Transitioning to a carbon neutral heating and cooling in Estonia by 2050

Deliverable 7 Report: Action plans

Trinomics

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Transitioning to a carbon neutral heating and cooling in Estonia by 2050

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Executive Summary

This executive summary provides an overview of the main results of Deliverable 7 of the project: *Transitioning to a carbon neutral heating and cooling in Estonia by 2050*. The objective of this deliverable was to bring together the results of the previous deliverables of the project to suggest a number of actions that would allow Estonia to reach a carbon-neutral H&C system along the pathways defined by the energy system modelling.

The main focus of this report is the Action Plan (described in Section 5) and the actions tailored for each pathway within Section 5 and Sections 7 to 10. The four pathways considered are described in the table below.

Table 0-1 Overview of the H&C decarbonisation pathways

Pathway	Description
All electric	All infrastructure and technologies are based on electric solutions (both district & local). The electricity needs will be covered by renewable electricity and will be added progressively depending on the resource availability, TRL, financial feasibility and access.
Push towards District H&C	All possible H&C requirements will be based on district H&C solutions. Energy sources are based on technologies that are considered sustainable and usable for district heating systems. Local heating solution are as limited as possible (only placed where district solutions are not in line with the balance of the pillars).
Push towards Local H&C	Mainly single house-based solutions and local autonomous systems. The district grid will be phased out while shifting all the possible demand towards local solutions. Industry needs are integrated through industrial clusters, which allows local solutions to be integrated with industry.
Technology Neutral	No preference towards any type of infrastructure (local and district) with the flexibility of using any kind of renewable technology, in accordance with the sustainability pillars.

The pathways with the above definitions have been modelled to indicate the future development of H&C technologies (Deliverable 3) and the results have been used as input in a macroeconomic model to examine the socio-economic impacts (Deliverable 4). These results, combined with the results of the stakeholder inputs from the risk analysis (Deliverable 5), are used to determine the key policy actions necessary for Estonia to achieve full decarbonisation of the heating and cooling sector by 2050.

The table below provides an overview of the indicators of the pathways' performance. It is important to note that all pathways achieve full decarbonisation by 2050 and meet Estonia's H&C demand. Therefore, the recommendations based on these indicators should be used as a supporting guide for the required political choices, and not as a definitive decision about the potential H&C technology development in Estonia. Indicator weights have a range 1-5 (indicator with weight 5 being the most important one) are assigned based on their sensitive nature to the scenario deployment (weights assigned by project teams' expert opinion).

Table 0-2 overview of indicators for pathway selection

Indicator	BAU	All electric	DHC	LHC	Tech. neutral	Weights
New installed capacity (GW) (2022-2050)	1.9	3.866	2.197	2.7	2.248	1
Input energy/Fuel consumption (TWh)	13.4	7.1	12.1	10.6	11.5	5
Biomass dependency (use) by 2050 (TWh)	12.99	0	11.37	7.93	9.99	5
GHG emissions in 2050 (kt $CO_{2eq.}$)	12	0	0	0	0	5
Total investment requirements (2022-2050)	€17,621M	€19,066M	€18,789M	€18,027M	€17,837M	1

Indicator	BAU	All electric	DHC	LHC	Tech. neutral	Weights
Average heating costs for households in 2050 (EUR/MWh)	62	97	62	74	68	5
Average cooling costs for households in 2050 (EUR/MWh)	113	112	114	113	110	3
Impact of fuel prices on H/C prices (*Elasticity)	0.59	0.53	0.54	0.62	0.58	5
Impact of technology investment costs on H/C prices (*Elasticity)	0.08	0.14	0.10	0.08	0.09	2
H&C activities as % of GDP in 2050	3.5%	3.2%	3.8%	3.0%	3.4%	2
Employment in 2050 due to HC activities (jobs)	16367	15216	18064	14133	16004	2
Scenario risk perception by stakeholders	Low to medium	Medium risky	Less risky	Riskier	Moderately more risky	5
Overall score	**10.8**	**13.1**	**12.8**	**10.7**	**12.3**	
Overall scenario ranking	**4th**	**1st**	**2nd**	**5th**	**3rd**	
Legend (Indicator score by colour)						
Colour						
Score	**1**	**2**	**3**	**4**	**5**	

*Biomass use for heating may not be climate-neutral when taking the life-cycle into account. The risk of deforestation from biomass use for heating could lead to reduction in the carbon sink

Lastly, each scenario may integrate differently the **7 guiding principles** or pillars for carbon neutral heating and cooling :

Table 0-3. Pillars and their integration in the model

Pillar	Scenario integration
Sustainability	All scenarios are renewable-based, and hence a similar impact on sustainability. However, the scenarios relying more on bioenergy have a higher likelihood to compromise sustainability
Economically reasonable model	This pillar should encompass the average energy cost for households, but also the more macro employment criteria, to consider the global economic balance.
Energy market integration	All scenarios should implement actions towards more energy system integration, but with different intensities. E.g. DHC in the DHC scenario should play a bigger role in system integration, compared to local units in the local scenario.
Energy efficiency	Cf. point above
Security of supply	All scenarios rely on local/national resources, and hence have the same impact on SoS from a feedstock perspective. The All Electric scenario, given the seasonal impacts, is probably more sensitive to electricity SoS, as supplying H&C does not solve the balancing issue without flexible assets and storage. Hence, significantly increasing electricity demand for Heating during the winter period may impact SoS
Reducing energy poverty	The more Energy efficiency, the more "protection against" energy poverty (reducing the need will sustainability reduce the energy bill). Hence the All Electric is better placed. It should also come with an accelerated renovation of worse performing buildings (mostly occupied/owned by vulnerable households).
High level of digitalisation	All scenario should see the same level of digitalisation, but the DHC scenario will probably digitalise the DH network and its operation and not the end consumer, while the other scenarios will probably ensure more households digitalisation.

Given the outcomes of the various indicators, the project team recommends basing the Estonian H&C decarbonisation strategy mainly on the **All Electric**, but also **partially on the DHC scenario**, to keep the cost lower for energy consumers, and adapt to the local context and needs. In this framework DHC will be supplied by local resources where available (like with geothermal, solar sources via heat pumps, or with bioenergy, ideally locally produced). We assume a full decarbonisation of the electricity system by 2050. If for the climate neutral electricity strategy, a less renewable pathways is selected for

electricity generation, we would then recommend increasing slightly the share of DHC (moving more from All Electric to DHC).

Actions considered

Based on discussions with international experts, stakeholders and a review of literature, this report provides an outline of the policy actions needed to carry out the development of the different H&C decarbonisation pathways. For each action, the policy is described based on several criteria (key stakeholders engaged, costs, value added, source of financing, complexity, timeline, underlying conditions and compatibility with Estonian legal system and public perception) and best practises from other EU member states are provided.

The table below provides an overview of these actions and identifies which actions are a priority for which pathways. Priority actions are policies which are crucial for the success of the pathway, where as supporting actions are important policy actions but not as critical. The actions which are shared priorities across the pathways are highlighted. These policy actions are considered *no-regret actions*, as they play an important role regardless of the pathway selection.

Table 0-4 Overview of priority actions per pathway

Policy area	Actions	All electric	DHC	LHC	Tech neutral
Streamline integrated H&C planning process	**1.A. Establish integrated infrastructure planning at local level**	**P**	**P**	**P**	**P**
	1.B. Promote cooperation between electricity grid operators and DHC grid operators	**P**	✓		✓
	1.C. Mainstream bioenergy in a complete bioeconomy roadmap/strategy	✓	**P**	**P**	**P**
Phase the renovation wave and integrate renewable supply	**2.A. Incentivise replacement of heating systems when undergoing deep renovation**	**P**	**P**	**P**	**P**
	2.B. Accelerate the renovation of worse performing buildings	**P**	**P**	**P**	**P**
	2.C. Energy efficiency/renewable system mortgages and repayment of investments through property taxes	✓	✓	✓	✓
Development of the required infrastructure	3.A. Incentivise existing DHC refurbishment & shift to geothermal, solar and HPs	**P**	**P**		**P**
	3.B. Combine renovation programmes with DHC refurbishment	✓	✓		✓
Strengthen local authorities' role in H&C decarbonisation	**4.A. Empower local authorities to play an active role in H&C decarbonisation, oblige them the plan H&C decarbonisation**	**P**	**P**	**P**	**P**
Set up level playing field and creating a market	5.A. Incentivise/promote individual HP when most appropriate option	**P**		**P**	**P**
	5.B. Establish a gradual carbon pricing	✓	✓	✓	✓
	5.C. Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC	**P**	**P**	**P**	**P**
Empower all consumers, especially households	**6.A. Engage dialogue with industry to analyse best decarbonisation options (at 2050)**	**P**	**P**	**P**	**P**
	6.B. Facilitate the renovation of specific market segments to replace heating systems	✓	✓	✓	✓
Strengthen professionals' skills and knowledge	**7.A. Support developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners)**	**P**	**P**	**P**	**P**
	7.B. Education, training and certification of energy consultancies and heating installers	✓	✓	✓	✓
	7.C. Support research and development of new technological solutions	**P**	**P**	**P**	**P**
Mobilise and mainstream financing and funding	**8.A. Ensure adequate and integrated financing of all renovation instruments**	**P**	**P**	**P**	**P**
	8.B. Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C	**P**	**P**	**P**	**P**

P = priority action; ✓ = supporting action

Shared priorities are in bold.

Across all the pathways, there are a number of actions that are necessary to enable the decarbonisation of the H&C sector, including:

- **Actions to streamline the H&C planning process**. The same intensity and commitment is required for all pathways, as this is a central piece for a long term decarbonisation. Of course, planning should be tailored to the selected pathway(s), for instance, focusing on integration of planning for H&C and electricity in the All electric pathway and mainstreaming bioenergy in the bioeconomy strategy in the pathways reliant on bio-based heating.
- **Mainstreaming bioenergy in a complete bioeconomy strategy**. The current energy system in Estonia relies massively on bioenergy, hence, whatever the expectations in the future, the use of biomass resources should be regulated and/or promoted in coherence with a global bio-economy vision.
- **Phasing the renovation wave and integrating renewable supply**. All pathways require the Renovation Wave to be effectively implemented to make buildings sufficiently energy efficient (to lower H&C demand) and integrated with renewable H&C systems. Synchronisation of energy performance action and switch to renewable is key, and should be tailored to each pathway to ensure appropriate design and heating system efficiency.
- **Actions to refurbish the existing DHC infrastructure, where feasible**. For the pathways where DHC is still relevant (all but the LHC pathway), refurbished DHC infrastructure is required to reduce heat/cool demand as well as increase renewable integration in the DHC system.
- **Actions to develop the required new DHC infrastructure, where appropriate**. For the pathways where DHC is still relevant and further developed (all but the LHC pathway), highly performant infrastructure (4th or 5th generation) is required to reduce heat/cool demand as well as increase renewable integration in the DHC system.
- **Empower local authorities to play an active role in H&C decarbonisation**. All local authorities (cities, municipalities) play a crucial role in the planning of H&C systems. Empowering them with clear guidance on H&C decarbonisation planning, dedicated financing and administrative support plays a key role in encouraging them to play an active role in H&C decarbonisation.
- **Set up a level playing field and create a market for renewable alternatives**. These actions should be tailored to the pathways' focused alternative H&C technologies to create a level playing field with traditional fossil-based H&C technologies (and possibly bio-based heating system for the All Electric pathway) in order for these alternative technologies to achieve economies of scale. Market development on the Estonian territory is crucial for some technologies to compete (e.g. HP in Estonia are still costly, only a market ramp up would lead to prices aligned with international markets).
- **Actions to empower industry and household consumers to decarbonise H&C systems**. H&C consumers (industry and households) require empowerment, beyond the energy renovation activities, in order to be well-informed and encourage to participate in H&C decarbonisation. They should all be provided technical assistance to ensure well-informed choices, in line with their needs and socio-economic situation. Dedicated actions would be required for low-income households.

- **Actions to strengthen professional skills in the H&C market**. The shortage of skilled labour required for decarbonising heating and cooling needs to be addressed in terms of improving skills within the existing H&C supply chain. All professionals should be considered.
- **Mobilise and mainstream financing and funding**. Given that various actions include different financing schemes for the H&C sector and consumers, actions are required to ensure that the necessary financing and funding are efficiently mobilised and mainstreamed, on the long term (and not only until 2027, end of the RRP).

Some further details on the different policy areas are provided in the table below.

Table 0-5 Action sets details

Action sets	Objective	Timeline	Responsible	Other key stakeholders	Cost
1. Streamline integrated H&C planning process	Increase planning coherence and optimize EE and RES actions	Mainly short-term	MKM	Local authorities, DHC and electriicity grid operators, CA, KEM, MEM	Low
2. Phase the renovation wave and integrate renewable supply	Improve the energy performance of buildings to reduce heat demand and encourage the integration of RES H&C in renovation	Short/medium -term	BA & KredEx	Ministry of Finance, local authorities, construction sector, building owners	Medium/ High
3. Development of the required infrastructure	Ensure that the DHC sector sufficiently invests in the extension and refurbishment of the DHC network	Short-term	MKM	DHC network operators, local authorities, KEM, CA, energy communities	Medium/ High
4. Strengthen local authorities' role in H&C decarbonisation	Engage local authorities to be active in H&C decarbonisation planning	Short to long-term	MKM	Local authorities, CA	Medium
5. Set up level playing field and creating a market	Ensure that RES H&C technologies are competitive with fossil-based H&C	Short to long-term	KredEx & CA	HP sector, RM	Medium/ High
6. Empower all consumers, especially households	Engage consumers to be active in H&C decarbonization	Mainly short/medium -term	MKM	KredEx, KIK, local/regional authorities, BA, industry, building owners	Medium
7. Strengthen professionals' skills and knowledge	Ensure that there is enough labour capacity in H&C sector	Short-term	Ministry of Education	Unemployment insurance fund, KIK, BA, professionals in H&C sector	Medium/ high
8. Mobilise and mainstream financing and funding	Ensure that all financing/funding is effectively mobilised to H&C sector and consumers	Short to long-term	MKM	Financial institutions, building owners	High

MKM = Ministry of Economic Affairs and Communication; RM = Ministry of Finance; CA = Competition Authority; KEM = Ministry of Environment; MEM = Ministry of Rural Affairs; BA = Building Authority; KIK = Environmental Investment Centre
Timeline: short-term = 2023-2024; medium-term = 2025-2030; long-term = 2030+
Costs: low = admin. costs only; medium = admin costs but long-term; high = admin. costs + investment costs required

PART A - Action plan introduction

1 Introduction

This report presents the results of deliverable 7 of the project Transitioning to a carbon-neutral heating and cooling in Estonia by 2050. This deliverable brings together the results of the previous deliverables of the project to suggest a number of actions that would allow Estonia to reach a carbon-neutral H&C system along the pathways defined by the energy system modelling.

In Section 2, the current state of Estonia's heating and cooling (H&C) system and policy framework is described and related Estonian strategies and targets are detailed. Most of the heating production in Estonia is consumed by residential buildings. The current heating system in Estonia is mainly based on solid bioenergy, though also still greatly dependent (reference to the fossil fuel dependency) on fossil fuels. There are several policies and measures which regulate the H&C sector as well as promote renewables and energy efficiency in buildings and H&C infrastructure. Further, Estonia has several plans which guide future H&C policy, namely the 2017 National Development Plan of the Energy Sector until 2030, the National Energy and Climate Plan (NECP), the Recovery and Resilience Plans (RRP) and the Long-term Renovation Strategy (LTRS). The various plans include high-level targets for the sector as well as investment programmes.

Section 3 summarises the current key problems and barriers for decarbonising heating and cooling in Estonia. The main problems for H&C decarbonisation are: low energy performance of buildings, biomass resource sustainability, low performing district heating and cooling (DHC) and limited alternatives to replace fossil-based and bio-based heating. The barriers underlying these problems are:

- *Policy barriers*: current vision for decarbonising H&C is not sufficiently long-term nor clear enough for concerned actors. Energy efficiency targets are not ambitious enough in the NECPI. Sustainability criteria do not prevent the rising use of biomass for energy purpose. Additionally, building energy performance regulations are constantly evolving, leading to unstable framework. Further, planning for decarbonising H&C tends to occur in silos.
- *Market barriers*: The cost of new renewable based technologies (other than bioenergy) remains high, compared to incumbent technologies. There is a lack of economies of scale for alternative H&C systems, resulting in higher costs. Additionally, the current heat market does not encourage DH companies to invest in more efficient/renewable solutions.
- *Financial barriers*: lack of easy access to financing, particularly in rural areas, is a major barrier for housing renovations and improving existing H&C systems.
- *Capacity barriers*: there is a shortage of skilled labour in Estonia, particularly for maintenance of H&C systems, construction works and preparatory works for renovations. There is a low knowledge level amongst local players, including local authorities. Further, there is not enough research and development and innovation in the H&C sector.
- *Technical barriers*: There is not everywhere enough available grid capacity, particularly in rural areas, to support decarbonising H&C with renewable electricity. Further, the required space for H&C technologies may be a major barrier in urban areas.

- *Social barriers*: owners and end-users are not aware of available energy efficiency and renewable H&C solutions. Public acceptance may be a barrier for the use or deployment of some energy sources.

