to what extent a system is circular, there are no numeric KPIs (Broersma et al 2018).

Other KPIs

While each of the sustainability goals comes with a different KPI there are also other relevant KPIs and sub-targets that could be used to support sustainable heat strategies. Figure 10 was developed within the SUI project and sets out a number of potential additional KPI's can be used (Jansen, Bokel and Müller, 2017; Jansen, S.C., et al., 2018) – see page 47 of the full report for a summary of these KPIs.

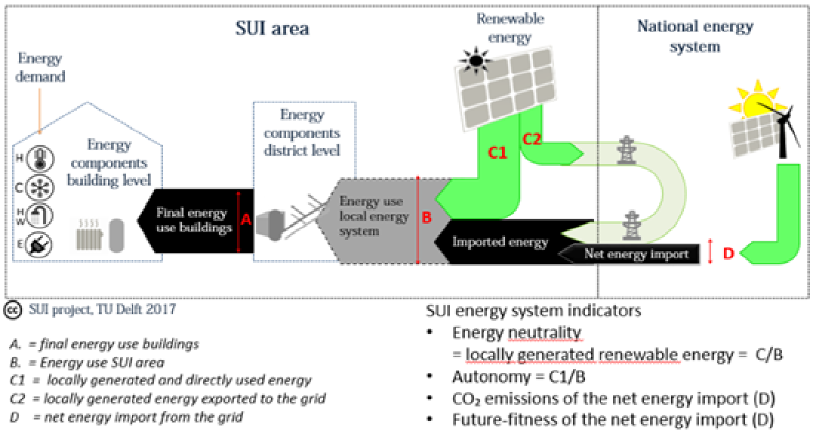


Figure 10. Energy Chain and Key Performance Indicators (source: Jansen et al. 2018)

How to calculate CO_2 emissions?

A common KPI is the reduction of CO_2 emissions. The Greenhouse Gas Protocol aims to set a global standard on how cities calculate their CO_2 emissions (Fong, W.K., et al., 2014) and is therefore used as the calculation method in SHIFFT. This Protocol divides the different emissions into three scopes, of which Scope 1 & 2 are relevant to local sustainable heat strategies:

- Scope 1 - direct GHG-emissions from the combustion of fossils within the city boundary.
- Scope 2 – GHG-emissions from sources occurring as consequence of the use of grid-supplied energy, heat, steam and/or cooling.
- Scope 3 – all other GHG-emissions that occur outside the city boundary as a result of the activities taking place within the city boundary.

Calculating the stationary emissions

The GHG protocol distinguishes six main sectors that cause CO_2 emissions from city activities. Within the SHIFFT project, only the stationary energy sector (related to the built environment) is considered. The stationary emissions that should be included within the SHIFFT project come from the combustion of fuels in residential, commercial and institutional buildings and facilities, as well as from grid-supplied energy (mostly electricity). Emissions are calculated by multiplying the activity data by the emissions factor related to this activity. Information on how to do this is provided on pages 48/49 of the full report.

4.3. Technical planning tools, methodologies and toolboxes

Translating the high-level strategies developed into concrete plans can be challenging. In this section, several tools, methodologies and toolboxes are described that can support this process by providing a technical basis.

4.3.1. EPM: Energy Potential Mapping (page 49 – 54 in full report)

Energy Potential Mapping (Broersma, Fremouw and Dobbelsteen, 2013) is the process of spatially quantifying demand, demand reduction potential and residual and renewable supply potentials and produces an **energy atlas**. At the core, EPM applies the New Stepped Strategy by connecting geospatial indicators with conversion factors in order to arrive at a functional demand, demand reduction and a technical supply potential, using the same units for all layers. The end goal is to connect these and facilitate the creation of heat zoning plans. The EPM method is the basis for any energy atlas and sustainable spatial planning tool.

An example is shown in the map highlights the energy potential for forest and agricultural biomass on one hand, and residual heat from large industrial companies and industrial zones on the other hand, in this case projected over residential space heating demand.

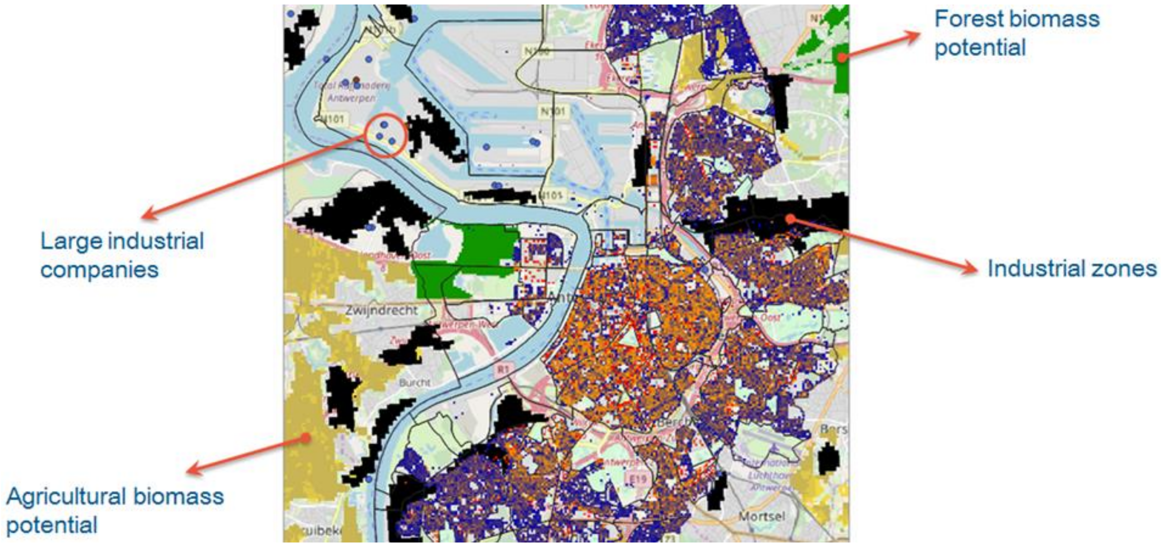


Figure 11. Energy potential mapping, illustrated for the city of Antwerp, using the PLANHEAT toolkit (PLANHEAT, 2019)