Section 4 provides a comparison of the results of the business-as-usual (BAU) pathway with the four pathways: All electric, push towards district H&C, push towards local H&C, and technology neutral. The section includes a comparison of the development of the technology mix, main infrastructure developments, GHG emissions, investment needs and socio-economic developments.

Section 5 describes the key policy areas and actions, which are directly linked to the main problems. The actions recommended have been identified by: i) reviewing current strategies and initiatives promoted by government that already align with the deployment objectives of the different pathways; ii) understanding main barriers stakeholders face in deploying the technologies according to the trajectories set in the pathways; and iii) asking stakeholders what actions they would like to see implemented to ensure they can do their part to implement different pathways. Stakeholders were involved via interviews and via a workshop held in February 2022. The key actions are:

- Streamlining integrated H&C planning process;
- Phasing the renovation wave and integrate renewable supply;
- Developing the required infrastructure to deliver energy carriers;
- Setting up a level playing field and creating the market;
- Empowering all consumers, especially households;
- Strengthening professionals' skills and knowledge; and
- Mobilising and mainstreaming financing and funding.

For each policy area, several specific policy actions are recommended.

In Sections 7 to 10, an overview of the pathway and the timeline of action plan is described for each pathway. Section 11 provides an overview of the negative and positive impacts each pathway can have on the environment, society and economy, and related recommendations.

Finally, the report concludes with Section 12, which provides series of overall recommendations, including identifying a number of no-regret actions that should be undertaken independently of the pathways chosen as well as a pathway recommendation.

2 Current situation and policies

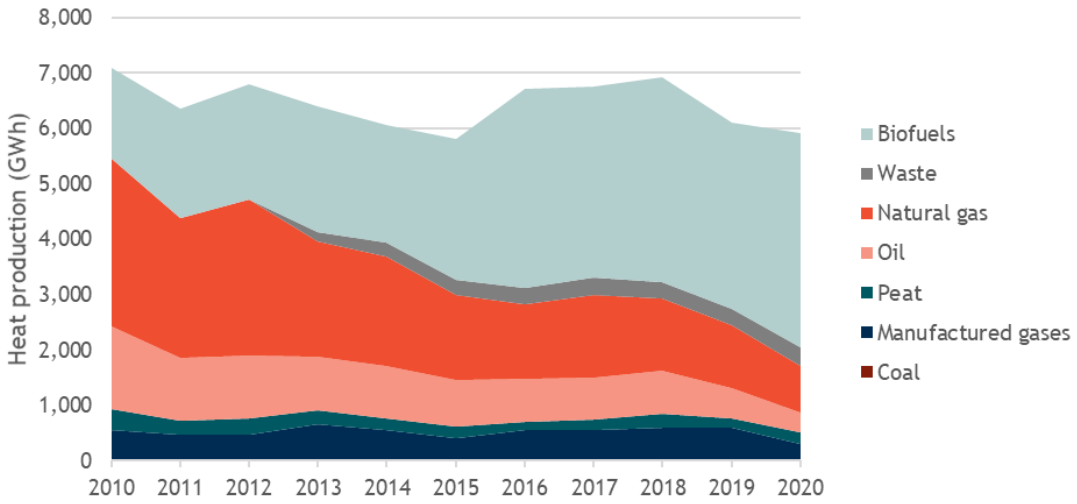
This chapter starts by recalling the current H&C situation, and then presents an overview of ongoing strategies and policies being implemented in Estonia.

2.1 Current situation

2.1.1 Heating and cooling in Estonia

Currently, heating in Estonia is based on biomass (rate in 2020). Figure 2-1 shows the role of different fuels/energy carriers for providing heat in different sectors (industry, residential sector, commercial and public services and other). In the past 10 years the role of biomass in heat provision increased from 23% to 66%, with a major decrease of natural gas (from 43% to 14%) and shale oil (from 21% to 6%). Manufactured gases (e.g. coke oven gas) and peat represent another 9%, which was fairly stable in the past 10 years. Coal plays almost no role in heating in Estonia.

Figure 2-1 Total heat production in Estonia by fuel type (GWh), 2010-2020

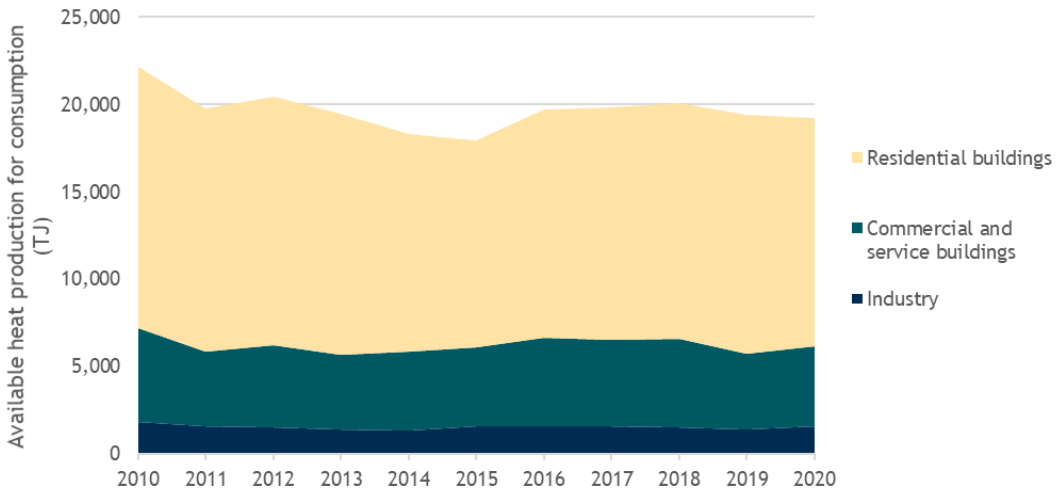


Source: Eurostat (2022). Production of electricity and derived heat by type of fuel

The provision of heat can be divided in three parts: 34% on fossil fuels (shale oil & gas), 37% through heat sales (e.g., through district heating), and 29% direct biomass. The overall shares of these three components have been relatively stable in the past decade. The main change is that heat distribution is changing from largely fossil based, to largely biomass based energy production.

Available heat production for consumption has remained fairly stable in the last decade, with most production available for residential buildings (Figure 2-2). Most of the heat production is supplied to buildings (92%). 68% of heat production is supplied to residential buildings and 24% to non-residential buildings (i.e. commercial and service buildings). About 8% of heat production is supplied to industry.

Figure 2-2 Available heat production for consumption in Estonia by consumer type (TJ), 2010-2020



Source: Eurostat (2022). Supply, transformation and consumption of derived heat.

2.1.2 Bioenergy for H&C

More than half of the Estonian land territory is covered with forest land and the role of forestry and wood industries in the Estonian economy is substantial, representing 11% of GDP. Approximately 36% of wood biomass removals in Estonia are primarily used for energy, mostly originating from low-quality wood and felling residues.

Renewables contributed to 34% of Estonia's *final energy consumption* in 2020, and 55% of the H&C sector[1], of which, more than 90% of renewable energy sources is from biomass.[2] Most of the bioenergy in Estonia comes from solid biomass, which is also exported to other European countries. The main application of bioenergy in Estonia is in renewable heat, both in direct heating (residential, services and industry) and in district heating. Biomass provides 50% of heat/fuel for heating in Estonia. The role of bioelectricity (through CHPs) continues to grow, replacing oil shale electricity.

There is a consistent growth of solid biomass, increasing from 22 PJ in 2006 to 44 PJ in 2019. The main increase is in CHP and heat plants (particularly replacing fossil fuels with wooden resources for district heating). Further, the use of solid biomass in residential applications is quite stable. However, the use in industry dropped in the past years and has a modest role. Further, Estonia also exports wood pellets to other European countries.

In **RED recast** (enforced from 15.05.2022) under Article 29(6), it is mentioned that the biomass shall meet the following criteria to minimize the risk of being unsustainable:

"The country in which forest biomass was harvested has national or sub-national laws applicable in the area of harvest as well as monitoring and enforcement systems in place ensuring: (i) the legality of harvesting operations;

(ii) forest regeneration of harvested areas;

[1] in 2019, bioenergy represented 50.5% of Heat demand, of which 29.1% from direct biomass and 21.4% from biobased heat

[2] IEA (2021). World Energy Balances and Renewable Information.

(iii) that areas designated by international or national law or by the relevant competent authority for nature protection purposes, including in wetlands and peatlands, are protected;
(iv) that harvesting is carried out considering maintenance of soil quality and biodiversity with the aim of minimising negative impacts; and
(v) that harvesting maintains or improves the long-term production capacity of the forest"

Since a detailed classification of the used biomass (wood chips, wood pellets, woody residues) for H&C was not available, all the biomass used for H&C is considered to be sustainable, and complies with the RED recast.

2.1.3 Current policy framework[3]

In Estonia, there are several policies and measures which regulate the heating and cooling sector as well as support the sector to transition to renewable energy and improve/develop heating and cooling infrastructure. Particularly, cooling needs more specific attention.

2.1.3.1 Regulatory framework

The Estonian **Competition Authority** supervises energy markets, i.e. electricity, natural gas and district heating. The competition authority ensures that prices for consumers for heat supply are reasonable in relation to the costs of production and transmission of the energy supply and ensure that suppliers do not abuse their, possibly, monopolistic market position.

District heating is regulated by the **District Heating Act**, which incentivises municipalities which use district heating to prepare a local heating infrastructure plan through investment grants.[4] This plan covers investment needs for energy production and distribution as well as energy efficiency measures for connected buildings. The District Heating Act allows local governments to grant monopoly status to district heating companies, which can be considered unfavourable as it does not encourage DH companies to install more efficient and renewable heating solutions. [5] To combat this issue, the Estonian government is promoting the development of local heating solutions using biomass instead of improving existing DH systems.[6]

In light of the energy performance requirements mandated by the EPBD, new buildings and major renovations are regulated by the **Minimum Energy Performance requirements Act** (adopted in 2013), the **Calculation Methodology for Building Energy Performance Calculations Act** and the **Requirements for Technical Building Systems Act**.[7] These legislative acts mandate the new building and building undergoing major and minor renovations adhere to minimum requirements for energy performance as well as guide the calculation of building energy performance (these levels are not reaching the low-energy and NZEB thresholds). The requirements are different between new buildings and undergoing major renovations. The current energy performance legislation includes the definition of low-energy buildings, NZEB and net zero- energy buildings. According to the final update of the NZEB requirements (2018), after 31 December 2018, all new public buildings should be NZEB, and after 31 December 2020, all new buildings must be NZEB.

[3] RES-Legal (2019). Promotion in Estonia.
[4] IEA (2019). Estonia 2019 Review.
[5] Ibid.
[6] Ibid.
[7] Concerted Action (2016). Implementation of the EPBD in Estonia.

Estonia has not set a separate definition for NZEB for existing buildings. At the moment, there are no national plans for renovating the existing building stock towards NZEB standards. Renovation of residential buildings is mainly guided through renovation grants that require major renovation or achievement of new building energy efficiency levels.

Estonia's **Energy Performance Certificates** are registered by the central public building register (Register of Construction Works), where EPCs are randomly checked by the Estonian Technical Regulatory Authority.[8] EPCs are currently required for all public buildings larger than 250 m^2. Public awareness for energy efficiency and energy certification systems is at a quite good level in the case of renting or buying buildings. People generally ask for the EPC, and the building law states that, in the case where a buyer or tenant enquires about the EPC, the seller has to provide it. Once all public buildings have EPCs, the focus will be to extend also to commercial and service buildings.

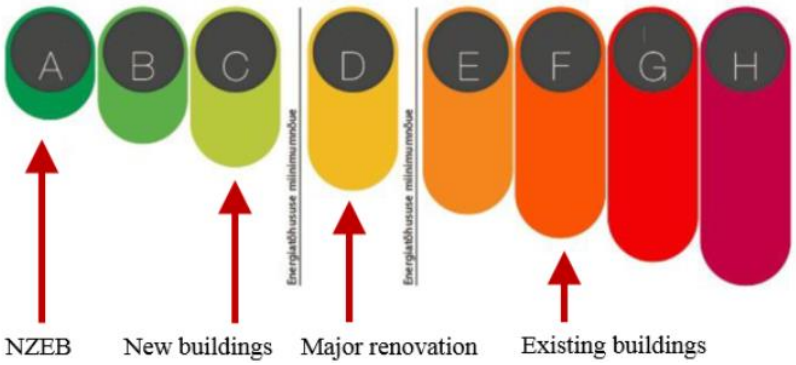
The Estonian government has also developed strategies and targets regarding the H&C sector, which guide the development of policies relating to the heating and cooling sector. These are explained in more detail in Section 2.2.

2.1.3.2 Current and recent support measures related to heating and cooling

There are several types of subsidies for the use, decarbonisation and better management of heating and cooling systems. These subsidies use various instruments, such as grants, tax exemptions and feed-in premiums, to support building renovation, renovation/construction of district and local heating systems and to promote renewable energy.

There are several grant programmes focused on **residential building renovation** that have either recently closed or are still ongoing. Namely, the Apartment Building Renovation Grants, run by the **KredEx**, the **Estonian Business and Innovation Agency set up by the Ministry of Economic Affairs and Communications**, is a grant programme focused on supporting the renovation of apartment buildings to improve energy performance and use of renewable energy from 2015 to 2023.[9] To illustrate the type of grant provided, the existing apartment buildings usually fall into EPC Classes F or G, whereas buildings with major renovations should fall under D and new buildings should fall under C (Figure 2-3). For minor renovation works, leading an EPC class of up to E, a 15% grant is given. For up to EPC Class D, this grant is up to 25%. When EPC Class C is achieved, up to a 40% grant is given.

Figure 2-3 EPC classes for apartment buildings



Source: Concerted Action (2016). Implementation of the EPBD in Estonia.

[8] Ibid.
[9] IEA (2021). Renovation of apartment buildings (Grant scheme 2).

Kredex also provides renovation loans for apartment associations, which receive a negative response from a bank to their request for a renovation loan.[10] Additionally, there are loans and grants for small residences for renovation with the aim to achieve energy efficiency and adopt renewable energy.[11] Further, there is an ongoing programme to support rural areas with establishing an autonomous electricity system.[12] Up until 2015, there was a tax exemption for heating fuels derived from shale or solid fuels used by households.[13] Further, KredEx has also carried out information campaigns, mainly targeting apartment buildings, which has positively impacted energy renovation activity and use of renovation grants.[14]

Estonia also has specific fiscal measures for **district and local heating.** Estonia has several investment subsidies for district heating companies including to support:

- Renovation of district heating boilers and replacement of fuel - the first round was carried out in 2016 and the last in 2020 (a few last decisions were taken in January 2021). All projects have to be completed by the end of August 2023;
- Renovation of amortised and inefficient heating pipes - the first round was carried out in 2016 and the last in 2020 (a few last decisions were taken in January 2021);
- Development plan preparation for heating management - this measure was for local governments 2015-2022; and
- Replacing district heating with local heating solutions - opened 2017-2020.[15]

The Environmental Investment Centre (KIK) is currently preparing 3 district heating measures for the period 2021-2027:

- 'Aid for the modernisation or reconstruction of district heating in the city of Narva', which is related to the decoupling of district heating from oil shale in Ida-Viru County. The aid is planned for a project for setting up a heat production plant based on renewable energy for district heating in the city of Narva. The aid amount is 20 million euros, adn is provided via the Just Transition Fund.
- 'Renovation of district heating boilers and replacement of fuel' and 'Renovation of amortised and inefficient heating pipes'. This is very similar to the previous DH measure in the past period. Boiler renovation technology is free (heat pumps for example), renewable energy must be used. The budget is 22,5 million euros.There is also a small-scale measure to support heat storage investments. The budget is about 6,5 million euros.

There are also tax exemptions for energy use (including H&C) in **energy-intensive industries**. This includes tax exemptions for the production of electricity[16] and gas[17] -intensive products. Notably, these

[10] KredEx (n.d.). Laen, käendus ja toetus.
[11] KredEx (n.d.). Laen, käendus ja toetus.
[12] Riigi Tugiteenuste Keskus (n.d.). Meede: Hajaasustuse programm.
[13] Estonian Goverment (2014). Environmental Charges Act .
[14] Concerted Action (2016). Implementation of the EPBD in Estonia.
[15] LowTemp (2020). Life Cycle Cost Analysis.
[16] EC (2018). SA.51535 (2018/X) Elektri soodusaktsiisimäär elektrointensiivsetele ettevõtetele.
[17] EC (2020). SA.60525 (2020/X) Maagaasi soodusaktsiisimäär intensiivse gaasitarbimisega ettevõtjatele.

tax exemptions do not apply to energy suppliers. The tax exemption for natural gas is to run up until the end of 2023.

Additionally, from 2004 to 2020, there were several **renewable energy production subsidies** (including feed-in premiums), which indirectly reduced the cost of renewably sourced heating and cooling. These subsidies cover biogas, biomass, CHP, wind, hydro and solar. Renewable electricity supports continue as auctions with the aim to have more renewable electricity in the Estonian grid. Most probably such auctions will increase wind and solar production and will have an impact on the renewable electricity production to be used for H&C, impacting mostly "electrified" scenarios.

Estonia also has measures support the **skilled labour** needed for the development of renewable heat infrastructure. The Ministry of Education and Research and the Estonian Qualification Authority have established certification programmes and requirements for RES installers.[18]

In light of rising electricity, gas and district heating costs, grant aid has been provided to reduce the impact of high gas, electricity and district heating prices.[19] The grant is given directly to gas, electricity and district heating companies, which translates to lower customer bills. The support period is March and April 2022.[20]

2.2 Estonian strategies and targets

There are several guiding policy plans which develop strategies and targets for decarbonising Estonia's H&C sector and renovating the existing building stock, particularly:

- 2017 National Development Plan of the Energy Sector until 2030;
- National Energy and Climate Plan;
- Recovery and Resilience Plans; and
- Long-term Renovation Strategy.

2.2.1 2017 National Development Plan of the Energy Sector until 2030 (NDPES 2030)

The NDPES 2030 is the guiding policy document of the Estonian energy sector (MEAC, 2017), integrating six policies among which the following address H&C: energy efficiency, renewable energy, housing and building, and energy technology programme. Its aim is to ensure that comprehensive planning of the energy sector is guided by a single development plan.

2.2.2 National Energy and Climate Action Plan 2030

Under the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, each Member State must have submitted a National Energy and Climate Action Plan 2030 (NECP) by the end of 2019, which provides an overview of the national targets per sector and the action plan to achieve them. The level of ambition of the Action Plans must meet a certain level in order to meet the EU-wide targets. Estonia's NECP has been developed by different national ministries based on existing development documents and various related studies and analyses. Estonia's NECP includes 71 measures to achieve their energy and climate policy targets. The aim of the plan is to provide Estonians,

[18] RES-Legal (2019). Certification Programmes for RES installations.
[19] KIK (n.d.). Rahastatud projektid.
[20] ERR (2022). Government agrees district heating compensation rate.

economic actors and other Member States information on what Estonia intends to achieve in terms of energy and climate policy objectives.

2.2.2.1 *Objectives*

The NECP 2030 sets the following national objectives related to H&C (in non-ETS):

- Renewable energy as a share of total final consumption must be at least 42% by 2030;
- Greenhouse gas emissions must reduce by 13% by 2030 compared to 2005 levels in the sectors covered by the Effort Sharing Regulation (ESR);
- Final energy consumption must continue to be at 32-33 TWh until 2030;
- 14% reduction of primary energy consumption (compared to the peak of recent years);
- Reconstruction of buildings
  - >40% of single houses have an EPC rating of at least category C or D
  - >50% of apartment buildings have an EPC rating of at least category C
  - >20% of non-residential buildings have an EPC rating of at least category C
- Industry
  - Manufacturing companies must have an annual energy savings of 460 GWh
- District heating and cooling
  - Cogeneration facilities must produce at least 25 MW_{el} of electric power in the additional district heating network built over period 2020-2030
  - At least 0.1 TWh reduction in heat loss of district heating by 2030
  - Energy security: cogeneration stations must produce at least 600 MW_{el} of electric power to the district heating network built.

2.2.2.2 *Measures*

The key measures mentioned in the Estonian National Energy and Climate Action Plan were:

- **EN3 Development of heating sector:** This measure covers the transition from fuel oils and natural gas to renewable energy, the reduction of heat losses in district heating networks and the transformation of inefficiently operating district heating networks into communal district heating systems and local heating systems.
- **EN4 Additional development of the heating sector (possible additional measure):** This measure covers additional reconstructions of boiler houses and heating networks and additional support for customers to transition to district and local heating systems

2.2.2.3 *Assessment of the necessity to build new infrastructure for district heating and cooling produced from renewable sources*

The activity 'Preparing the heating development plan' of the measure 'Efficient thermal energy production and transmission' was funded in the implementation of the 'Operational Programme (OP) for Cohesion Policy Funding 2014-2020, and in the course of its implementation local governments received help in analysing the efficiency of district heating systems and future needs. Based on the analysis, it may generally be claimed that it would be more profitable to reconstruct the existing district heating infrastructure than to build a new local heating system in its place. Today new residential areas are mainly connected to district heating regions.

The perspective regions for the district cooling in Estonia are downtown Tallinn and Tartu. There are two district cooling stations operating in Tartu – the downtown 13 MW district cooling station and the Aardla 5.4 MW district cooling station. The total length of the district cooling route is 2.9 km.

In addition, to ensure the security of supply in district heating systems, the District Heating Act provides for additional commitments for the power companies. The power company is the provider of the lifeline services for the district heating systems where more than 50 GWh/year of thermal energy is transmitted to the customer and that are located in the local government unit with a population of at least 10 000 inhabitants.
In very large systems, where the consumption of thermal energy is at least 500 GWh/year, it is compulsory to provide the possibility of using the amount of reserve fuel that would ensure the heat supply over three twenty-four hours periods.

2.2.2.4 *Where applicable, specific measures on the promotion of the use of energy from biomass*

The NECP contains a section describing the availability of biomass resources, including both domestic potential and also imports from third countries. Different biomass uses by other sectors (agriculture and forest-based sectors) as well as measures for the sustainability production and use of biomass are also examined.

The NDPES 2030 document describes different measures for achieving the renewable energy targets described in the development plan. NDPES measure 2.1 'Increasing the use of alternative fuels in transport' contributes most directly to the deployment of new biomass resources. The measures listed in the table of measures in Annex III and IV of the NECP also help to increase the use of biomass:

- EN1 Renewable energy support and support for efficient cogeneration of heat and power
- TR1 Increasing the share of biofuels in the transport sector
- PM8 Investments to enhance the effectiveness of farms
- PM11 Production of bioenergy and increasing the share of bioenergy in agriculture

The generation of energy from biomass takes into account the biomass sustainability criteria, waste hierarchy, and the principles of sustainable forestry management by preserving natural diversity.

2.2.3 *Estonia's Long-term Renovation Strategy*

Estonia's Long-term Renovation Strategy (LTRS) provides a long-term vision for the renovation of the existing building stock and ultimately provides several measures to support the renovation wave in Estonia. These measures include:

- **Adoption of new technological solutions**: to accelerate the rate of renovation, while not exacerbating the problem of labour shortage, adopting new technological solutions, such as *prefabricated building materials* and *(simplified) digital tools*, are suggested.
- **Research and development**: R&D is an important element to improve quality and efficiency of data collection as well as reduce the problem of the labour shortage.
    - *Development of state registries*: as lack of data is a major issue for preparing renovation strategies, the development of state registries improve monitoring of renovation activities
    - *Mapping of decision-making process*: in order to guide renovation processes, it is key to have an understanding of why owners decide to start renovation works.
    - *Development of strategic spatial planning*: general architectural guidance materials for renovating various types of buildings and local government guidance materials for renovating buildings in different regions are needed.
    - *Analysis of the impact of buildings renovation*: an understanding of the economic and environmental impact of renovating the Estonian building stock as well as of the impact of

climate change on potential energy savings is needed to find solutions for decreasing the burdens of and risks from climate changes.

- *Development of technical expertise*: to ensure that renovation of buildings include solutions which are economical and affordable as well as ensure a high indoor environmental quality (IEQ). The following topics need R&D:
  - Development of technical solutions and guidance materials for the renovation of small residential buildings
  - Cost-effective solutions for major renovations of commercial buildings
  - Renovation using prefabricate components
  - Reduction of carbon emissions achieved by LTRS measures

- **Awareness raising**: guidance materials and awareness raising are needed for private houses, particularly apartment buildings, and private sector commercial buildings. This includes cooperation with apartment associations and supporting energy audits for commercial buildings.
- **Demolition of buildings falling out of use:** due to internal migration within Estonia, demolition of underused buildings will need to be planned in such a way to resolve ownership issues and ensure full functionality of urban spaces for displaced residents.
- **Financing measures:** various financial measures are needed for private houses, private sector commercial buildings and public sector buildings.
- **Creating additional services for residential buildings:** suggestion to making residential building investments via KredEx, which involves private partners and minimises burden on state resources.

2.2.4 The Estonian Recovery and Resilience Plan

The Estonian Recovery and Resilience Plan (RRP) is one of the annexes to the newly completed national strategy "Estonia 2035", which focuses on the objectives and reforms and investments funded by the European Union's Recovery and Resilience Facility (RRF). The reforms and investments planned in the RRP are based on the Estonia 2035 Strategy and its accompanying Action Plan, where the Estonian government has agreed on the reforms and changes needed to achieve the strategic objectives and address the EC's country-specific recommendations. The most important investments of the RRP are related to the green and digital transitions, where a total of more than 600 million euros is planned to be directed, of which a large part will go to businesses.[21] Estonia's RRP includes the following relevant investments:

- Development of e-construction (9 MEUR);
- Energy efficiency promotion;
- Support for renovation of apartment buildings (45 MEUR);
- Support for the renovation of small residential buildings (2 MEUR); and
- Pilot energy storage programme (8 MEUR).

2.2.4.1 Development of e-construction (9Meur)

The aim of this investment is to speed up the digital transition of the construction sector, which will increase productivity, reduce environmental impact and improve the quality of buildings.[22] The measure has three parts:

- Developing software interfaces between the national e-construction platform and existing public/private information systems already used in the sector;

[21] Estonian Government (2021). Taaste-ja Vastupidavuskava (EE).
[22] European Commission (2021). Annex to the proposal for a council implementing decision on the approval of the assessment of the recovery and resilience plan for Estonia.

- Supporting the introduction of international standards and best practices for digitalisation in construction and building maintenance (i.e. construction data classification system, database on construction materials/products, building information modelling); and
- Supporting projects related to digital construction tools and private/public services related to the national e-construction platform.

The implementation of the investment is to be completed by end of 2025.

2.2.4.2 *Energy efficiency promotion*

The aim of the energy efficiency promotion reform is to remove administrative barriers for energy renovations via advice to apartment associations, private households and local authorities on technical, financial and legal aspects of renovation. [23] The reform also includes aspects concerning pre-fabricated building material to reduce labour intensity and the environmental impact of renovation. The measures includes the development of a regional advisory network and capacity building for technical consultants. From this measure, a dedicated website and digital tool will be set up to help building owners understand the renovation process, costs and benefits. The implementation of the investment is to be completed by the end of 2024.

2.2.4.3 *Support for the renovation of apartment buildings (45Meur)*

The aim of this measure is to stimulate deep renovations of apartment building to increase energy performance and reduce energy demand as well as improve living conditions. [24] The support will be provided to apartment associations to complete renovations which increase the EPC class of the building at least one class level or at least class C. The investment is to be completed by July 2026.

2.2.4.4 *Support for the renovation of small residential buildings (2Meur)*

The aim of this measure is to stimulate deep renovations of single houses to increase energy performance and reduce energy demand as well as improve living conditions. [25] The support will be provided to private owners to complete renovations which increase the EPC class of the building at least one class level or at least class C. The investment is to be completed by end of 2024.

2.2.4.5 *Pilot Energy Storage Programme (8Meur)*

The Pilot Energy Storage Programme includes an investment support scheme for the installation of heat storage of at least 35,000 m^3 in district heating systems. [26] The overall aim of the measure is to pilot renewable energy storage in Estonia. The implementation of the investment should be completed by end of June 2026.

[23] Ibid.
[24] Ibid.
[25] Ibid.
[26] Ibid.

3 Summary of key barriers and related risks

Overall, Estonia's current policy framework and strategies/targets provide a support system and vision for the decarbonisation of heating and cooling; however, problems and key barriers to fully decarbonising H&C in Estonia still exist. In this section, the main problems, barriers and related risks for fully decarbonising H&C are explained.

3.1 Main problems

We have identified 4 main problems to the full decarbonisation of the H&C in Estonia, and to the uptake of one or more pathways:

- Low energy performance of buildings;
- Biomass resource sustainability;
- Low performing DHC; and
- Limited affordable alternatives to replace fossil-based & bio-based heating and cooling (building & industry).

Overcoming these problems and their underlying barriers will contribute realising the pathways.

3.1.1 Low energy performance of buildings

The majority of Estonia's building stock has a low energy performance, i.e. not energy efficient, with a energy performance rating of D or lower. Based on the Buildings Registry, the percentage of buildings constructure before 2000[27] with an energy performance class of A, B or C ranges between 9-27%, depending on the building type.[28] Namely, apartment buildings are the worst performing, in terms of share of high performance rated buildings. This is followed by municipal buildings (17%) and small residential buildings (22%). Increasing the energy performance of buildings via renovation is an integral component of decarbonising heating and cooling by reducing heat demand, and allowing for a higher penetration of renewable based energy sources.

To ensure an appropriate decarbonisation of H&C supply (by switching to renewable based sources), the performance of the building is crucial, and should be addressed simultaneously or prior to the switch to low-carbon sources. Considering the scarcity of all potential resources to produce appropriate renewable-based H&C, reducing their use as much as possible is a prerequisite to ensure the right resources and carriers is going to the right users. This directly relates to economic savings. For instance, a performant building can afford an efficient heat pump, while a non-performant building would require operating at higher temperature levels leading to significantly decrease the HP efficiency (lowering its Seasonal Performance Factor). Installing or renovating technical systems (e.g. heating system, piping and radiators) should be done on the best performing building in order to ensure an appropriate dimensioning of the system (e.g a well-insulated house could require only a 8kW heating system, while the same house could require a 15kW system if not well insulated). To conclude, worst performing buildings are not yet fit to switch to renewable energy sources, and constitute therefore a barrier to their full decarbonisation.

[27] Buildings built after 2000 generally have a relatively high energy performance rating.
[28] TalTech & Ministry of Economic Affairs and Communication (2020). Long Term Strategy for Building Renovation in Estonia.

Table 3-1 Percentage of registered buildings constructed before 2000 with an energy performance class of A, B or C

Type of building	% of registered buildings constructed before 2000 with an energy performance class of A, B or C
Small residential	22%
Apartment	9%
Non-residential (service/commercial)	27%
Public, Government-owned	25%
Public, Municipal	17%

Source: TalTech & Ministry of Economic Affairs and Communication (2020). Long Term Strategy for Building Renovation in Estonia.

3.1.2 Biomass resource sustainability

One of Estonia's strategies to decarbonise district heating is to replace oil shale with biomass. However, there are concerns that biomass is not a sustainable alternative since increasing biomass use for heating can put pressure on the forest biomass sector,[29] reducing Estonia's carbon sink, as well as harming the environment and increasing conflict of interest with bio-based industry (new material industry using biomass as feedstock). There have been calls at EU level to strengthen the sustainability criteria for biomass used for energy.[30]

3.1.3 Low performing DHC

Even though a lot has been done in the last two decades to improve the energy efficiency of heating production[31], district heating network in Estonia is aging and still requires improvement to increase efficiency,[32] and integrate more renewable energy sources, while decreasing the overall end-use demand (e.g. decreasing temperature needs for buildings). According to a study conducted by the Estonian Development Fund, the average thermal losses in the heating pipelines are about 21% and part of the boilers need either renovation or replacement.[33] As mentioned, Estonia has set up several measures as well as action plans to improve the district heating system in light of this issue.

3.1.4 Limited affordable alternatives to replace fossil-based & bio-based heating and cooling (building & industry).

There are currently limited options for replacing fossil-based and bio-based heating with alternative solutions. Besides, the replacement of oil shale with biomass in district heating, other solutions require significant investment in infrastructure, especially for large heat pump deployment (mainly due to high electricity prices). For instance, because of the current lack of available grid capacity in Estonia, electrification of H&C would require considerable investment in grid infrastructure, particularly in rural areas. Geothermal and solar heat are not yet exploited, and the production of renewable fuel of non-biological origins (RFNBOs, usually renewable hydrogen and its derivatives) is not yet considered in the H&C decarbonisation roadmap.

The revised Renewable Energy Directive (RED II) includes a specific chapter on mainstreaming renewable energy into heating and cooling (H&C)[34] and district heating and cooling (DHC)[35]. It requires

[29] CEE (2022). Assessment of the Estonian operational programme.
[30] CEE (2022). Assessment of the Estonian operational programme.; European Climate Foundation (n.d.). NECP National Scorecard: Estonia.
[31] E. Latosov, S. Umbleja, A. Volkova (2022, Elsevier). CO2 emission intensity of the Estonian DH sector
[32] IEA (2019). Estonia 2019 Review.
[33] IEA (2019). Estonia 2019 Review.
[34] Article 23
[35] Article 24

Member States (MSs) to raise the share of renewable energy in H&C yearly by an average of 1.3 percentage points (ppt) from 2021 to 2030 (or 1.1 ppt with the use waste heat and cold). The same applies to district heating and cooling (DHC), requesting MSs to raise the share of RES and waste heat and cold by at least 1 percentage point yearly (2021-2030). RED II outlines the methodology to calculate RES shares for electricity, transport and heating. As mandated by RED II, the EC adopted on 14 December 2021, a delegated regulation as regards a methodology for calculating the amount or renewable energy used for cooling and district cooling.[36] The main challenge of cooling decarbonization, is to account the renewable share appropriately, which strongly relies on the evolution of the primary energy efficiency of electricity generation, as key input parameter for the calculation of Seasonal Performance Factor (SPF) defined in primary energy terms.

3.2 Main barriers

There are several barriers to decarbonising H&C, which can be broadly categorised as:

- policy barriers,
- market barriers,
- financial barriers,
- capacity barriers and
- technical barriers.

Tackling these barriers are important to ensure that consumers and the H&C sector opt for renewable H&C solutions and invest in energy efficiency improvements.