Mapping heat demand

Mapping the heat demand in most cases is a first step towards a sustainable heating strategy. The main challenge is collecting the data. Consumption figures for natural gas and electrical heating can (relatively easily) be acquired from the distribution system operator (DSO), although figures for other heat sources such as fuel oil or biomass can be more challenging. Examples of where data can be sought are provided on page 51 of the full report).

Heat density maps (e.g. Figure 12 and Figure 13) in particular might be a valuable tool to provide information about the potential for district heating (from a demand-side perspective). Valuable resources in this regard are the national and regional databases developed under the framework of the European research projects TABULA and EPISCOPE , which categorised residential typologies of residences (both individual and collective), depending on the year of construction, the type (e.g. detached house, terraced house, apartment building) and the thermal insulation level.

Mapping heating supply

The transition to a sustainable built environment requires making better use of local and regional energy potentials. This is especially the case when considering heating and cooling, because these are difficult to transport economically over greater distances.

Because of the highly varying nature of the energy categories involved, input data can come from many sources, which are increasingly publicly available. The projects mentioned further down this chapter streamline the process of converting this data into useful maps for making heat zoning plans.

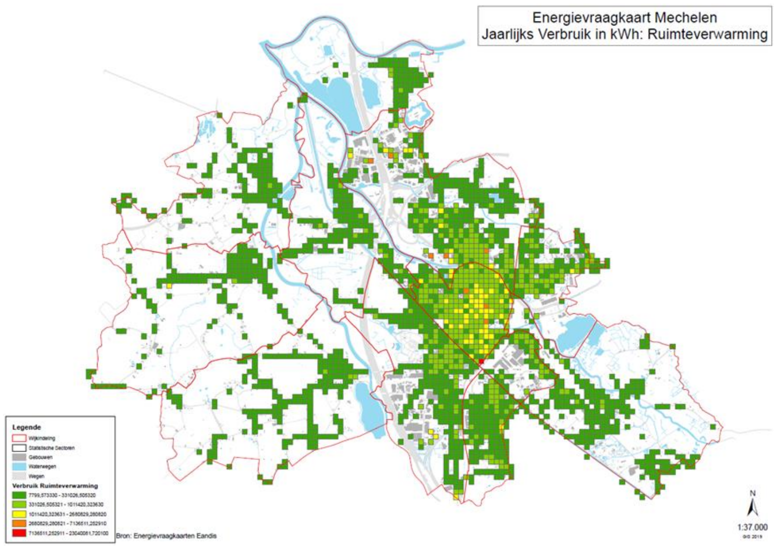


Figure 12. heat density map of the city of Mechelen (raster 100x100m) (Fluvius, 2017)

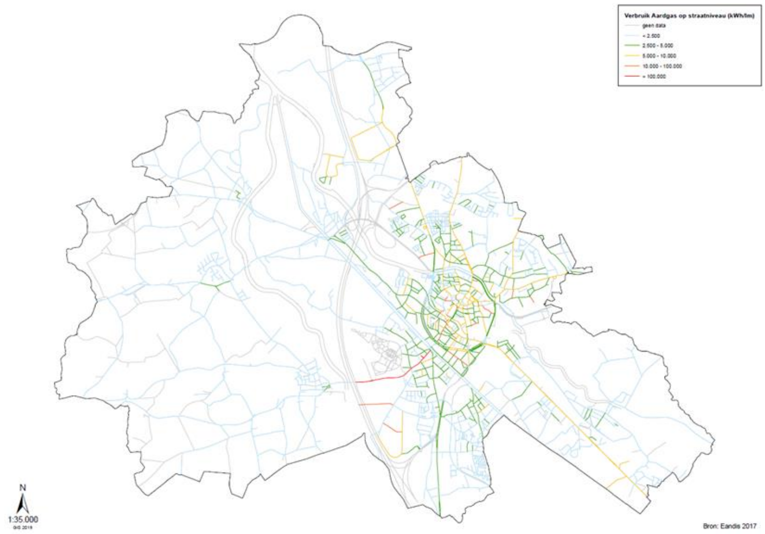


Figure 13. Linear heat density per street map of the city of Mechelen (Fluvius, 2017)

4.3.2. CELSIUS toolbox

The CELSIUS project aimed to cover the transition to residual and renewable heating and cooling in the built environment as broadly as possible, and revolved around five partner cities (Gothenburg, London, Rotterdam, Cologne and Genoa), their demonstrators (near market Heating Cooling technologies) and knowledge partners (like TU Delft), with the intent to comprehensively increase the impact of these technologies within the European Union.

Around twenty large scale demonstrators were built, monitored and used in experiments. Examples of these are the Heat Hub in Rotterdam (an 8.000 m^3, 185 MWh heat store located in the demand area rather than next to the production facility), demand side management in Gothenburg (reducing peak demand by using buildings as heat batteries) and subway ventilation heat recovery in the London Borough of Islington.