3.2.1 *Policy barriers*

There is concern that Estonia's **current policy framework and strategies do not sufficiently provide a long-term and adequate vision for decarbonising heating and cooling**, and the energy sector in general. This is crucial to signal to citizens, businesses and municipalities about the national plan for decarbonising heating and cooling so that they can make informed decisions on renovation and decarbonising heating and cooling. An analysis of Estonia's NECP by the European Climate Foundation[37] concluded that their NECP makes a strong link to 2050, provides sufficiently detailed policies, measures and guidelines as well as involve several stakeholders. However, they found that the **energy efficiency targets are too low**, the plan **fails to mention a phase-out plan for fossil fuel subsidies** and there is a **lack of sustainability criteria** for the 94% of renewable energy sourced from biomass. According to an analysis by the BPIE[38] on Estonia's Long-Term Renovation Strategy (LTRS), the strategy's carbon emissions reduction ambitions are in line with EPBD guidelines. However, the **energy efficiency goals are considered not ambitious, nor adequate** (buildings meeting energy label C). Although, as mentioned by Estonia's LTRS, meeting energy label C will be a challenge, given the current market conditions.

[36] European Commission (2022). Commission Delegated Regulation (EU) 2022/759 of 14 December 2021 amending Annex VII to Directive (EU) 2018/2001 of the European Parliament and of the Council as regards a methodology for calculating the amount of renewable energy used for cooling and district cooling.
[37] European Climate Foundation (n.d.). NECP National Scorecard: Estonia.
[38] BPIE (2021). The Road to Climate-Neutrality: are national long-term renovation strategies fir for 55?.

Additionally, non-residential building owners consider the **constant changes to building energy performance regulation** a problem.[39] Performance requirements and calculation methodologies change every five years, which make it difficult for owners to develop a long-term plan.

Further, **planning for decarbonising buildings and H&C systems tends to occur in silos**. Energy efficiency improvements and renewable H&C systems are closely linked. Depending on the available renewable energy supply, improving energy performance of buildings and H&C systems can have a considerable impact by decreasing the overall demand for heating and cooling. However, currently, these issues tend to be tackled separately.

3.2.2 Market barriers

Alternative heating and cooling technologies are currently not competitive with traditional fossil fuel-based systems. This is due to lower costs of fossil-based fuels, lack of economies of scale and perceptions of uncertainty in renewable H&C investment.

There are **incoherent incentives** to decarbonise heating and cooling in Estonia. For instance, there are still **indirect subsidies for fossil fuel use** (to support energy-intensive industries). As mentioned, there is not a clear phase-out plan for fossil fuel subsidies, which does not give a clear signal to the H&C market to decarbonise. Even though the total cost of ownership (TCO) of renewable-based systems may be lower than fossil-based systems, the lack of internalisation of external costs for fossil-based fuels creates a lack of a level playing field. Additionally, the **lack of economies of scale** for alternative H&C systems results in higher costs.

One of the key barriers restricting energy efficiency improvements in Estonia's district heating system is the **current price regulation**, which does not encourage DH companies to invest in more efficient DH systems or renewable solutions.[40] Additionally, in particular regions, district heating companies are also concerned about the **uncertainty of the long-term business model for district heating**, which hinders incentives to invest in improving efficiency.[41] Namely, Estonia's plans to allow local heat production makes the long-term viability of the district heating network uncertain. These uncertainties, coupled with **high upfront costs**, increases perceptions of risk. Additionally, energy companies are generally in favour of using fossil fuel plants until the end-of-life, which delays the switch to renewable technologies.[42]

3.2.3 Financial barriers

Despite the existing financial measures for housing renovation and improving existing H&C systems (e.g. via KredEx), it **not easy to finance** building renovations. This is particularly an issue for low-income households, which tend to live in the worst energy performing buildings. Further, access to finance is particularly an issue in **rural areas, where property values tend to be low**.[43]

Split incentives are a major barrier for energy renovation in the rented sector. Split incentives is the issue where building owners and tenants have conflicting incentives, which prevent energy renovation.

[39] TalTech & Ministry of Economic Affairs and Communication (2020). Long Term Strategy for Building Renovation in Estonia.
[40] IEA (2019). Estonia 2019 Review.
[41] Ibid.
[42] Reda, F. et al (2021). Towards low-carbon district heating: investigating the socio-technical challenges of the urban energy transition.
[43] TalTech & MKM (2020). Long Term Strategy for Building Renovation in Estonia.

Tenants are not in favour of renovation because they fear that it will only benefit the landlord and lead to higher rent prices, whereas the landlord may perceive that the benefits only impact the tenants in terms of lower energy bills. In this way, neither the tenant nor the landlord are willing to invest in energy renovations.

3.2.4 Capacity barriers

Like many sectors in Estonia, there is a **shortage of skilled labour** required for decarbonising heating and cooling.[44] Particularly, current curricula at universities and vocational skills are still based on oil shale energy, which diminishes interest from students to enter the energy field. Additionally, there is a lack of independent regional energy consultants, which can advise citizens, apartment associations and companies on energy savings and renewable energy solutions. There is particularly an issue with having sufficient labour in maintenance of heating and cooling systems. As employees in the oil shale industry already have the necessary technical background, retraining these workers would help reduce the shortage of skilled labour. [45] For renovation, here is not only a **labour shortage for construction works**, but also for **preparatory works for renovation**, such as energy auditors, designers and consultants.[46] Additionally, there is a **low knowledge level of local players**, such as service providers and municipalities.

Additionally, there is **not enough research and development (R&D) and innovation in the H&C sector**, which is needed to develop the necessary technical solutions to accelerate decarbonising H&C and renovating the building stock.[47] Additionally, the **process of environmental impact assessments**, particularly for primary circuits of heat pumps in water bodies, **is slow and inefficient**.

3.2.5 Technical barriers

For the case of decarbonising the H&C sector with renewable electricity, the major technical barrier is ensuring that there is enough **available grid capacity**. Particularly, electricity grids in Estonia are underdeveloped in rural areas. Additionally, in city centres, there are also capacity constraints. As Estonia increases RES electricity capacity, in general, the issue of lack of sufficient grid capacity will increase.

An additional issue is the **required space needed for H&C technologies**, particularly heat pumps and biomass fuel storage. This is particularly an issue in densely populated areas, where it will be a challenge to install heat pumps, solar thermal collectors and biomass fuel storage.

Finally, there is an issue with the available options to supply the industry requiring high temperature levels (e.g. in cement) or which processes cannot turn to electrification.

3.2.6 Social barriers

Additionally, **owners and end-users are not aware of available energy efficiency and renewable H&C solutions** as well as the possible energy savings and additional benefits of renovation.[48] This can be due to limited access to information and lack of trust due to lack of technical expertise. This lack of awareness can be exacerbated amongst the Russian-speaking population in Estonia due to the language

[44] European Climate Foundation (2022). Lack of technical training and expertise in Estonia.
[45] European Climate Foundation (2022). Lack of technical training and expertise in Estonia.
[46] TalTech & MKM (2020). Long Term Strategy for Building Renovation in Estonia.
[47] TalTech & MKM (2020). Long Term Strategy for Building Renovation in Estonia.
[48] MKM (2018). Korterelamute Renoveerimistoetuste Meetme Arendus Lõpparuanne.

barrier.[49] The public acceptance of deploying some technologies (e.g. wind plants or PV farms) may become an obstacle to their large scale uptake. The sustainable use of biomass could also become an issue when public is rejecting its use as fuel.

[49] MKM (2018). Korterelamute Renoveerimistoetuste Meetme Arendus Lõpparuanne.

4 Summary of scenario results

The section reports the results from the four different pathways from 2022 to 2050. The pathways are defined in Table 4-1.

Table 4-1 Climate-neutral scenarios assessed

Pathway	Description
BAU	H&C mix which assumes that there will be limited changes in people's attitudes and priorities. The BAU pathway focuses on technologies that are already commercialized or nearly so and will account for existing climate and energy policies that affect Estonia's heating sector.
All electric	All infrastructure and technologies are based on electric solutions (both district & local). The electricity needs will be covered by renewable electricity and will be added progressively depending on the resource availability, TRL, financial feasibility and access.
Push towards District H&C	All possible H&C requirements will be based on district H&C solutions. Energy sources are based on technologies that are considered sustainable and usable for district heating systems. Local heating solution are as limited as possible (only placed where district solutions are not in line with the balance of the pillars).
Push towards Local H&C	Mainly single house-based solutions and local autonomous systems. The district grid will be phased out while shifting all the possible demand towards local solutions. Industry needs are integrated through industrial clusters, which allows local solutions to be integrated with industry.
Technology Neutral	No preference towards any type of infrastructure (local and district) with the flexibility of using any kind of renewable technology, in accordance with the sustainability pillars.

Table 4-2 provides a summary of the results for each pathway. The results are described in depth in the reports of Deliverables 3 and 4.

Table 4-2 Summary comparison of the pathway results

	BAU	All electric	DHC	LHC	Tech. neutral
Heating and cooling Consumption					
Non-industrial Heating consumption by 2050 (TWh)	8.536	8.536	8.536	8.536	8.536
Industrial Heat consumption by 2050 (TWh)	4.394	4.394	4.394	4.394	4.394
Non-industrial cooling consumption by 2050 (TWh)	1.441	1.441	1.441	1.441	1.441
Technology mix development					
New installed capacity (GW) (2022-2050)	1.88	3.87	2.20	2.70	2.25
Heat production in 2050					
% district	*24%*	*24%*	*48%*	*2%*	*24%*
% local	*42%*	*42%*	*18%*	*64%*	*42%*
% industrial	*34%*	*34%*	*34%*	*34%*	*34%*
Cooling production in 2050					
% district	*6%*	*6%*	*46%*	*6%*	*6%*
% local	*94%*	*94%*	*54%*	*94%*	*94%*
Fuel consumption in 2050 (TWh)	1.51	7.55	14.17	10.75	12.85
Electricity (TWh)	*1.2*	*6.6*	*1.9*	*2.8*	*2.3*
Biomass (TWh)	*12.99*	*0*	*11.37*	*7.93*	*9.99*
GHG emissions[50]					
CO2 emissions in 2050 ($ktCO_2$)	11.8	0	0	0	0
Main infrastructure development					
Expansion of DH network (km)	0	0	764	0	0
Expansion of DC network (km)	33	33	315	33	33
Increase in heat storage (MW)	1311	1311	2610	114	1311
Investment needs					
Total (2022-2050)	**€17,670M**	**€19,066M**	**€18,789M**	**€18,027M**	**€17,837M**
*H&C technologies**	*€878M*	*€2,274M*	*€1,038M*	*€1,236M*	*€1,045M*
DHC infrastructure	*€53M*	*€53M*	*€1,012M*	*€52M*	*€53M*
Building renovation	*€16,739M*	*€16,739M*	*€16,739M*	*€16,739M*	*€16,739M*
Socioeconomic impacts					

[50] CO2 emissions for electricity-based H&C are based on the emissions factors calculated from the climate neutral electricity scenarios. Biomass use for heating may not be climate-neutral when taking the life-cycle into account. The risk of deforestation from biomass use for heating could lead to reduction in the carbon sink

Average heating costs for households in 2050[51] (EUR/MWh)	60	97	62	74	68
Average cooling costs for households in 2050[52] (EUR/MWh)	113	112	114	113	110
H&C activities as % of GDP in 2050	3.5%	3.2%	3.8%	3.0%	3.4%
Employment in 2050 due to HC activities (jobs)	16367	15216	18064	14133	16004
Avg. change in disposable income	- €122M	- €389M	- €194M	- €236M	- €162M
Stakeholder preferences					
Perception of risk	-	*Medium*	*Less*	*High*	*Medium/High*

**investment costs for heat pumps are lowered for the All electric and LHC pathways since the mass deployment of heat pumps will lower costs (economies of scale)*

[51] Based on the levelized cost of heating
[52] Based on the levelized cost of cooling

5 Description of key actions

The main objectives are directly linked to the main problems, while specific objectives should tackle the related barriers. The actions or policy measures to take are categorised under the specific objectives. The main objectives are:

- Increase building energy performance;
- Sustainable use of bioenergy;
- Improve DHC efficiency to incorporate RES;
- Secure the potential of alternative energy sources to deploy; and
- Ensure market conditions for alternative fuels to deploy (for industry and buildings).

For each policy action, some elements are provided on a scale of low/medium/high. These scales are defined in the table below.

Table 5-1 Definition of levels for policy elements

	Low	Medium	High
Timeline of implementation	Short-term: 2023-2024	Medium-term: 2025-2030	Long-term: 2030+
Costs	Short-term development and administrative costs only. Staff only needed for deployment	Administrative costs only, but also in the long-term. Staff required for deployment and implementation	Administrative costs and investment costs required (e.g. for grants)
Complexity (reasons can very depending on specific actions)	Builds on existing measures; requires involvement of only a few stakeholders	Requires involvement of several stakeholders; consists of several actions	Requires *significant* involvement of several stakeholders; consist of several actions; specific issue such as conflict with Estonian legal system or public perception

5.1 Policy Area 1 - Streamline integrated H&C planning process, addressing EE & RES

While energy efficiency and renewable H&C systems are closely linked, they tend to be treated separately. To more effectively reach Estonia's national climate targets, energy efficiency and renewable integration should be tackled simultaneously. To initialise integration of energy efficiency and renewables, an integrated H&C planning process needs to be streamlined.

Also, more energy system integration is required to optimally deploy energy infrastructure and integrate energy markets, such as maximising the interactions between DHC and electricity systems. Given the possible demand for cooling in the future, planning ahead is also an important element to address future demand for cooling. Such planning should consider implementing integrated solutions by decreasing the cooling needs of buildings and deploying the best available and renewable space cooling technologies[53]. The key drivers for the decarbonisation of space cooling are:

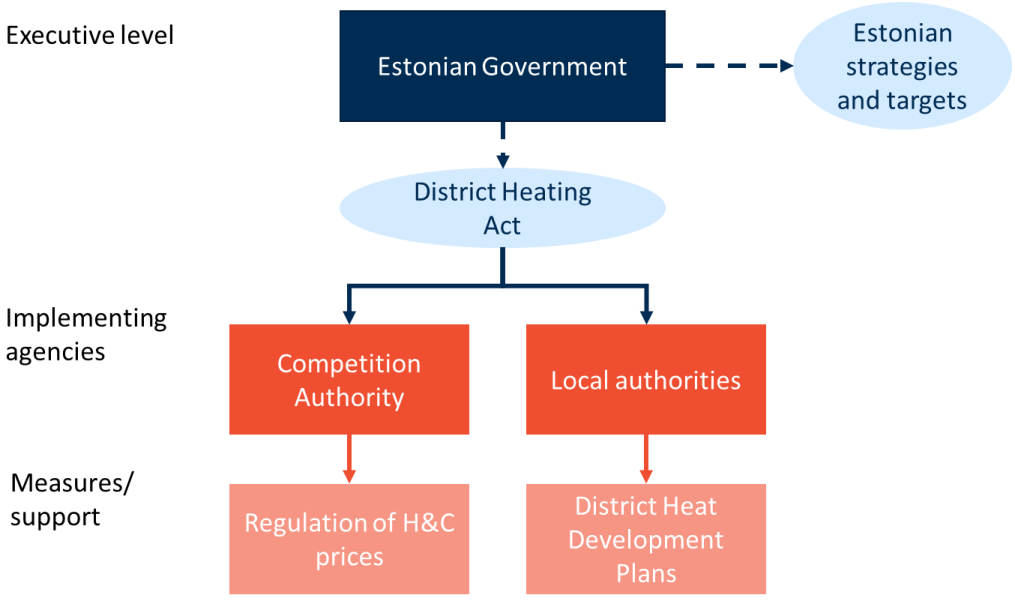
- Reduction of space cooling demand by increasing the thermal performance of buildings (passive cooling)
- Increasing the efficiency of cooling appliances (incl. the use of free cooling)
- Transformation of the electricity sector (increasing the share of renewable)
- Increasing the share of cooling technologies using renewable heat or waste heat, and thermal energy storage

[53] EURAC, ARMINES, TU Wien, VIEGAND MAAGOE, E-THINK (2021). Cooling technologies overview and market shares

5.1.1 Existing policies on H&C planning

As mentioned in Section 2.1.3.1, The District Heating Act regulates the production, distribution and sale of heat from district heating networks as well as the connection to DH networks (Figure 5-1). To support DH, a 2016 amendment to the DH Act allows for local authorities to create *district heating regions* (DHRs) within their administrative region,[54] where all buildings have to connect to DH networks except for buildings not connected to DH prior to the establishment of the DHR. However, the DH act is outdated and needs to be improved, as it does not promote innovation, including integration of renewables, nor performance.

Figure 5-1 Simple diagram of the Estonian institutional framework of district heating and cooling planning



The organisation of heat management in Estonia is the responsibility of local authorities, which establish these DHRs and the procedures for providing service.[55] In this respect, the local authorities are responsible for making an assessment of the area and preparing DH development plans. DH development plans include an analysis of the current situation in terms of consumers, DH network and heat generation units and development scenarios. The plans are completed in cooperation with heat network contractors.[56] However, the scenario modelling methods tend to be unclear and based on the judgments of local authorities and experts.[57]

The development of the bioeconomy in Estonia is the responsibility of the Ministry of Rural Affairs, the Ministry of the Environment and the Ministry of Economic Affairs and Communications. The Ministry of Rural Affairs is currently developing a bioeconomy strategy, to be completed at the end of 2022.