CELSIUS has produced an extensive online knowledgebase called the 'toolbox', which combines the collective results of the research project, from a technical and economic perspective, and includes a vast array of useful information that helps implement these technologies. The toolbox can be found at http://www.celsiuscity.eu/toolbox/ and is kept up to date by the CELSIUS 2.0 initiative.

4.3.3. PLANHEAT toolkit

In the PLANHEAT project, a QGIS-based software toolkit was developed to guide the user through all stages of developing heating and cooling plans for an urban area. The toolkit consists of three elements: Mapping module; Planning module; and Simulation module. Once data has been inputted, scenarios can be produced for reference years to determine the impact of choices (for example CO_2 exhaust, number of working hours per source, storage charge and discharge) compared to the baseline. Because the modules build upon one another, many different scenarios can be run and compared without having to repeat the initial mapping process.

4.3.4. HoTMAPS toolbox

The open source toolbox HoTMAPS helps local authorities and city planners to develop heating and cooling strategies. The toolbox provides models and default data that enables the user to identify, analyse, model and map H&C resources and solutions.

4.3.5. THERMOS tool

The THERMOS (Thermal Energy Resource Modelling and Optimisation System) software is developed to accelerate the planning process of a district heat network and to make it more efficient and cost effective. Allowing the user to identify the options for DHC-networks in their project area by developing thermal energy system models and optimisations. This tool is useful for local authorities and energy planners and can be applied to city and district scale.

4.4. Citizen and stakeholder engagement in the heat transition

Energy, climate, or environmental officials easily slip into the roles of stressing advantages and 'selling' environmental change (Horsbøl, 2018). Many citizens react critically to this or become suspicious due to the resemblance of advertising practices or unwelcome paternalistic behaviour. Public officials can quickly find themselves defining what is important for the citizen (for instance, a job, housing comfort, etc.) instead of taking a step back and letting citizens define what is important to them (Horsbøl, 2018).

A thorough stakeholder analysis and engagement belongs to the basics of any public involvement in the energy transition. The social side of the transition to sustainable heating and gas-free living is however complex and not linear. This results in a new tension between project management and an orientation towards clear objectives, milestones, and follow-ups on the one hand with the iterative and reflexive behaviour of stakeholders and citizens on the other. A second inevitable tension exists between the principle that a broad range of affected and interested parties should be included and the reality that intensive deliberations on complex issues require thorough preparation, time, commitment, and inclusion, which not everyone is capable or willing to provide. There is evidence that, even when sustainable heating technologies are voluntarily installed in homes by the occupants, they do not necessarily replace previous fossil fuel heating, but complement them, leading to installed systems that are far from optimal (Wrapson and Devine-Wright, 2014). These would not be predicted or expected by technical experts but show how crucial engagement is for effective heat transitions, even when dealing with willing volunteers, before, during and after installation phases. In order to avoid citizen and stakeholder engagement being followed by intuition rather than using a sound methodical approach, we offer a few essential guidelines. While these guidelines are written as recommendations, they are certain to need adaptation to local cultures and contexts.

4.4.1. Discovering objectives and co-benefits (page 56)

Public engagement means addressing matters that are already emerging within a community. A community is unlikely to be motivated to engage in a project which doesn't come from the community itself. Citizens become involved in working together with the municipality for different reasons. For example, someone who is about to buy an apartment and is concerned that in a few years the expensive heating system will need replacing may be seeking clarity on sustainable heating. Another person, who loves cooking with gas, might be reluctant to give up on this known technology.

4.4.2. Stakeholder identification (pages 56 to 58)

Deciding which groups, or which representatives, need to be engaged is a sensitive matter and conveys a decision that should be made collectively. There are different strategies for this but, ultimately, it should serve the objective of inclusiveness. This, in principle, simply means that everyone who is affected by the issues and the outcome of a decision should have the right to participate or to be represented in that process. No one should be prevented from exercising these rights (Susskind and Cruikshank, 2006).

One of the best ways of identifying all relevant stakeholders is to start by identifying key internal colleagues within your organisation (Carbon Trust, 2018). Internal stakeholders represent those within the organisation that might have important knowledge or authority over certain domains or policies that touch upon sustainable heating, fossil-free living, urban design, and co-creation. Examples of this could be colleagues from departments such as: Energy and environment; Sustainability and circularity; Building; Social affairs; Finance; Housing; Health; ICT and digital city; Planning; Economic development; Democratisation. These colleagues might be helpful in drawing a first map of who needs to be invited. It is also crucial to keep them in the loop about the process as, without their consent or even active cooperation, you might run into blockages, mostly at a later stage, within your organisation.

Outside your organisation there are many stakeholder groups that can be included, especially considering the heating transition at the city district and neighbourhood level. Table 4 lists some stakeholders that can be considered.

Table 4. A summary of some of the stakeholders who may be involved in the transition to sustainable heat

Demand side	Supply-side	Regulatory institutions
• Landlords • Tenants of privately owned properties • Project developers • Housing associations or cooperatives • Tenants of social housing or cooperatives • Social housing agencies • Private homeowners • Local businesses • Public sector buildings • Industry buildings • Condominium associations	• Energy providers • Heat sources • Energy utilities • Local community energy collectives generating energy • Contractors • Prosumers • Construction companies (contractors, subcontractors) • Technology solution providers • Architects • Installers • Electricians • Plumbers	• Distribution system operator • Public agencies (planning, procurement, environmental protection) • European regulations **Investment, trading sector** • Property owners • Investors • Energy data-base or platforms • Energy brokers
Intermediary organisations		
• Cultural institutions • Energy poverty groups • Tenant ambassadors • Consultancy agencies and engineering companies • Knowledge institutes • Process managers	• Local politicians • Local NGOs • Local media • Local influencers • Neighbourhood cooperatives • Neighbourhood managers	• Governmental organisation delivering intermediary services • Citizen initiatives (including community energy collectives) • Energy balancing managers

4.4.3. Sustainable heating technologies and stakeholder selection (pages 58 to 61)

Selecting stakeholders to work with relates to the type of sustainable heating technology chosen**.** Table 5 provides an overview of alternative heating solutions for the built environment and suggests how citizens and stakeholder engagement might take shape depending on the technology, respectively depending on individual and collective heat systems (district heat networks). Table 5 gives an overview of different sustainable heating solutions and how citizens and stakeholder engagement differs in terms of the scope and site, and the actors involved.

Table 5. Overview of sustainable heating solutions and citizens and stakeholder engagement

Technology	Scope and site	Actors
Individual solutions (Home and building owners)		
• Heat pumps • Solar thermal • (Geothermal) • Biogas, biomass • Insulation	• Co-initiating thematic workshops on how co-benefits can be realised through individual solutions • Co-researching homeowner preferences • Co-creating a local platform on opportunities and learning experiences • Co-designing customer journeys • Co-creating the communication on the difference between a heat price and a gas price • Co-creating demand side management for electric solutions • Collective procurement	• Private homeowners • Local businesses • Local media • Local influencers • Neighbourhood cooperatives • Energy communities • Prosumers • Construction companies (contractors, subcontractors) • Architects • Installers • Electricians • Plumbers
• Individual storage • Electric or pump solutions	• Co-research for storage opportunities • Co-testing individual storage applications	• Similar actors to above
Shared solutions (Owners and tenants)		
• Heat pumps • Solar thermal • Geothermal • Biogas, biomass • Insulation	• Co-writing feasibility studies • Co-designing combination of solutions • Co-implementing user guidelines and maintenance strategies • Co-creating a local platform on opportunities and experiences • Collective data collection • Collective procurement	• Investors • Developers • Housing associations • Housing contractors • Tenants • Management firms • Energy communities
• Shared storage • Electric or pump solutions	• Co-research for storage opportunities • Co-testing shared storage solutions	• Similar actors to above
Collective solutions (Urban, district, or neighbourhood)		
• District heating networks (DHN) • DHN with PVT and seasonal storage • Sewage water exchanger • Mini DHN with individual heat pump • High temperature DHN with solar collectors and storage	• Co-writing feasibility studies and action plans • Co-initiating thematic workshops on how co-benefits can be realised through collective solutions • Co-initiation Living Labs • Collective deliberation on preferred scope, scale, and sources of district heating network	• Distribution system operator • Public agencies • European regulations • Energy providers • Businesses who produce excess heat • Energy utilities • Local community energy collectives

Technology	Scope and site	Actors
• Biomass in DHN • DHN on industrial waste heat • Mid-temperature DHN on residual waste heat • Power-to-Heat in a DHN	• Co-designing customer journeys for switching to a DH system • Co-designing communication campaign towards large and small customers	• Construction companies • Local politicians • Local media • Local influencers • Neighbourhood managers • Energy balancing managers
• Collective storage • Heat hub • Borehole thermal energy storage • Aquifer thermal energy storage • High temperature seasonal thermal energy storage in underground closed systems • High temperature storage in the ground	• Co-research for storage opportunities • Co-design of storage facilities • Deciding on preferences	• Similar actors than above

4.4.4. Stakeholder drivers and barriers (pages 61 to 62 of full report)

One of the pivotal steps is to understand, from every stakeholder, whether they are from within your organisation or external, what their main drivers and barriers are that might lead to engagement, resistance, or ignorance of the policy, the project, or issue at stake.

- Exploring and aligning interests and motivations - the interests and motivations of the stakeholders might not align in the first place, gaining insights into the distinct drivers and barriers of the various stakeholders will be important.
- Spokesperson authority - it is crucial that stakeholder representatives involved in participatory processes have sufficient authority to make commitments on behalf of their organisation.
- Extent of stakeholder influence - It is important to determine the amount of influence citizens and actors exert over certain parts of the project.
- Intermediary organisations and networks - intermediary organisations play an important role in reaching out, encouraging and involving citizens since decisions that are made in heat consumption are largely a matter of personal and private interests.

4.4.5. Managing co-creation: Investing time, energy, and resources (pages 62 to 63 in full report)

A thorough assessment of the necessary time, energy, and resources that citizens and stakeholder engagement requires can support the municipality as well as stakeholders in making informed decisions about whether they are realistically prepared. In the early stages of citizens and stakeholder engagement, it is key to balance flexibility and practicality of the process against the increase in complexity and sensitive issues.

- Supporting citizens - getting communication departments on board is a must. Not only are they familiar with which language to use with citizens, they may also have internal expertise, tools, and contacts that will come in handy during the process.
- Using external support – if internal support is not available, you may need to consider external facilitators, if so, there are some key criteria to consider in deciding who to work with (see page 63 of full report).

4.4.6. Embedding citizen and stakeholder involvement in ongoing planning or formal decision-making processes (pages 63 – 64 in full report)

There is a paradox that participation and dialogue processes can still be detached from current decision-making even though that might not be initially intended. In the beginning, the intention is that involving citizens and stakeholders takes place in close proximity to decision-making processes and has a significant influence on decision-making. In reality, however, many citizen involvement processes set off a participation biotope with scope for creative ideas but very limited intersect with political decision-making. Beware that, despite good intentions and competences, citizen and stakeholder engagement may be completely disconnected from political activity, as if it is happening in a parallel world.