5.1.2 Recommended actions

To streamline an integrated H&C process, the following actions are recommended:

- Action 1.A: Establish integrated infrastructure planning at local level;

[54] Volkova. A. et. al (2020). Planning of district heating regions in Estonia.
[55] Majandus- ja Kommunikatsiooniministeerium (MKM) (2022). Kaugküte.
[56] Energiatalgud (2021). Soojusmajanduse arengukavad Eesti kohalikes omavalitsustes.
[57] Volkova. A. et. al (2020). Planning of district heating regions in Estonia.

- Action 1.B: Promote cooperation between grid operators of electricity and DHC grids (and gas to a certain extent); and
- Action 1.C: Mainstream bioenergy in a complete bioeconomy roadmap/strategy.

5.1.2.1 *Action 1.A - Establish integrated infrastructure planning at local level*

The idea behind this measure is to ensure that any energy infrastructure planning fully integrates the energy efficiency of the consumer or the development of new buildings, capitalise on local renewable resources, and comes as a part of a broader spatial planning at territory level. Ensuring buildings and local heating and cooling infrastructure are developed hand in hand is the one chance to have the maximum out of the renovation wave both in terms of buildings and energy infrastructure.

Providing a clear vision for the future of the heating and cooling sector is essential to support market development, avoid undesired lock-in effects and ensure a stable policy framework. The long investment cycles and the long periods needed for planning and constructing the infrastructure, equipment and building systems require an equally long-term policy perspective, and sufficient time for market adaptation to new regulations. The Policy support for heating and cooling decarbonization roadmap[58] provides some general guidance on building the steps for the long-term H&C planning.
The main principles of H&C planning encompass:

- the development of a vision and the definition of long term targets, objectives and measures;
- the evaluation of the existing progress and gaps regarding H&C decarbonisation;
- the assessment of the potential for renewable production and possible import;
- the development of scenarios based on existing policies and plans; and
- the enabling of municipalities and local authorities to conduct and implement local heat planning.

These elements could also be set in a legal framework, as seen above.

Table 5-2 General overview of Action 1.A: Establish integrated infrastructure planning at local level

1.A - Establish integrated infrastructure planning at local level	
Concrete actions	• **Revise the DH** act to direct local authorities to modernise heat infrastructure development plans to integrate energy efficiency principles and renewable energy integration; • Adapt the spatial planning framework to consider long-term[59] H&C decarbonisation planning in all related programmes/projects/works. Assessing the cooling needs should be part of the planning; • Establish a resettlement plan, identifying areas for new construction and/or deep renovation, to coordinate with the infrastructure planning and globally heating and cold supply, ensuring buildings and local heating and cooling are developed hand in hand.
Stakeholders engaged, with an active role	Ministry of Economic Affairs and Communications (MKM), local authorities, Ministry of Finance (RM) & spatial planning, to establish the appropriate framework for integrated infrastructure planning. MKM and local authorities to develop resettlement plans.
Targeted stakeholders, as beneficiary	Local authorities, district heating operators, DHC users/consumers
Costs	Low • Efforts to prepare the Act's provisions (involving all parties), and to negotiate within the Government • Slight additional workload for parties concerned by implementation (more coordination efforts, and broader scope to encompass)

[58] Trinomics (2022). Policy Support for Heating and Cooling Decarbonisation
[59] TNO & DBDH (2021). Best practices for planning and construction of thermal networks identified in the EU.

1.A - Establish integrated infrastructure planning at local level	
Value added for H&C sector	Higher coherence between spatial planning and climate policy, regarding H&C; Optimisation of efforts towards more energy efficiency and renewable supply
Financed via	National tax revenues (requires more staff)
Relevance	Equally relevant for all pathways. Addresses the following: • Low performing DHC and limited alternative resources to replace fossil-based heating • Lack of incentives for DH networks to become more efficient and integration of renewables. • Incoherent incentives to decarbonise heating
Complexity	Medium – due to the number of stakeholders involved
Timeline	Short-term (2023-2024)
Underlying conditions	Recognition local authorities play an important role in H&C decarbonisation; Existing DHC can be more efficient and supply at low temperature;
Impact on the infrastructure	Improvement of efficiency of DHC systems and integration of renewables; Alignment with other spatial infrastructure
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system, though it would possibly require a new framework; No concerns about public perception.

Best practices in other EU Member States

The Policy support for heating and cooling decarbonization roadmap (section 4.3) provides guidance for the development of energy planning.

In Denmark, a strategic energy plan is a tool for planning and prioritising different development pathways for local energy demand and supply. [60] These plans should ensure that the potential for energy savings and switch to renewable energy are exploited hand in hand. Given the expected role they should play in reaching the decarbonisation goals of the country, municipalities in Denmark have a number of mandatory duties related to heat planning, as they are considered to be in a unique position to facilitate changes, given their capacity as local planning and land-use authority, but also due to the fact they owner supply and transport companies.[61]

As example, in Baden-Wurttemberg, Germany, the *Climate Protection Law: Heat Planning* requires certain municipalities (depending on size) to develop a roadmap for carbon-neutral heat supply by 2050.[62] This roadmap encompasses residential buildings and industry. Local authorities are required to share consumption data to encourage effective energy management and financial support is provided to support the municipal planning process.[63]

Tailored actions for each pathway

For each pathway, there are different specifications needed for integrated planning. The following table describes how the measure comply with the 5 SMART criteria for each pathway.

[60] Danish Energy Agency (2020). Strategic Energy Planning in Denmark at municipal and regional level.
[61] Danish Energy Agency (2020). Strategic Energy Planning in Denmark at municipal and regional level.
[62] DBDH (2021). Large and Growing Markets, 2021. *International Magazine on District Heating and Cooling*.
[63] Lemoine, P. et. al (2021). The road to energy efficiency.

Table 5-3 SMART criteria for each pathway for Action 1.A Establish integrated infrastructure planning at local level

SMART actions	All electric	Push towards DHC	Push towards LHC	Technology neutral
Specific (simple, sensible, significant)	Local authorities have to plan with concerned stakeholders the evolution of the energy infrastructure in their territory, considering a massive deployment of HPs. The planning should focus on the electricity grid, and its ability to address an increasing penetration of large scale and small scale HP. It means both the distribution and transmission levels are concerned. The District Heating Act should ensure the link is made with electricity planning, which should integrate the following aspects: anticipate the HP deployment (large scale and small scale); adapt market design accordingly (e.g. ensure eligibility of flexible assets, …); and synchronise with building renovation programmes	Local authorities have to plan with concerned stakeholders the evolution of the energy infrastructure in their territory, considering the expansion of DHC networks. Planning should focus on the expansion of DHC and the required efficiency and new infrastructure required to extend the current DHC network. The District Heating Act should provide a clear signal to District Heating operators and local authorities that investment in the current DHC networks, expansion of the DHC networks will be needed as well as switch to renewable DHC systems.	Local authorities have to plan with concerned stakeholders the evolution of the energy infrastructure in their territory, considering the massive deployment of LHC systems. Planning should focus on the long-term transition to local H&C and the required phasing out of DHC networks.	Planning should focus on the increased development of local H&C and maintenance and efficiency of the existing DHC networks.
Measurable (meaningful, motivating)	• Prepare the infrastructure (electricity and DHC) for a large deployment of HPs and other electric appliances in the most cost effective way; while avoiding stranded assets and over investments; and creating synergies between energy system components (energy system integration). • Significant co-contribution to install 3.87GW electricity-based H&C systems by 2050 • Cost of electricity distribution system remains *acceptable* • Alternatively, DHC plays an increasing role in providing flexibility services to the electricity system thanks to large HPs and heat storage	• Prepare the infrastructure for greater renewable H&C systems as well as greater demand for DHC due to increase in connections to DHC system, taking into account the need for greater efficiency in DHC systems. • Significant co-contribution to install 2.2GW renewable-based H&C systems by 2050 • Alternatively, DHC plays an increasing role in providing flexibility services to the electricity system thanks to large HPs and heat storage	• Create a clear signal to the H&C sector of the phasing out of DHC and development of LHC. • Significant co-contribution to install 2.7GW renewable-based H&C systems by 2050 • Development of LHC systems and gradual decommissioning of DHC networks.	• Ensure that DHC operators are incentivised to maintain DHC networks and increase efficiency, while also indicating the increased need for LHC. • Significant co-contribution to install 2.25GW renewable-based H&C systems by 2050
Achievable (agreed, attainable)	This is already applied in other countries or regions (e.g. the Netherlands, Baden Wurttemberg (Germany), Flanders, Denmark)			

Relevant (reasonable, realistic and resourced, results-based)	Operate in 3 phases • Carry out demonstrations (one in a middle size city, one in rural municipality) to develop a tailored guidance • Prioritise where the most relevant or urgent (known problems with electricity grid, DHC efficiency, HP deployment) • Deploy across the country
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• launch as soon as possible the demonstration (2023) • develop the guidance, for a large roll out (2024) • Adaptation of spatial planning framework (2024)

5.1.2.2 *Action 1.B - Promote cooperation between grid operators of electricity and DHC grids (and gas to a certain extent)*

Still in the framework of integrated planning, this is a more concrete measure requiring **coordination efforts between DHC and electricity operators**. The final goal is to ensure as much energy system integration as possible, building on each infrastructure characteristics and ultimately leading to more efficient sector coupling between heat and electricity systems.

This should be complementary to the previous integrated planning measure (Action 1.A), to maximise the synergies between the electricity and heating/cooling systems. Hence, planning should not only focus on the electricity grid, but also the role of DHC. It means mainly middle and high voltage are concerned, but should not underestimate the importance of the low voltage. The DH Act should ensure the link is made with electricity planning, which should integrate the following aspects:

- Adapt market design accordingly (e.g. ensure eligibility of flexible assets, …), and analyse all potential from large HPs; and
- Synchronise with DHC refurbishment programmes/works.

The final goal of the measure is to ensure the most appropriate combination of electricity grid deployment/reinforcement by creating synergies between DHC and electricity system, in the most cost-effective way (leverage the flexibility potential), while avoiding stranded assets and over investments

Table 5-4 Overview of Action 1.B: Promote cooperation between grid operators of electricity and DHC grids (and gas to a certain extent)

	1.B - Promote cooperation between grid operators of electricity and DHC grids (and gas to a certain extent)
Policy description	In parallel in the DH act (DH operators planning) and in the frame of the electricity network operators planning, the following actions can be taken: • Revise DH act to include link to electricity planning • Require energy sector development plans at local municipality level, including cooling • Provide distinct support for rural municipalities with energy sector development plans • Annual meetings for information exchange between energy operators and local municipalities • Oblige operators to consult the other concerned operators when planning and when starting investment projects • Ensure the electricity market act does appropriately design grid codes and grid tariffs to promote energy system integration (sector coupling)
Stakeholders engaged, with an active role	MKM, Competition Authority, DH & electricity operators, local authorities
Targeted stakeholders, as beneficiary	DH & electricity operators, local authorities, particularly non-urban communities
Costs	Low/medium, mainly administrative costs • Efforts to prepare the new regulation or guideline (with all concerned parties) • Slight additional workload for parties concerned by implementation (more coordination efforts, and broader scope to encompass)
Value added for H&C sector	Energy system cost optimisation (through synergies between infrastructure and markets); Cost optimisation to mainstream energy efficiency and renewable supply
Financed via	National tax revenues (it requires more staff)
Complexity	Medium/high – due to the number of stakeholders involved
Timeline	Short/medium-term (2023-2025 for deployment; implementation is medium-term)
Underlying conditions	Recognition that local authorities play an important role in H&C decarbonisation; No conflict of interest between operators; Renewable electricity prices are sufficiently low
Impact on the infrastructure	Synchronised improvement of electricity and DHC grids
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system as it would mainly pertain to the regulator (or competition authority); No concerns about public perception

Best practices in other EU Member States

Denmark is a good example of well-functioning sector coupling between heat and electricity, [64] given the large district heating network and high integration of renewables in the electricity system (wind).[65] In Denmark, in partnership with the Danish Energy Agency, the majority of the municipalities have set up strategic energy planning.[66] The plans included a mapping of energy efficiency and renewable energy resources, analysis of energy futures, setting up targets and action plans as well as presenting green solutions. It is noted that successful sector coupling depends on low renewable electricity prices.

Tailored actions for each pathway

For each pathway, there are different specifications needed for cooperation between DHC and electricity grids. The following table describes how the measure comply with the 5 SMART criteria for each pathway, except for the Push towards LHC pathway where this action is not relevant.

[64] Energinet (n.d.). Sector coupling – the key to a climate-neutral future.
[65] Kvarnström (2019). District Heating: heat-as-a-service and sector coupling.
[66] Danish Energy Agency (2020). Strategic Energy Planning in Denmark at Municipal and Regional Level.

Table 5-5 SMART criteria for each pathway for Action 1.B: Promote cooperation between grid operators of electricity and DHC grids (and gas to a certain extent)

SMART actions	All electric	Push towards DHC	Technology neutral
Specific (simple, sensible, significant)	• Require energy sector development plans at local municipal level, incorporating analysis of potential from large HPs and synchronisation with DHC refurbishment works. • Regulator could strongly recommend or even impose operators to consult each other when developing their plan (network reinforcement, changes in assets, new production or storage, …), considering the replacement of fossil and bioenergy-based H&C systems in DHC by large HPs.	• Require energy sector development plans at local municipal level. • Regulator could strongly recommend operators to consult each other when developing their plan (network reinforcement, changes in assets, new production or storage, …), considering the replacement of fossil H&C systems in DHC by large HPs.	• Require energy sector development plans at local municipal level, incorporating plan for meeting DHC demand with heat pumps • Regulator could strongly recommend operators to consult each other when developing their plan (network reinforcement, changes in assets, new production or storage, …), considering the replacement of fossil H&C systems in DHC by large HPs.
Measurable (meaningful, motivating)	• significant co-contribution to install electricity-based H&C in DHC • positive impact on electricity price fluctuation thanks to the flexibility provided by DHC (HP and storage) to the system		
Achievable (agreed, attainable)	This is already applied in some cases, and should just become systematic		
Relevant (reasonable, realistic and resourced, results-based)	Operate in 2 phases • Consult DHC and electricity grid operators (DSO and TSO) to determine the most appropriate set up (possibly develop guidance) • The regulator could ask such coordination in the planning (and its annual revision) or impose it		
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Revise DH act to include link to electricity planning (2023) • Launch as soon as possible the consultation (2023) • Develop the set up or guidance, for a large roll out (2025)		

5.1.2.3 *Action 1.C - Mainstream bioenergy in a complete bioeconomy roadmap/strategy*

Bioenergy appears to be currently the main renewable energy source, while biomass faces issues of sustainability and is considered as an important potential feedstock for an emerging bio-based economy. Therefore, conflict of interest between energy and material use could arise, increasing the pressure on the resource and therefore jeopardising the transition to a low carbon economy while moving to more bio-based economy. This is particularly crucial in Estonia with large biomass potential, and substantial perspectives for export.

It is recommended that **bioenergy is mainstreamed in the current framework of the bioeconomy strategy** currently being developed. In line with the proposal of the revised Renewable Energy Directive (RED)[67] as well as the EU Bioeconomy Strategy[68], it is recommended that the Estonian bioenergy strategy adopts the **cascading principle**, where biomass use is prioritised based on the highest added value and the use for energy generation is only used when no other use is possible, and is used locally as much as possible. In this context, the strategy should envision support schemes to incentivise cascading use of woody biomass. This includes R&D support for wood recovery/recycling, CCU/S (to compensate emissions) and awareness raising amongst the bioeconomy sector.[69] Additionally, a **preference for local use** should be clear, where local resources should be preferably used by local facilities.

Additionally, depending on the pathway, the bioeconomy strategy should take into account the sustained, or rather phase out of biomass in heating. In either case, the strategy should set the long-term vision for bioenergy to give the H&C sector a signal in order to make informed investment decisions (i.e. invest in bio-based H&C technology or not).

Table 5-6 Overview of Action 1.C: Mainstream bioenergy in a complete bioeconomy roadmap/strategy

	1.C - Mainstream bioenergy in a complete bioeconomy roadmap/strategy
Concrete actions	Develop a bioenergy strategy, which is fully integrated in the bioeconomy policy framework and streamline sustainability. The strategy should guarantee sustainable use of biomass, incentivise the anticipated replacement of inefficient bioenergy H&C systems, clear guidance and support incentives for sustainable sequential cropping, consider all uses of biomass and pragmatic implementation of the hierarchy of use. The cascading principle should be adopted and related support schemes should be envisioned.
Stakeholders engaged, with an active role	MKM, Ministry of Environment (KEM), Ministry of Rural Affairs (MEM)
Targeted stakeholders, as beneficiary	Energy consumers, bio-based industry (paper, mill, panels, chemistry), agriculture, forestry, energy actors/players (utilities, DHC operators, suppliers), local authorities
Costs	Low – administrative costs only; depending on the ambition, as many actors should be involved, it can be a long process
Value added for H&C sector	• Provide a safe framework for both bio-based activities and production/use of bio-based fuels • Provide a signal to the H&C sector of whether to invest in bio-based technologies
Financed via	National tax revenues (requires some dedicated staff)
Complexity	Medium/high, due to the conflict of interest (some high level principles could possibly be easy to handle, but other may lead to sensitive translation into concrete actions)

[67] The revision of RED in 2021 introduced obligations on MSs to develop support schemes relating to the biomass cascading principle.
[68] The EU Bioeconomy strategy highlights the importance of the cascading principle for the use of biomass to minimise environmental impact.
[69] IEEP (n.d.) Barriers to cascading and potential solutions.

	1.C - Mainstream bioenergy in a complete bioeconomy roadmap/strategy
Timeline	Short-term (2023)
Underlying conditions	Recognition that there is need to set some rules for one of the most important economic sectors in Estonia
Impact on the infrastructure	Replacement of inefficient bioenergy H&C, possible long-term reduction of bioenergy H&C if not sustainable
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system (possibly with competition, depending whether the strategy comes with some constraints); Some concerns with public perception in relation to the extent of sustainability criteria and conflict of interest

Tailored actions for each pathway

The table below provides an overview of the tailored actions per pathway using the 5 SMART criteria. The DHC, LHC and Technology neutral pathways all have the same recommended actions/results as they all are highly dependent of biofuel. As the All electric pathway uses no biofuel by 2050, the recommendations for the bioenergy strategy focus on the phase out of bioenergy in H&C.

Table 5-7 SMART criteria for each pathway for Action 1.C: Mainstream bioenergy in a complete bioeconomy roadmap/strategy

SMART actions	All electric	All other pathways
Specific (simple, sensible, significant)	Plan gradual (to 2050) replacement of bioenergy in H&C systems by HP (large scale and small scale) and strengthen sustainability criteria for use of bioenergy	• Based on the deployment of a bio-based economy and on the potential strengthening of sustainability criteria, agree on the place of bioenergy • Require that existing biomass-based H&C systems are sufficiently efficient to reduce biofuel requirements
Measurable (meaningful, motivating)	Significant co-contribution to the complete phasing out of bioenergy in H&C in Estonia by 2050	Significant contribution to increasing sustainable use of bioenergy in H&C and increasing in efficiency of bio-based H&C systems
Achievable (agreed, attainable)	This is already being developed by the Ministry of Rural Affairs, Ministry of Environment and Ministry of Economic Affairs and Communication	
Relevant (reasonable, realistic and resourced, results-based)	Operate in 2 phases: • Consult with relevant stakeholders to create a feasible strategy • Publish strategy and ensure that it provides stakeholders with a clear signal of the plan for the use of bioenergy in H&C	
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	Publication of bioeconomy strategy (2023)	

5.2 Policy Area 2 - Phase the renovation wave and integrate renewable supply

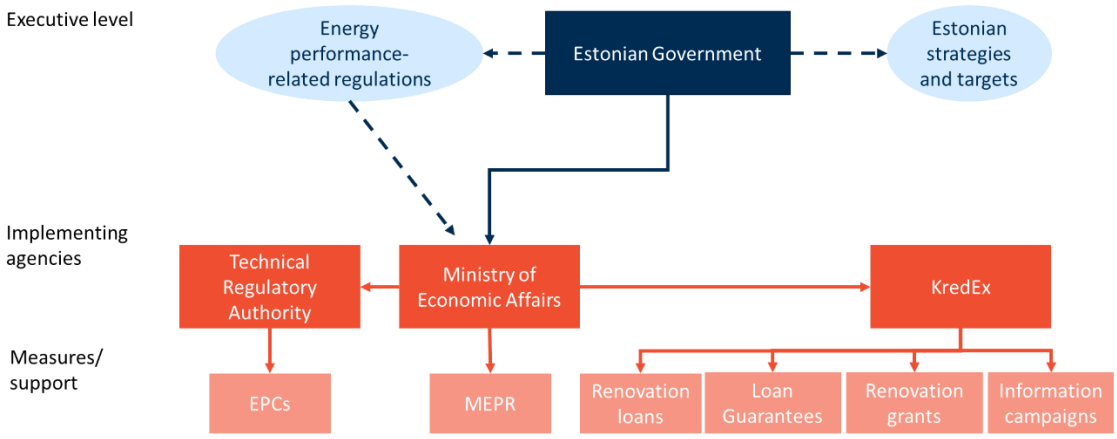
Renovation of the existing building stock in Estonia is a key element of decarbonising H&C, in terms of both making buildings more energy efficient and integration renewable H&C systems in buildings. Despite the ongoing policies to support the Renovation Wave in Estonia, further action is required to incentivise energy renovation activities. Continuous changes of the building energy performance

standards are also an issue, as it does not create a favourable and stable framework for building owners and the construction sector.

5.2.1 Existing policies on renovation and renewable supply integration

Figure 5-2 illustrates how the Estonian government is currently supporting the renovation wave. As mentioned in Section 2.1.3.1, Estonia has several measures to phase the renovation wave. Firstly, legislative acts mandate that all new buildings and deep renovations adhere to **minimum energy performance requirements (MEPR)** based on EPC class. To support these renovations, KredEx, serving as a one-stop-shop, provides financial support coupled with technical assistance. There are several **grant programmes for residential building renovation**, which supports the improvement of energy performance and user of renewable energy in apartment buildings. For these grants, the building has to fulfil an energy performance of Class C. Additionally, KredEx provides **renovation loans** for apartment associations. Similar grants and loans are also available for small residences. Further, KredEx also provides **loan guarantees** to up to 80%. KredEx has also carried out **information campaigns**, mainly to apartment associations, to illustrate the positive impacts of energy renovation activities and the use of renovation grants. Moreover, the **support measures for apartment buildings and small residential buildings from Estonia's NRRP** (47 MEUR in total) will be administered by KredEx.

Figure 5-2 Simple diagram of the institutional framework of support for the renovation wave



However, current trends in renovation activities, under the current policy framework, are not sufficient to completely renovate the existing building stock by 2050, with only central government building renovations meeting renovation targets.[70]

5.2.2 Recommended actions

To phase the Renovation Wave while deploying renewable in the H&C sector, the following policy actions are recommended:

- Action 2.A: Incentivise replacement of heating systems when undergoing deep renovation;
- Action 2.B: Accelerate the renovation of worst-performing buildings; and
- Action 2.C: Energy efficiency/renewable system mortgages and repayment of investments through property taxes.

[70] TalTech & MKM (2020). Long Term Strategy for Building Renovation in Estonia.

5.2.2.1 *Action 2.A - Incentivise replacement of heating systems when undergoing deep renovation*

The guiding principle to determine the deep renovation approach is to reach climate-proof of all buildings and contribute to the delivery of a climate-neutral (net zero energy and carbon) building stock by 2050.[71] Hence, performing deep renovations without integrating replacement of the existing non-renewable/inefficient heating system is a missed opportunity as integrated building renovation is a key way to efficiently meet national energy efficiency and renewable targets as well as more cost-efficient than implementing renewable and efficiency measure separately. However, consumers are not fully aware of the positive impacts of integrated renovation nor of the available technical solutions.

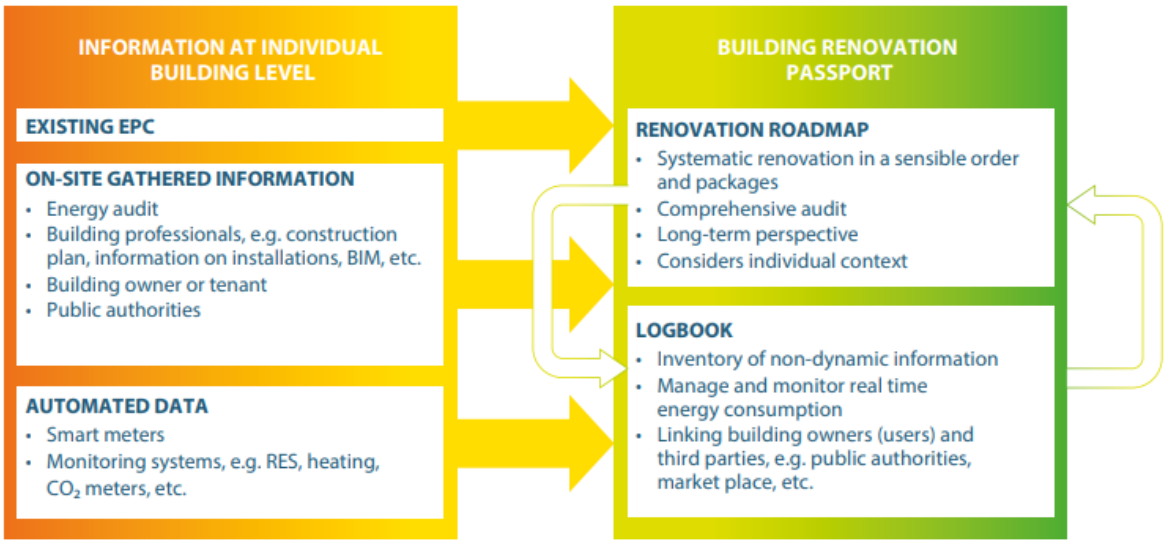
Deep renovation considers key building elements to cover, and when these cannot be addressed in one step, careful renovation steps are required outlining the selection of energy-saving measures and renewable energy installations. One tool which can be used to address the replacement of heating systems while conducting the deep renovation of the envelope is a **Building Renovation Passport** (BRP), which provides a tailor-made long-term, step-by-step plan for renovation of a specific building. Such BRP will also support avoiding lock-in, and can possibly be linked to progressive financial support. Deep renovation should lean towards a minimal carbon footprint for both operational and embodied emissions. The revised EPBD proposal (Art. 10) indicates that MSs will be required by end of 2024 to introduce a renovation passport scheme. For Estonia, it is recommended to develop a (digital) building renovation passport, which includes not only link to EPCs and financial opportunities, but also **include recommendations on replacement of the heating system**. This is crucial to ensure that building owners can effectively prevent urgent replacement of their existing heating system. To comply with the revised EPBD proposal, the BRP scheme should:

- Be issued by a qualified/certified expert, including a follow-up on-site visit;
- Include a renovation roadmap, with step-by-step planning to decarbonise the building by 2050;
- Include the anticipated benefits (i.e. energy savings, cost savings, GHG reduction, health/comfort benefits, ability to adapt to climate change);
- Include information about possible financial/technical support.[72]

The Renovation Roadmap/Passport presents renovation as a home-improvement plan, not just as a technical intervention. It is based on the occupant's needs and specific situations (e.g. age, financial situation, composition of the household, etc.) and outlines each step and links proposed measures. By doing so, owners can fully understand and embrace the project. Figure 5-3 depicts the BRP components, illustrating that many factors should be considered. These BRP are prepared on a case-by-case basis, requiring practical expertise from auditors, and national guidance.

[71] BPIE (2021), Deep Renovation: shifting from exception to standard practice in EU policy
[72] European Commission (2021). Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast).

Figure 5-3 Building Renovation Passport – Overview of its components



Source: BPIE

Given the complexity of building renovation, there is unfortunately not a single solution that fits all, with basic conditions under which a heating system should be changed while conducting renovation works. Building Renovation Passports, even though these are quite recent across Europe, have been demonstrated to be a relevant and efficient approach centred on accompanying the building occupier/owner while capitalising the practical expertise of the auditor.

As example, in France[73], the Energy Efficiency Passport is a web platform offering advice to three groups of users: owners, auditors and renovation professionals. The passport provides a set of solutions (*mesures combinatoires*), combining the best measures to reach low-energy buildings levels, based on specific features like building type, age, climate, etc. P2E, the association leading the initiative, promotes a pragmatic approach, building upon the opportunity to trigger energy renovation every time maintenance work is done in a building. A pilot concluded in June 2017, allowed defining the specifications in collaboration with energy auditors. Experts in building renovation (architects, energy auditors, public energy advisors, building companies) did test the approach in 123 houses throughout France. The final report of the experiment[74] validates the use of polyvalent tools, like BRP, allowing to approach the building as a whole system (holistic vision) to tackle one step or multi-steps renovation to reach high performance levels. We recommend to conduct pilots across the country, such in France, to establish the appropriate framework for BRPs.

Information campaigns are also recommended, to make sure that consumers are well informed about the benefits of timely replacement of heating and cooling systems. If building owners wait until replacement is necessary, it can lead to quick-decision making and ill-informed choices, leading ultimately to less integration of efficient, renewable solutions.

Additionally, providing **financial incentives**, such as grants for replacement of heating systems, is recommended.

[73] Expérience P2E (2021). Expérience P2E.
[74] Expérience P2E (2021). Le passeport efficacité energetique.

Last but not least, improving heating systems' efficiency by replacing some components should also be considered in the frame of light renovations (upgrading substation, balancing heating system, upgrading valves, pumps, thermostats, etc.) and not only when undergoing deep renovation. Often, simple measures can significantly improve the efficiency, and lead to important energy savings (and money savings).

Table 5-8 Overview of Action 2.A: Incentivise replacement of heating systems when undergoing deep renovation

	2.A - Incentivise replacement of heating systems when undergoing deep renovation
Concrete actions	Incentivise anticipated replacement of existing H&C systems with RES systems in time to prevent urgent replacement via: • (Digital) Building Renovation Passports, considering the replacement of the H&C system and linked to the national building register (alias digital passport) • Information campaigns • Additional financial incentives like grants for the replacement of heating systems (>20 years), data-based predictive/prescriptive targeted offers with reasonable finance plans to replace heating systems
Stakeholders engaged, with an active role	MKM, KredEx, building authority, to develop the BRP, conduct information campaigns and set up financial incentives. Local authorities to strengthen local campaigns, to support the design of BRP, and ensure the link with heat and cold supply infrastructure planning. The construction sector (including H&C system installers) to design and experiment BRPs, start developing capacity building programmes (see below).
Targeted stakeholders, as beneficiary	Residential and commercial housing associations, homeowners (urban and non-urban)
Costs	Medium/High • Increases the efforts to ensure coordination, and appropriate guidance (e.g. in which case to install a heat pump) • Lower energy system cost, as it would lead to the most optimal solution • Cost of increasing financial incentives • Administrative costs for the deployment BRPs and information campaigns
Value added for H&C consumers	Avoid missed opportunity to replace H&C system during deep renovation. Reduce overall costs in comparison of separate deep renovation and H&C replacement activities
Financed via	National tax revenues (for the authorities to define the appropriate framework)
Complexity	Medium – consists of several actions, but mostly builds on already existing measures
Timeline	Short/medium-term (short-term deployment; medium-term implementation)
Underlying conditions	• Strong belief that EE & RES should go hand in hand to optimise the decarbonisation of the building stock; • All heat supply options should be available and well known (e.g. is a grid reinforcement foreseen, is a DHC foreseen…?); • Knowledgeable professionals (mainly auditors or other assistance provider) to advise the most appropriate solution, with a deep understanding of heat markets
Impact on the infrastructure	Installation of more efficient/renewable heating systems at building level
Compatibility with Estonian legal system and public perception	• Some conflict foreseen with current Estonian legal system in relation to mandating building renovation passports; • Some concerns about public perception concerning mandating building renovation passports.

Best practices in other EU Member States

Building Renovation Passports: Several EU countries already have BRPs. In Belgium, the BRP (*WoningPas and EPC+*) is linked to EPCs and includes a digital logbook.[75] In Germany, the BRP (*Individueller Sanierungfahrplan*) is focused on staged renovations and the on-site energy audits are subsidised up to 60%.[76] This measure led to 2,300 renovations. The French BRP (*Passeport Efficacité*

[75] Dorizas P.V. et al. (2019). How can Member States implement iBRoad?.
[76] Fabbri M. et al. (2018). The Concept of the Individual Building Renovation Roadmap.

Energétique) is a digital, online platform, which includes also indicators on additional benefits (such as comfort). [77] 68% of the piloted passports led to additional energy savings measures.

Information campaigns: The city council in Tartu, Estonia is considered a best practice for their communication efforts in raising awareness of the benefits of district heating.[78]

Financial incentives: In Ireland, grant aid for heat pumps led to almost 3,000 heat pumps installed (grant was up to €3,500). The grant was based on prerequisites on minimum energy performance.[79]

Tailored actions for each pathway

Each pathway requires incentives for different H&C systems, meaning the incentives for H&C system replacement during deep renovation will need to target different H&C systems. The table below details the tailored actions for Action 2.A using the 5 SMART criteria.

[77] Dorizas P.V. et al. (2019). How can Member States implement iBRoad?.
[78] EBRD (n.d.). District heating and cooling: Tartu, Estonia.
[79] SEAI (2020). Encouraging heat pump installations in Ireland.