Embedding collaborative heating systems adaptation in an ongoing planning or formal decision-making process can reduce disruption and cost. It may also contribute to achieving multiple goals (e.g. installing district heating infrastructure to support lowering the carbon footprint in a given neighbourhood while at the same time contributing to improving resilience to extreme weather events). This will also contribute substantially to the cost-effectiveness of construction activities by reducing the risk of unexpected consequences, foot-dragging, or resistance.

4.4.7. Inviting stakeholders and citizens (pages 64 – 65 in full report)

Having identified the most obvious stakeholders, a small group of these stakeholders should be contacted and informed early on that the municipality seeks to initiate a process towards more sustainable heating. These pre-identified stakeholders should be asked if they would be interested in engaging in such a process and to specify who, in their eyes, seems to be a further relevant or affected party that should be represented in the systems or the decision-making level of the heat transition. To reduce the risk of excluding non-visible groups, the municipality can also actively decide to include groups that are typically underrepresented, or hard to mobilise.

When you try to involve citizens and stakeholders, this can be a small or large group. It should however be an inclusive group and a reasonably representative sample. The sample is based on the critical mass needed for transition, i.e. not the 10% most advanced in sustainability or the 10% most reluctant, or the 10% who may not care about anything but the 60–65% of the remaining middle group.

To activate those middle groups, first make use of existing contacts, resources, and established communication channels within your organisation. Are there citizen panels, ambassadors, neighbourhood committees? Are there other project partners or intermediary organisations already involved that can co-invite? Make use of established contact points such as direct mailing, social media, apps, or office branches.

To increase participation, use catchy entry questions and communicate clearly about the transparency of the process, the value of their inclusion and by providing answers to what happens with the results.

It is not only pertinent to identify and activate less powerful and marginalised groups but also to organise the citizens and stakeholder processes in such a way that allows these groups to participate in a meaningful way. The goal essentially, is to provide low barriers to entry:

- Design and use language as close to the private sphere as possible;
- Combining on- and offline co-creation spaces;
- Foster trust in individual competence/expertise to participate;
- Demonstrate the potential impact of participation;
- Enable the possibility of passing the invitation on to someone else;
- Offer incentives, e.g. compensate participants or provide them with a special experience.

4.4.8. Timing

As a baseline, the earlier the involvement with citizens and stakeholders starts, the more everyone will have the feeling of an equal partnership. A good indicator is to scrutinise previous experiences with stakeholders and citizens and understand their opinion on the timing of their involvement. Another option is to find out if there is already an ongoing community initiative around sustainable heating or a third-party project that the municipality might get involved with. Timing also depends heavily on clarifying the stage at which stakeholders, citizens, and the municipality get engaged; determine if is this in co-initiating, co-designing, or co-implementing sustainable heating initiatives.

4.4.9. Best practices of citizens and stakeholder involvement in the sustainable heating transition

In the following section, we provide an overview of state-of-the-art approaches and good practices in sustainable heating with citizen and community energy involvement that involve case studies from different European countries. Denmark is the leading country on sustainable heat, which is why we start with three key inspirations from there.

4.4.10. Denmark as a guiding country (pages 65 – 66 in full report)

In Denmark, 65% of all homes are supplied from a heat network. Consumer-owned district heating facilities (heat source, network, and supply) produce 36% of this heat. Of the 430 Danish heat networks, 360 are owned by residents through a cooperative. Specialised service companies are responsible for the development and operation of these heat networks. Three key approaches have been part of Denmark's success:

- A district heating package – that takes homeowners through the whole process of connecting to a DH;
- An instrument to help customers save energy – to help identify measures to save heat and reduce heating bills;
- The customer journey - to persuade and unburden householders who switch their connection from the conventional gas grid to the DH system.

Community energy action in sustainable heating transition

Working with community energy collectives[1] in sustainable heating projects offers certain benefits over working with conventional parties only. There are several reasons that these specific groups are better positioned to accelerate sustainable transitions than other energy service providers.

4.4.11. The case of Meer Energie (Page 67 in full report)

4.4.12. The case of Thermo Bello (Page 67 in full report)

Thermo Bello (Culemborg, NL) - a small-scale power-to-heat district heating scheme drawing heat from a drinking water basin to supply 210 households and seven commercial buildings.

4.4.13. Lessons from local energy communities (Page 67-68 in full report)

Key conditions for promoting local energy community models and practices:

- There should be a clear political commitment
- Awareness that energy communities are vulnerable to policy changes

[1] Energy cooperatives have several internationally agreed principles governing their operations. For more informaition visit www.REScoop.eu

- Community project developers may also run into barriers related to permits and environmental impact assessments that they are not equipped to overcome.
- Communities can also face challenges in entering the energy market, gaining access to grids, and competing on a fair basis with energy utilities
- Cultural issues relating to common ownership of resources will also affect how quickly a community adapts to these set-ups.

Natural gas free neighbourhoods (Delft, NL) (Pages 68 – 69 in full report)

National government in the Netherlands expects municipalities and cities to develop neighbourhood-level strategies for alternative sources of heat. Within Delft the approach taken has been to open up this discussion to its inhabitants through information and discussion events on natural gas free neighbourhoods, in which citizen involvement in policy and project development was encouraged. The meetings took a stepwise approach:

1. In the first meeting, a brainstorm session was held in which inhabitants could voice concerns and values they deemed important for the topic.
2. The second meeting prioritised these concerns and reformulate them into several key topics.
3. The last meeting presented a summary of common rules, focused on recognition and identifying relevant actions for establishing a heat plan.
4. Besides giving a voice, these meetings also helped to create a sense of community around energy policy. They also led to the creation of a platform to share knowledge about the energy transition and the technological options available to residents.

Schools as neighbourhood energy embassies (Pages 69 – 70 in full report)

Schools can play an important role in spurring energy transition at the neighbourhood level, because:

- School buildings can be used to install measures and serve as landmarks in neighbourhoods;
- Pupils can be educated about sustainability and influence their parents and social environments;
- Schools can be seen as social hubs in neighbourhoods.

An example project is the Dutch "Schools as energy embassies in neighbourhoods (SEE)" which used Living Labs the combined a school and a network of stakeholders connected to the school or neighbourhood, including wider relevant stakeholders from local government, housing association, DNOs, etc. This process helped to create several new initiatives.

Neighbourhood engines (Pages 70 -71 in full report)

Two neighbourhoods with high (cultural) heritage value in the 'Wijkmotor' Kempen region of Belgium, saw a Living Lab set up to generate knowledge on how to sustainably renovate homes. This used a neighbourhood engine model, that can add economic and social value and create better environmental quality and greater comfort for the homes in the neighbourhood. The neighbourhood engine involves five steps: Co-initiate; Co-sensing; Co-creation; Prototyping; and Co-evolve. A major output of the project was a renovation project toolbox, including neighbourhood renovation concepts.

4.4.14. Co-writing a narrative for a sustainable heating transition (Pages 71-72 in full report)

Successful narratives in sustainable transitions can be useful, a good example is the Leuven roadmap for climate neutrality. This began in 2011 with the mayor officially declaring to make the city climate neutral. A scientific report was completed in 2013, listing possible and necessary measures and scenarios for achieving a climate-neutral city by 2050. This led to the birth of a wider co-creation and narrative writing process, when 60 founding members, representing residents, companies, knowledge institutions and (semi-)public authorities, jointly founded the urban non-profit association Leuven

2030. This organisation continued to grow and develop a roadmap 2025 - 2035 – 2050 to serve as a guideline for achieving the climate-neutral city goal by 2050 as well as a narrative ranging from 'doing what you can' to 'doing what you have to do' to co-create a systemic change in the city, in the built environment and in local communities.

4.4.15. New roles and responsibilities (Pages 72 to 73 in full report)

The sustainable heating transition implies changing roles for citizens, from being passive participants to active initiators, designers and implementers, through an increase in citizen agency and professionalisation. At the same time, the sustainable heating transition implies new roles for public officials too, as brokers, area managers or advisers, using their competencies and their network in leveraging citizen initiatives, respectively offering public spaces and infrastructure to be used by citizens, social entrepreneurs, artists, and other actors of urban change.

The sustainable heating transition is a process that develops on a shared platform that is driven less by rules and more by initiatives taken by both citizens and public authorities to involve each other in ensuring better governance. Asking people to make changes to their homes and lifestyles can spark a range of issues that have to be addressed. Co-creating solutions can help overcome this, and the process of co-creation will be rendered more efficient when the authorities themselves realise the importance of looking outside the bounds of legal role and professional expertise and leveraging citizen perspectives in order to create a joint understanding of problems and solutions.

To sum up, in dealing with changing roles and responsibilities, the key is to adopt a learning attitude where citizens, stakeholders, and government officials learn from each other. Therefore, perspective-taking during the heat transition helps to find the necessary balance between competition and cooperation, between self-interest and other-interest.

4.5. Building blocks for a local heating policy

4.5.1. Importance of a local heating policy and the role of a local authority (page 73 in full report)

Around 72% of the European population lives in urban areas and cities will need to play a key role in driving the sustainable heat transition. As such, cities and municipalities have an important role to play and can influence whether or not the heat transition that we have to realize will succeed.

4.5.2. Role of local authorities in the heat transition (page 73 in full report)

There is pressure from citizens in certain cities and municipalities to act on climate change means there is a need for local authorities to act on sustainable heat. Municipalities need to take an active role, raising awareness, mobilising, unburdening and guiding the target groups with a view to investing in energy efficiency and environmentally friendly energy production.

Position	Passive passenger	Traffic director	Active pilot
			
Role	Tolerating/permitting heat network project	Facilitating heat network and drawing the outlines	Setting up municipal heat network to realise heat network
Impact	Minimal impact on staffing and budget	Provide with staffing and financial resources	Major impact on extra staffing and extra resources
Risk	Blootstelling aan verdoken risico's	Risks made visible and primarily assigned to external parties	Almost all risks borne by local government
Focus	Granting access to public domain	Facilitating a feasible and broadly-supported project; anchoring agreements in law	Making its own heat company operational with own accents
Policy impact	Risk of fragmented and suboptimal local spatial and energy policy	Option to expand a coherent local spatial and energy policy	Need to expand a coherent local spatial and energy policy

Figure 14. Possible roles of local authorities for district heating projects (Cyx, W. 2017)

4.5.3. Challenges and opportunities for local authorities (pages 74-75 in full report)

Cities and municipalities must take up a pioneering role in order to unlock the heat transition. However, they often lack support to implement it. Moreover, the extent to which a local government can implement a local heat policy depends on its governmental capacity, as there is a need for sufficient time and manpower to be able to play this supporting role in the implementation of the heat transition. In that sense, the policy options of local authorities can differ greatly. This demand for support or unburdening is widely supported by many local authorities. Examples of challenges and opportunities include:

- Lack of data – to develop a strong local energy policy, local governments need detailed data on energy consumption and renewable energy production on the territory and within their own organization (Diran *et al.*, 2020).
- Lack of specific expertise and skills – there is a need for knowledge and specific expertise at the local government, requiring training of technicians, civil servants, and decision-makers from regional and local authorities, in order to provide the technical background necessary to approve and support renewable heating and cooling projects.
- Interaction with other policy levels - cities' efforts will only have the desired impact if they are complemented by compatible regulatory frameworks and favourable investment mechanisms established at the European and national levels. Alignment between different policy domains internally can also help support actions at the local level.
- Learning network - Knowledge exchange between cities and municipalities developing heat transition can aid learning