Table 5-9 SMART criteria for each pathway for Action 2.A: Incentivise replacement of heating systems when undergoing deep renovation

SMART actions	All electric	Push towards DHC	Push towards LHC	Technology neutral
Specific (simple, sensible, significant)	• Provide more attractive grants for installation of heat pumps (in non-urban areas) and grants for connection to DH (in urban areas) when undergoing deep renovation; or • Conduct information campaigns to raise awareness of the benefits of replacing fossil-based H&C systems with HPs • Develop digital BRPs with recommendations on replacing H&C systems based on the availability of local and district H&C options	• Provide more attractive grants for the replacement of existing heating systems with mainly connection to DH (both urban and non-urban and individual heat pumps (for mainly non-urban, single-houses) • Conduct information campaigns to raise awareness of the benefits of replacing fossil-based H&C systems with HPs and connecting to DH network • Develop digital BRPs with recommendations on replacing H&C systems based on the availability of local and district H&C options	• Provide more attractive grants for the replacement of existing heating systems with individual heat pumps • Conduct information campaigns to raise awareness of the benefits of replacing fossil-based H&C systems with HPs • Develop digital BRPs with recommendations on replacing H&C systems with HPs	• Provide more attractive grants for the replacement of existing heating systems with heat pumps. Incentivise connection to DHC for apartment buildings only. • Conduct information campaigns to raise awareness of the benefits of replacing fossil-based H&C systems with HPs • Develop digital BRPs with recommendations on replacing H&C systems based on the availability of local and district H&C options
Measurable (meaningful, motivating)	• Determine the share of building undergoing renovation to be equipped with HPs/connected to DH, and establish a grant accordingly • Determine number of BRPs administered and the number of deep renovations resulting from BRPs • Positive impact on heating bill for households			
Achievable (agreed, attainable)	This should be mainstreamed in the renovation programmes			
Relevant (reasonable, realistic and resourced, results-based)	Grants: Operate in 2 phases: • develop the rules establishing when a small-scale local HP is the most appropriate H&C system (compared to other RES technologies and DHC • Design the appropriate scheme to incentivise the installation of HP based on the rules (e.g. providing adequate grant, and creating awareness in the frame of the renovation programmes) Launch information campaign directed towards apartment associations and homeowners concerning the benefits of HPs/DHC and the available grants.			

	Develop and launch Building Renovation Passport with the relevant aspects to encourage planned replacement of fossil-based H&C systems, first with a pilot BRP
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Develop the rules for grants as soon as possible (2023) • Design the appropriate scheme based on the rules right after having established the rules (2024) • Launch information campaign on HPs/DHC and available grants (2024) • Launch pilot digital BRPs (2024-2025) • Launch digital BRPs nationwide (2025)

5.2.2.2 *Action 2.B - Accelerate the renovation of worst-performing buildings*

One of the key targets of phasing the renovation wave is addressing the worst-performing buildings, which can have the greatest impact on overall energy performance of the building stock as well as improve energy poverty and improve health comfort. Due to the increase in internal migration in Estonia towards more urban living, some of the worst-performing buildings will be vacated by 2050. With this change in building occupancy, renovation of the worst-performing buildings will have to be optimised to focus on buildings which will remain occupied in the long-term.

Beyond the current minimum energy performance requirements for new buildings in Estonia, **Mandatory Minimum Energy Performance Standards** (MEPS) is an effective solution to progressively tackle the country's worst-performing buildings. As indicated in the 2021 proposal for revision of the EPBD (Art. 5), MSs are required to set up a national MEPS for existing buildings.[80] As indicated in the revised EPBD, the Estonian MEPS should be designed in light of the national roadmap and national targets for the Renovation Wave. Mandatory MEPS would make deep renovation of the worst-performing buildings compulsory. The revision of the EPBD stipulates that all public and non-residential buildings should achieve an EPC class of F by 2027 and for residential buildings by 2030. Public and non-residential buildings should achieve an EPC class of E by 2030 and by 2033 for residential buildings.[81]

As mentioned, internal migration in Estonia implies that MEPS would need to be carefully administered such that renovations are not done on buildings suitable for demolition. This means that **exceptions should be made for buildings which are due to be demolished**. Though, it is important to ensure that this exemption is only afforded to property owners that provide extensive evidence of suitability and intention to demolish. Otherwise, property owners may improperly use the exemption to avoid renovation. This is not considered in the revised EPBD proposal, but highly relevant for Estonia's situation.

While mandatory measures are an important trigger for renovation of the worst-performing buildings, in parallel, financial and technical support is also crucial, as highlighted in the revised EPBD proposal. This can come in the form of **targeted one-stop shops**, which tailor to the needs of worst-performing buildings, **information campaigns, financial measures** or **pilot projects**.

In Estonia, there is already a national EPS, KredEx, which provides financial assistance, combined with technical assistance for renovation. This OSS could be expanded to provide more targeted services for worst-performing buildings or alternatively, OSSs at regional/municipal level can be established where most needed. At national level, to support OSSs, it will be important to ensure: stable energy regulation on houses, stable, long-term financing for fundings of renovation as well as alternatively linking loans to the property instead of the homeowner. These issues are tackled in other recommended actions.

The final goal of the measure is to accelerate the pace of renovation of building stock:

[80] European Commission (2021). Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast).
[81] European Commission (2021). Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast).

- By approaching the building in a holistic way, addressing first the performance of the envelope, to allow the further replacement of the H&C system by a HP, or a connection to a highly performant DHC;
- Allow worse performing buildings occupiers to generate energy savings (usually low income households); and
- Ensure building can operate at optimal conditions.

Table 5-10 Overview of Action 2.B: Accelerate the renovation of worst-performing buildings

2.B - Accelerate the renovation of worst-performing buildings	
Policy description	• Mandatory minimum energy performance standards (MEPS) for worst-performing buildings, triggered by change in tenancy or ownership. Exceptions for buildings which will fall out of use. • Financial and technical targeted support for worst-performing buildings (targeted One-stop shops, pilot projects)
Stakeholders engaged, with an active role	MKM, building authority, building owners and occupiers, and construction sector to develop together the MEPS
Targeted stakeholders, as beneficiary	Building owners, residence of worst-performing buildings
Costs	High • Upfront cost will be higher in a first stage (accelerate deep renovation) But will produce energy savings faster, will consequent benefits
Value added for H&C consumers	Improve significantly the energy performance of buildings and energy savings; improve health and comfort quality for those living in worst-performing buildings
Financed via	National tax revenues, EU Social Climate Fund (for MEPS), carbon pricing revenues
Complexity	Medium/high – because not all worse-performing buildings will still be used in the long-term there needs to have exemptions for buildings which will fall out of use. As a mandatory measure, can become complex when enforcing the regulation.
Timeline	Short-term deployment; Medium-term implementation
Underlying conditions	MEPS concept should be accepted, under certain condition; Strong funding commitment to ensure appropriate accompanying support; Public acceptance should be addressed
Impact on the infrastructure	Decommission of buildings which fall out of use; Deep renovation of worst-performing buildings
Compatibility with Estonian legal system and public perception	• Some conflict foreseen with current Estonian legal system concerning mandatory minimum energy performance standards for existing buildings. • Some concerns about public perception concerning mandating MEPS for existing buildings, particularly in buildings of low-income residents as well as possible protest to demolition plans of buildings.

Best practices in other EU Member States

Minimum Energy Performance Standards: There are several European examples of mandatory minimum performance standards:

- *United Kingdom:* mandatory MEPS for the rental residential building sector, which is triggered by change in tenancy or ownership and buildings must reach at least an EPC class of E;[82]
- *Belgium:* restrictions on renting residential buildings which do not meet minimum insulation and glazing standards, enforced at municipal level and supported by renovation grants and information campaigns;[83]

[82] Sunderland L. & Santini M. (2020). Case Studies: Minimum energy performance standards for European buildings.
[83] Ibid.

- *The Netherlands*: by 2023, all office buildings will be required to be of EPC class C. If not, the building cannot be used as an office. The standards are accompanied with an online tool about technical information for compliance as well as tax incentives to compensate for the cost of renovation.[84]

Although some of these MEPS have not taken full effect, it is already observed that the market has reacted to the signal the measure creates for building owners to renovate.[85]

Targeted one-stop shops: A JRC study provides a detailed overview of the current one-stop shops in the EU. Some relevant examples of assistance tools which focus on vulnerable groups (which are most impacted by worst-performing buildings) are:

- *Opengela (Spain)*: OSS with tailored assistance, particularly for vulnerable households;
- *Tighean Innse Gall (UK)*: local OSS, which assists with information, advice, implementation and financing. The programme has a focus on vulnerable households;
- *Retrofit Works (UK)*: assistance in the renovation process as an mediator between contractors and consumers. Provides assistance through the entire renovation as well as with acquiring grants. There is greater financial assistance for those affected by energy poverty;
- *Center for Sustainability (the Netherlands)*: local OSS, which provides targeted assistance to private residential houses and apartments, with specific attention to mitigating energy poverty.

Tailored actions for each pathway

As the renovation needs are the same for each pathway, there are no tailored actions for addressing the worst-performing buildings. The table below describes the action for all pathways using the 5 SMART criteria.

Table 5-11 SMART criteria for each pathway for Action 2.B: Accelerate the renovation of worst-performing buildings

SMART actions	All pathways
Specific (simple, sensible, significant)	• Under a possible MEPS, target first worst-performing buildings • Provide technical and financial assistance targeted towards occupants of worst-performing buildings (via one-stop shop)
Measurable (meaningful, motivating)	• Renovate all label E and above by 2035 • Positive impact on heating bill for the concerned households • Monitored use of one-stop shop services
Achievable (agreed, attainable)	This should be mainstreamed in the renovation programmes. MEPS and one-stop shops have been introduced in several European countries.
Relevant (reasonable, realistic and resourced, results-based)	Operate in 2 phases • Set up one-stop shop services for occupants of worst-performing buildings and provide grants to accelerate their renovation • from 2035, establish fines for building with a label F or above
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Adapt the grant as soon as possible (2023) • Adapt KredEx to provide tailored services to worst-performing buildings (2023-2024) • start preparing MEPS, on middle term (2025)

[84] Ibid.
[85] Hinge, A. (2020) Minimum Energy Standards for Rented Properties: an international review.

5.2.2.3 *Action 2.C - Energy efficiency/renewable system mortgages and repayment of investments through property taxes*

One of the main barriers for renovation is the lack of available/attractive financing and the very long payback time. As recommended in the revised EPBD proposal, **energy efficiency/renewable system mortgages** are an efficient way to provide available financing for renovation as well as incentivise building owners to improve energy efficiency and install renewable H&C systems, possible on a longer term than with a common loan. Energy efficiency mortgages (EEMs) are loans with a lower interest rate to finance energy efficiency improvements of the building. In the case of renewable system mortgages, the financing is for integrating renewables in the building system.

As the loan is attached to the property and not the owner, repayments are attached to the property as well. This puts less of a burden on the owner, who can still move without problem.

Table 5-12 Overview of Action 2.C: Energy efficiency / renewable system mortgages & repayment of investments through property taxes

	2.C - Energy efficiency / renewable system mortgages & repayment of investments through property taxes
Policy description	• Introduce energy efficiency/renewable system mortgages as another financing scheme provided by KredEx: • Provide favourable mortgage financing conditions or increase loan amount to incentivise building owners to improve the energy efficiency of the building or install renewable H&C systems. • Attach the repayment of investment to the property, not the property owner such that repayments are an addition to the property taxes. • Information campaigns targeted towards building owners to raise awareness of the benefits of energy efficiency/renewable system mortgages • Link mortgage schemes with existing EPCs and proposed Building Renovation Passports (BRPs) • Encourage the use of energy performance guarantees (such as energy performance contracting) with EEMs, but do not mandate
Stakeholders engaged, with an active role	MKM, Building Authority, KredEx, Ministry of Finance
Targeted stakeholders, as beneficiary	Building owners
Costs	Medium/high, • Developing the appropriate scheme may require some efforts, as it would require various stakeholders to agree; • Its implementation would require some adjustments of the property taxation system, to be linked to loan providers
Value added for H&C consumers	Facilitate access to finance, also with a longer pay back period
Financed via	National tax revenues (to set up the scheme), repayment of loan via property taxes
Complexity	Medium (few best practices), depends on property system
Timeline	Short/medium-term (2023-2025)
Underlying conditions	Public acceptance
Impact on the infrastructure	Improvement of energy efficiency and integration of renewables in existing building stock
Compatibility with Estonian legal system and public perception	• Little/no conflict foreseen with current Estonian legal system • No concerns about public perception

Best practices in other EU Member States

In 2017, the Energy Efficient Mortgages Action Plan (EeMAP) was launched,[86] which is an EU funded project that aims to standardise energy efficiency mortgages (EEMs). The pilot project involves thirty-seven banks in thirteen European countries, which is still in development. In this pilot project, the following policies are identified as facilitating EEMs:

- Improving data on energy efficiency in buildings to establish the level of energy performance required to obtain EEMs;
- Link EEMs with building renovation passports to make BRPs more attractive; and
- Energy performance Guarantees (via energy performance contracting) to reduce risks for lenders. [87]

Tailored actions for each pathway

As all pathways require the same amount of investment in renovation, there are not tailored actions per pathway. The table below describes the action for all pathways using the 5 SMART criteria.

Table 5-13 SMART criteria for each pathway for Action 2.C: Energy efficiency / renewable system mortgages & repayment of investments through property taxes

SMART actions	All pathways
Specific (simple, sensible, significant)	• KredEx to introduce energy efficiency/renewable system mortgages as another financing scheme, which provide favourable financing conditions and increased loan amounts. Attach the repayment to the property, not the property owner, such that repayment is an addition to the property taxes. Link the mortgage scheme with existing EPCs and proposed BRPs. • Launch information campaign on the financial benefits of energy efficiency/renewable system mortgages. Encourage the use of energy performance guarantees (e.g. energy performance contracting), but do not mandate. •
Measurable (meaningful, motivating)	• Significant contribution to increasing private investment in (deep) renovation and replacement of fossil-based H&C systems
Achievable (agreed, attainable)	The measure is already been taken up in several European countries
Relevant (reasonable, realistic and resourced, results-based)	• Develop mortgage scheme and eligibility criteria • Launch information campaign to promote mortgage scheme
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Develop mortgage scheme and criteria (2023-2024) • Launch information campaign to promote mortgage scheme (2025)

5.3 Policy Area 3 - Development of the required infrastructure

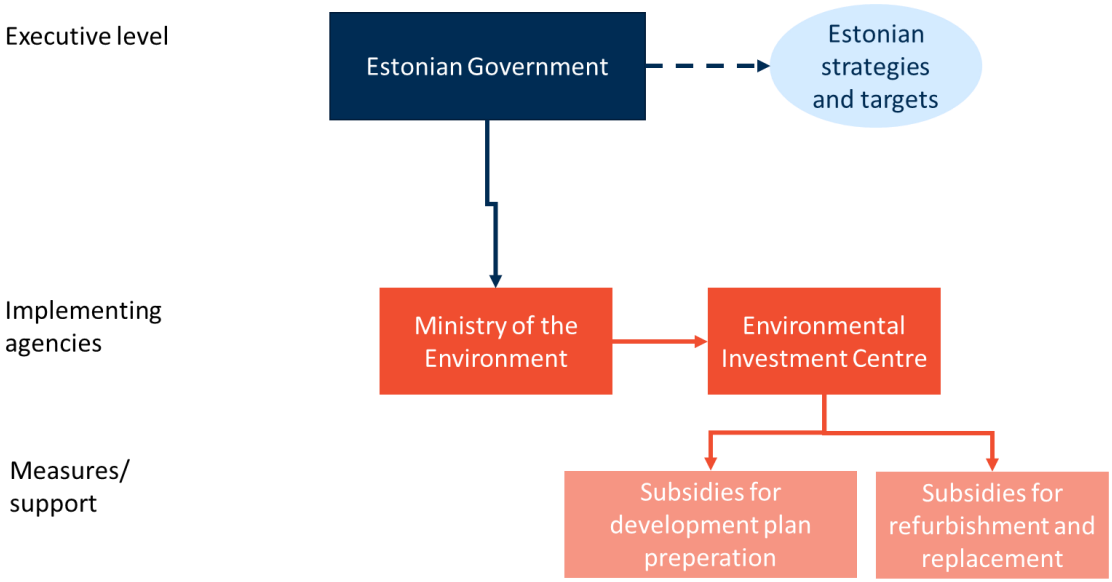
To decarbonise H&C in Estonia, new/refurbished infrastructure is required to both reduce heat/cool demand as well as increase renewable integration. However, particularly in the district heating sector, uncertainty about long-term viability and lack of coherent incentives slow down the construction/refurbishment of H&C infrastructure. Stronger incentives are required to reduce these market barriers and encourage the H&C sector to invest in energy efficient/renewable solutions.

5.3.1 Existing policies on heating infrastructure

[86] World GBC (2018). Creating an energy efficient mortgage for Europe: towards a new market standard.
[87] Ibid.

There is currently no national regulation on the support for renewables in heating, however there is the Environmental Investment Centre (KIK) (under the Ministry of Environment), which provides support for modernise heat economy development plans and renovation of district heating infrastructure (Figure 5-4). As mentioned in Section 2.1.3.1, there are **specific fiscal measures to refurbish the DHC infrastructure**, including subsidies for: renovation of DH boilers and replacement of fuel, renovation of amortised and inefficient heating pipes, development plan preparation for heating management and replacement of DH and LH solutions. The support for preparation of heating development plans includes the analysis of the efficiency of DH systems and the future needs. These measures will end in 2023. Further, NECP 2030 includes a measure for additional reconstruction of boiler houses and heating networks and additional support for customers transitioning to district and local heating systems.

Figure 5-4 Simple diagram of the institutional framework of support for DH infrastructure



However, there still remain barriers to improving the performance of Estonia's DHC systems. DH companies need greater incentives to move faster to refurbish DHC systems and switch to renewable sources.