4.5.4. Policy instruments related to the heat transition (pages 75-76 in full report)

A successful local heating policy will require a carefully selected mix of policy instruments. Figure 15 shows several policy measures that can support sustainable heating. It includes conventional, existing instruments and policy tools, and more innovative ones, that have showed promising results in particular cases. Four classes of policy instruments are shown: (1) steering / direction setting; (2) regulating; (3) facilitating; and (4) stimulating. Furthermore, a local government (5) can also act on its own, which can be treated as a fifth class of policy instrument or action: demonstrating. The examples are discussed in more detail in the sections below.

Figure 15. Overview of policy instruments for local authorities related to sustainable heating (based on (Verheul W.J. et al 2017))

4.5.5. Steering and envisioning (pages 76 to 78 in full report)

Mapping the heating demand and supply potential of its territory can strongly contribute to developing support, interest, capacity and insight into its own heat situation within the city or municipality. The resulting heat maps or heat zoning plans are at least as informative and potentially mobilising – it is also an aid for heat users to plan investments in energy renovation.

Local heat zoning plans based on heat maps can be a key component for a local heat strategy. Local heat plans show in detail which sustainable heating technologies or solutions are techno-economically preferred in a certain district/part of a city or municipality. For instance, a heat zoning plan can indicate where heat networks (or equivalent alternatives) are to be placed in the future – 'mandatory zones', where heat networks are desirable if feasible (e.g. connection in later phase) – 'potential zones', and also where heat networks may not be installed – i.e. 'restriction zones'. In the latter, individual heat solutions will need to be installed or all-electric heating systems must be encouraged.

The Dutch government has developed various instruments to support the cities and municipalities. This includes the "Start Analysis", a techno-economic analysis based on national data, using the Vesta MAIS model. This analysis provides a first idea of the techno-economic and environmental impact (such as national costs, energy demand, CO_2 emissions) at neighbourhood level for five sustainable heating alternatives.

4.5.6. Regulating (page 78 - 79 in full report)

Legislation related to heating will most of the time be the result of regional and national policy. Nevertheless, local authorities do have the opportunity to complement it with additional legislation adapted to the local context. Some examples include:

- Building permit regulation - quick scan or pre-feasibility check for sustainable heating can be used for new construction projects or urban developments. This can include obligations to gain insight in the feasibility of sustainable heating alternatives at the technology and on the system level.
- Building permit regulation - collective buildings with multiple residential units and mixed functions may be attractive users for a heat network, due to their relatively high energy consumption for heating. A local authority can impose the obligations to provide a central boiler room for new constructions of medium to large-sized condominiums.
- Spatial planning requirements - when drawing up Municipal Spatial Implementation Plans guidelines about a conditional connection obligation, a boiler room at ground level and/or reserved lanes for heat pipes can be set.

4.5.7. Stimulating (page 79 in full report)

Grants can be put in place for energy efficiency or renewable energy measures. As is the case with regulatory policy instruments related to sustainable heating, financial incentives are more likely to be imposed from regional or national government, but these can be complemented with local grants or financial stimuli if resources allow.

4.5.8. Facilitating (page 79 to 81 in full report)

There are several ways to help facilitate action on sustainable heat at the city and municipality level. Examples include:

- Energy cooperatives can be a valuable partner in mobilizing financing and public support for local energy projects.
- Energy information centres offer a route to connect demand (homeowner) and supply (construction and installation sector). Energy information centres have been established in almost all municipalities in recent years.
- Energy broker - the project DOEN develops the methodology of the "energy broker" in Flanders and The Netherlands, as a public service that links (residual) energy from companies to potential energy customers.

4.5.9. Demonstrating (pages 81 – 82 in full report)

Defining pilot zones or projects - urban renewal projects can serve as leverage projects to accelerate the heat transition. Figure 16 for example shows the urban renewal project Keerdok in Mechelen, which will feature a low temperature heat network, supplied by heat pumps with sewage water recovery and borehole thermal energy storage (BTES) fields.

Public buildings can be used as examples of sustainable practice. There is much to gain for local authorities in developing, financing and implementing a sustainable real estate strategy. A local authority is often also a (public) building owner. Public buildings are therefore typically the first candidates to connect to a district heating network.

Figure 16. Urban renewal project Keerdok in Mechelen (Dousselaere, 2019)

5. Conclusion

This summary document provides a high level overview of a much more detailed SHIFFT report which can be accessed via the SHIFFT website: [A Common Approach for Sustainable Heating Strategies](#).

The transition to sustainable heating is a complex challenge that requires long-term planning and preparation by local authorities, distribution system operators, builders, homeowners, and communities. It requires robust, practical, tested tools and approaches for cities to mobilise, inform and facilitate local communities to make this change. We have developed the SHIFFT Common Approach to help provide solutions to the challenge of heat decarbonisation.

This summary report provides a common understanding of sustainable heating and a common approach for how to develop locally focussed sustainable heat strategies. It sets out a step-by-step common approach and provides background information on technologies, social aspects, and policies for low carbon heating. It covers existing high-level strategies; technology overviews; planning tools; citizen and stakeholder co-creation; and building blocks for heat policy. More detailed information on all these aspects is available within the full report, which also provides: a wider introduction to SHIFFT and the partner cities; data on heating and cooling across the EU and 2 Seas regions; and a policy overview for sustainable heating in each of the 2 Seas Member States.

The Common Approach is based on the needs of cities, national requirements, state-of-art insights, and available best practice. It is currently a draft framework for developing a heat strategy, which is being used by the four SHIFFT partner cities of Bruges, Fourmies, Mechelen, and Middelburg who are each developing their own heat strategy. These partner cities will identify and analyse heating needs, heat supply opportunities (e.g. residual heat, geothermal), actors, technologies, and barriers for sustainable heating for their city. This will be done in an interactive process involving different city departments, community groups and stakeholders.

The practical experience gained by these cities will help inform the development and enhancement of the SHIFFT Common Framework. This will be one of the final outputs of SHIFFT – a new stand-alone practical guide for local authorities and community groups on how to accelerate the transition to sustainable heating of homes and community buildings, with the partnership and consent of their residents. You can keep up with developments and find out more about SHIFFT from our project website: https://shifftproject.eu/

6. References

Broersma S., Dobbelsteen A. van den, Blom T., Fremouw M., Sturkenboom J., Keeffe G., Pulselli R., Vandevyvere H. (2018) *Amsterdam Roadmap.*

Broersma S., B. T. (2018) *City-zen catalogue of measures: part of city transition and development methodology for EU-wide application*.

Broersma, S., Fremouw, M. and Dobbelsteen, A. (2013) 'Energy Potential Mapping: Visualising Energy Characteristics for the Exergetic Optimisation of the Built Environment', *Entropy*. Multidisciplinary Digital Publishing Institute, 15(2), pp. 490–506. doi: 10.3390/e15020490.

van den Brom, P., Meijer, A. and Visscher, H. (2019) 'Actual energy saving effects of thermal renovations in dwellings—longitudinal data analysis including building and occupant characteristics', *Energy and Buildings*. Elsevier, 182, pp. 251–263. doi: 10.1016/J.ENBUILD.2018.10.025.

Carbon Trust (2018) *Stakeholder Engagement in Heat Networks. A guide for project managers.*

Cyx, W. (2017) *Naar een vergroening van de warmtevoorziening voor huishoudens in Vlaanderen.*

Diran, D. *et al.* (2020) 'A Data Ecosystem for Data-Driven Thermal Energy Transition: Reflection on Current Practice and Suggestions for Re-Design', *Energies*. Multidisciplinary Digital Publishing Institute, 13(2), p. 444.

Van Den Dobbelsteen, A. (2008) '655: Towards closed cycles-New strategy steps inspired by the Cradle to Cradle approach'.

Dousselaere, D. (2019) 'Warmtenetconcept Keerdoksite Mechelen.' Presentation by Fluvius during the SHIFFT stakeholdermeeting in Bruges, 7/11/2019.

European Council (2019) *EUCO 29/19 CO EUR 31 CONCL 9 European Council meeting (12/12/19) Conclusions*.

Eurostat (2019) *Distribution of population by degree of urbanisation, dwelling type and income group*

Fluvius (2017) *Fluvius Open Data*.

Fong, W.K., Sotos, M., Doust, M., Schultz, S., Marques, A. & Deng-Beck, C. (2014) 'Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. An accounting and reporting Standard for Cities'. Published by the World Resources Institute (WRI) C40 Cities and ICLEI Local

Heat Roadmap Europe (2017) *Profile of heating and cooling demand in 2015.*

Horsbøl, A. (2018) 'Co-Creating Green Transition: How Municipality Employees Negotiate their Professional Identities as Agents of Citizen Involvement in a Cross-Local Setting', *Environmental Communication*. Informa {UK} Limited, 12(5), pp. 701–714. doi: 10.1080/17524032.2018.1436580.

IPCC (2018) *Special Report: Global Warming of 1.5oC.*

Jansen, S.C. Mohammadi, S., van den Dobbelsteen, A.A.J.F., Cararbias-Hütter, V., Kuehn, T., Hotwagner, M., & Koehler, S. (2018) *SUI mini network Guidelines for developing SUI energy concepts. Smart Urban Isle project.* A

Jansen, S. C., Bokel, R. M. J. and Müller, S. (2017) 'Buiksloterham Integrated Energy Systems', in *PLEA 2017: 33rd International Conference" Design to Thrive"*. Network for Comfort and Energy Use in Buildings (NCEUB).

Duijvestein, K. (1997) *Ecologisch bouwen*. Delft University of Technology, Faculty of Architecture.

Lysen, E. H. (1996) 'The Trias Energica: solar energy strategies for developing countries', in *Proceedings of the EUROSUN Conference*, pp. 1–6.

PLANHEAT (2019) *Training module 2: Mapping heating and cooling demand/supply*.

smartenergycities.nl (no date) *Over Smart Energy Cities*, *undated*.

Susskind, L. E. and Cruikshank, J. L. (2006) *Breaking roberts rules: the new way to run your meeting, build consensus, and get results*. Oxford University Press.

Tilllie, N., Dobbelsteen, A. van den, Doepel, D., Jager, W. de, Joubert, M., Mayenburg, D. (2009) *REAP: Rotterdam Energy Approach and Planning – Towards CO2-neutral urban development*.

Verheul W.J., Daamen T., H. E. & H. F. (2017) *Meervoudig sturen in gebiedstransformaties: op zoek naar rollen en instrumenten.*

Wrapson, W. and Devine-Wright, P. (2014) '"Domesticating" low carbon thermal technologies: Diversity, multiplicity and variability in older person, off grid households', *Energy Policy*. Elsevier, 67, pp. 807–817. doi: 10.1016/j.enpol.2013.11.078.