5.3.2 Recommended actions

For the development of the required H&C infrastructure, the following actions are recommended:

- Action 3.A: Incentivise existing DHC refurbishment & shift to geothermal, solar and HPs; and
- Action 3.B: Combine renovation programmes with DHC refurbishments.

5.3.2.1 Action 3.A - Incentivise existing DHC refurbishment & shift to geothermal, solar and HPs

There are currently insufficient incentives for DHC operators to make the current systems more efficiency/renewable. A major element of incentivising refurbishment is creating more certainty for the long-term viability of DHC networks. In order to reduce the perception of risks for DHC operations, more clarity is needed of whether their investment in DHC refurbishment is economically viable. This should be supplemented with strengthening current subsidies for refurbishing DHC systems and adjusting current price regulation to encourage DH companies to investment more in DHC systems.

As mentioned, the current DH Act allows municipalities to establish district heating regions. To further establish a clear long-term vision, this regulation can be made mandatory, to **require local authorities to define heating supply areas**. This has been found to be successful in Denmark, where *heat zoning* establishes what heat supply is used in specific areas and required connection to DH networks where defined.[88] Enforcing households and any other heating/cooling consumers (buildings and/or light industry) to connect to existing DHC should also be considered, while also ensuring appropriate consumers protection rules (against price increase, guaranteeing qualitative supply, etc.).

There is currently about €34 million of EU funding for Cohesion Fund projects dedicated to the renovation and construction of district heating systems and boilers in Estonia from 2022 to 2027, which covers 50% of the total project costs. An additional €19 million is dedicated to connecting residential buildings to district heating networks. However, particularly for the DHC pathway, **funding will need to be strengthened** (either from EU sources or Estonian government), will be needed in the next few decades to meet the requirements for DHC infrastructure investment.

Integrating large scale Heat Pumps in DHC requires that DHC can also operate at low temperature levels, to maximise the HP efficiency. In order to compete with other heat supplies, incentivising district heating operators to extensively incorporate large-scale heat pumps into existing district heating networks should be considered to support reducing the Levelized Cost Of Heating (LCOH) of large scale HPs, by, e.g.:

- Lowering electricity prices for heat pumps[89]
- Establishing a Guarantee of Origin scheme for large scale H&C systems combined with a quota of renewable share (on H&C suppliers, DHC or consumers)
- Establishing Heat Purchase Agreement (HPA) scheme, for large scale consumers; and/or

Support capital expenditure through investment subsidy.

All HP sources should be considered, with a specific attention to water-to-water HP systems (non-ground, hence river or sea water), given the availability of the water resource in Estonia, and the higher expected efficiency. A water source heat pump uses submerged pipework to absorb energy from water sources such as lakes, sea, ponds, rivers, aquifers and mine water.

Regarding sea water heat exchangers, the experience still remains limited in Estonia, and elsewhere, and would probably need to operate some pilot projects before considering a roll out. In such configuration, a large scale heat pump utilises thermal energy absorbed from sea water at least during the summer, and turn it into district heat. There is possibly a need to combine with other heat sources during the winter season.

The main challenges regarding sea water heat exchangers concern: the physic-chemical environment (salty water inducing corrosion) of the water extractors and its related infrastructure; the transport of water until the heat pump; the release of used water in the marine ecosystem; the environmental impact of the infrastructure on the marine ecosystem. Examples of sea water exchangers projects can

[88] Steinbach et al (2017). Policy recommendations to decarbonise European heating and cooling systems.
[89] Steinbach et al (2017). Policy recommendations to decarbonise European heating and cooling systems.

be found in similar conditions, like in Denmark[90], or Helsinki[91,92]. Except the salt composition of water, these challenges will be the same to extract heat from river water.

Table 5-14 Overview of Action 3.A: Incentivise existing DHC refurbishment (improve efficiency), & shift to geothermal, solar & HPs

	3.A - Incentivise existing DHC refurbishment (improve efficiency), & shift to geothermal, solar & HPs
Policy description	• Revise DH act to ensure that local heating development plans provide a clear long-term vision[93] for DHC, detailing whether DHC plays a key role or not • Strengthen current incentives for refurbishing DHC systems • Adjust current price regulation to encourage DH companies to invest more in efficient DH systems
Stakeholders engaged, with an active role	MKM, Ministry of Environment, Environmental Investment Centre (KIK), Competition Authority, local authorities. DHC operators should be involved in all revisions, to ensure consistency with their difficulties (engage mainly frontrunners).
Targeted stakeholders, as beneficiary	DHC network operators
Costs	Medium – greater role of creating a long-term vision for DHC will reduce the need for public financing.
Value added for H&C sector	Make refurbishment of DHC systems more financially attractive and provide DHC sector more certainty of a long-term vision for the sector.
Financed via	National tax revenues
Complexity	Medium – due to the number of stakeholders involved
Timeline	Short/medium term (2023-2027+)
Underlying conditions	DHC continues to play a major role in the long-term vision of H&C in Estonia
Impact on the infrastructure	Refurbishment of DHC systems to improve efficiency and installation of renewable DHC systems
Compatibility with Estonian legal system and public perception	• Little/no conflict foreseen with current Estonian legal system, suggestions similar to existing measures (except for ESOs due to mandates on DH operators) • No concerns about public perception

A recent Aalborg University report[94] develops a step by step approach towards the **integration of low-temperature renewables in district energy systems**. The general approach comprises the following steps:

- Overview of RES for DHC & key enabling technologies
- Development of strategic heating and cooling plans (mutually reinforcing local and national actions, mainstreaming sustainability as key principle, defining the scope and purpose)
- Engaging stakeholders
- Assessing & mapping heating (&cooling) demand and energy resources
- Integrating low-temperature supply into existing buildings and district heating networks
- Addressing the technical challenges in the exploitation of low-temperature energy sources
- Enabling the regulatory conditions, financing and business models
- In Estonia, district energy supply systems require **price regulation** to protect consumers from the monopoly situation. It is crucial that pricing reflects the service received and a high level of transparency in the pricing structure. Without transparency and reliability of

[90] DBDH (2021). AffaldVarme Aarhus – Testing a new seawater heat pump system that can make district heating for 1000 homes.
[91] Helen (2022). Helen's sea water heat recovery project progresses - project alliance partner sought for the development and implementation phases of Sea Water System in tendering process .
[92] Helen (2019). New, unique heat pump utilising sea water heat to be built in Vuosaari
[93] TNO & DBDH (2021). Best practices for planning and construction of thermal networks identified in the EU.
[94] Aalborg University (2021), integrating low-temperature renewables in district heating, guidelines for policy makers

the pricing, consumers will lose trust in the district energy operators. This could lead to weak operation and potentially enter a negative cycle with disconnections, increasing pricing and lack of satisfaction.

- To facilitate the fuel switch to **geothermal energy**, the laws and regulations governing the licensing of geothermal and water resource extraction play a key role. Given the limited use of geothermal and water resources, there are possibly policy loopholes for their specific utilization for heating and cooling in Estonia. Developing a dedicated and streamlined geothermal and/or water (sea and river) licensing regime could attract more investment and facilitate the development of projects. Key recommendations for a regulatory framework for geothermal DH are propose by the GEODH project.[95]
-

Among the **barriers to invest in DHC systems** including their refurbishment, there is the uncertainty associated with heat demand (of which potential customers or connection rates play a key influencing role) or with the potential and reliability of renewable resources. Given the long timeframe of DHC network investments, long-term stability must be ensured. This can be addressed through concession contracts, zoning and mandatory connections, or connection of public consumers as well as customers with high demand. Managing risks for any investment is key to ensure the lowest expected return (Internal Rate of Return depends on the level of risk). To manage risk in new development projects, including in retrofitting, is to secure high-consumption customers, for higher certainty of the investment. Usually, the upfront capital costs for the construction and refurbishment of a DHC network, as well as of some renewable heat production, are substantial. Although DHC networks should on the long term pay for themselves, it will usually take more than a decade before the initial expense is reimbursed and any profits realised. These projects therefore are good matches for investors seeking a comparatively secure long-term revenue stream, rather than a quick return on their investment.

The development of low-temperature resources such as geothermal can be financially risky, particularly in the inception phase of development when limited information about the potential is available (e.g. subsurface heat). The (geological) risk could be covered by de-risking instruments (like state guarantees, covering e.g. unsuccessful wells due to low or no permeability).

In many MS supporting the deployment of DHC, **traditional financing sources** are supported by grants, concessional loans and other incentives. Grants and concessional loans typically come from international, sub-national or national funds, or from city-level initiatives. Economic and financial instruments may include direct investment like grants or public procurements; fiscal or financial incentives like feed-in tariffs, taxes or taxes exemption; or market-based instruments like green or white certificates, green bonds. In addition, development banks' programmes can contribute to support financing through dedicated programmes (e.g. the Renewable District Energy in the Western Balkans (ReDEWeB) Programme fund from EBRD[96]).

Tailored actions for each pathway

All of the pathways, but the LHC pathway have a similar need for DHC refurbishment, thus the tailored action is the same for the remaining three pathways. As the LHC pathway phases out DHC, investment

[95] GEODH (2014). Regulatory Framework for Geothermal District Heating in Europe.
[96] EBRD (n.d.). Renewable District Energy in the Western Balkans (ReDEWeB) Programme.

in DHC systems is not recommended. The table below describes the measure for the three pathways using the 5 SMART criteria.

Table 5-15 SMART criteria for each pathway for Action 3.A: Incentivise existing DHC refurbishment (improve efficiency), & shift to geothermal, solar & HPs

SMART actions	All electric, DHC and Technology Neutral pathway
Specific (simple, sensible, significant)	• The refurbishment of DHC is already ongoing thanks to the DH Act, but some improvement may be necessary to steer innovation, and allow for the highest level of performance. A revision of the DH Act should ideally address the following: • Stimulate innovation to reach the highest level of performance, assuming the operating conditions of the users (i.e. level of temperature) are adapted • Assess the potential of alternative renewable energy sources (waste heat, solar heat, geothermal) and use large HPs to replace existing fossil fuels (and bio-based fuels for the All electric pathway) • Additionally, funding for DHC system refurbishment should be strengthened and current price regulation should be adjusted to incentivise refurbishment of DH systems (lower electricity prices for HPs in DHC systems).
Measurable (meaningful, motivating)	• More efficient DHC systems • Significantly increase renewable integration in DHC (less bioenergy in the case of All Electric) • DHC emitting less CO2
Achievable (agreed, attainable)	Regulator seems to be demanding party (or at least concluded the DH Act does not integrate innovation)
Relevant (reasonable, realistic and resourced, results-based)	District Heating act already exists (which facilitate)
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Lower electricity prices for heat pumps in DHC (2023) • Consult DHC operators, and possibly renovations actors (construction, architects, and building owners) on the short term (2023) • Adapt the District Heating Act in the short term (2024) • Ensure continuation of funding towards refurbishment of DHC systems (post-2027)

5.3.2.2 Action 3.B - Combine renovation programmes with DHC refurbishment

When possible, it is most efficient to simultaneously address building renovations with the refurbishment of DHC systems. Therefore, coordination of building renovations and DHC refurbishment should be encouraged and supported.

Table 5-16 Overview of Action 3.B: Combine renovation programmes with DHC refurbishment

	3.B - Combine renovation programmes with DHC refurbishment
Policy description	• Include in revision of DH Act local heat development plans to guide on when and how the DHC sector should develop together with renovation programmes (pilots should be conducted, and possibly grants being provided to support operators) • Support cooperation between energy communities and DHC sector to integrate renovation programmes with DHC refurbishment via pilot projects
Stakeholders engaged, with an active role	MKM, DH network operators, local authorities, energy communities
Targeted stakeholders, as beneficiary	DH network operators, energy communities, (urban) buildings
Costs	High, investment into pilot projects
Value added for H&C sector and consumers	Avoid missed opportunity to invest in DHC refurbishment simultaneously with renovation activities and reduce overall costs
Financed via	National tax revenues
Complexity	High – due to the number of stakeholders involved and need for strong cooperation

Timeline	Short/medium term (2023-2026)
Other policy recommendations closely linked	• Establish integrated infrastructure planning at local level • Ensure adequate and integrated financing of all renovation instruments (e.g. MEPS) • Incentivise existing DHC refurbishment (improve efficiency), & shift to geothermal, solar & HPs
Underlying conditions	DHC continues to play a major role in the long-term vision of H&C in Estonia
Impact on the infrastructure	Synchronised improved energy efficiency and integration of renewables of DHC systems and of existing buildings
Compatibility with Estonian legal system and public perception	• Little/no conflict foreseen with current Estonian legal system • No concerns about public perception

Tailored actions for each pathway

No further tailored actions are required for combining renovation programmes with DHC refurbishment, with the exception of the LHC pathway, where this action is not a priority. The following table describes how the measure complies with the 5 SMART criteria.

Table 5-17 SMART criteria for each pathway for Action 3.B: Combine renovation programmes with DHC refurbishment

SMART actions	All electric, DHC and Technology Neutral pathway
Specific (simple, sensible, significant)	• Revise DH Act (and possibly municipal energy act) to require that local heating development plans include guidance for the DHC sector on how and when to combine renovation and DHC refurbishment. • Launch pilot projects to create a best practise example of how to combine renovation and DHC refurbishment
Measurable (meaningful, motivating)	• More efficient DHC systems and more efficient buildings, making the investment more cost-effective • DHC emitting less CO2
Achievable (agreed, attainable)	Regulator seems to be demanding party (or at least concluded the DH Act does not integrate innovation)
Relevant (reasonable, realistic and resourced, results-based)	District Heating act already exists (which facilitate)
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Consult DHC operators, and possibly renovations actors (construction, architects, and building owners) on the short term (2023) • Adapt the District Heating Act in the short term (2024) • Start pilot projects with combined building renovation and DHC refurbishment (2024-2026)

5.4 Policy Area 4 - Strengthen local authorities' role in H&C decarbonisation

In Estonia, local authorities play a crucial role in the planning of H&C systems and therefor are a key player in the decarbonisation of H&C. However, local authorities, particularly in rural regions, have lack of capacity and knowledge to effectively plan H&C decarbonisation. Therefore, local authorities need to be empowered to play an active role.

5.4.1 Existing policies on institutional framework

As mentioned in Section 5.1.1, local authorities play a central role in heating and cooling planning. As mentioned, there are several measures to support local authorities with planning H&C decarbonisation, including the housing development support for local governments to build new/renovate existing buildings (via KredEx) and the support for the preparation of heat economy development plans (via the

Environment Investment Centre). However, local players still tend to have insufficient knowledge to play an effective role in H&C decarbonisation.

5.4.2 Recommended actions

In order to strengthen local authorities' role in H&C decarbonisation, it is recommended to empower local authorities via technical assistance and guidance, possibly increasing their responsibilities, and providing them the needed capacities (e.g. if they lack the required resources, hiring new staff may be needed).

5.4.2.1 Action 4.A - Empower local authorities to play an active role in H&C decarbonisation, oblige them the plan H&C decarbonisation

To facilitate decarbonisation of heating and cooling, local authorities require support in the form of providing high-quality information and technical assistance as well as streamlining planning requirements and assistance with capacity and financing requirements. In line with the REPOWEREU Plan, local authorities need to play a leading role in developing local energy savings (as well as decarbonising) measures. One way to empower local authorities is to **require local H&C decarbonisation planning, supported by financial and technical assistance**.

As there are already many planning requirements at local level, which can be a burden for planners, streamlining and consolidating the different planning requirements is of paramount importance (e.g. with energy efficiency plans, urban planning, etc.). This could be done by **developing guidance** with clear information on planning requirements as well as tools to support the development of local heating plans. Establishing **networks to support the coordination of local decarbonisation plans** would be beneficial in involving different types of stakeholders in the planning process, and increasing the understanding of decision makers. All steps of the decarbonisation process should be clear and easy to understand, possibly via visuals and graphs making the link clear between policy measures and the expected results. Furthermore, building staff competences, is a crucial element to provide capacity at local level for the development of decarbonisation plans. Guidance for local authorities on heat planning is important and should be provided by the national level. **Dedicated financing and human resources for small and medium size local authorities** is of paramount importance (such as through the Just Transition Fund).[97] Finally, rural communities with low population densities would probably require dedicated programmes. This measure is closely link to the integrated planning measure, and should be seen as complementary.

The final goal of the measure is to significantly improve the capacity of local authorities to play their role in the decarbonisation of the building stock:

- To make use of the locally available RES resources;
- To ensure coherent planning, fully adapted to the territory and the local climate policy needs; and
- To engage their citizens and buildings owners/occupiers to renovate and switch to more appropriate H&C technologies (HP in this pathway).

Table 5-18 Overview of Action 4.A: Empower local authorities to play an active role in H&C decarbonisation, oblige them to plan H&C decarbonisation

4.A - Empower local authorities to play an active role in H&C decarbonisation, oblige them to plan H&C decarbonisation

[97] Trinomics (2022), Policy support for heating and cooling decarbonization roadmap

Policy description	• Support local government with provisions of high-quality information on regional renewable energy resources, support local/national policy makers to design and manage EU funding schemes. Set up an expertise centre for decarbonisation of the H&C sector with experts that can be consulted by small municipalities to provide technical assistance. • Streamline and unify different planning requirements (energy efficiency plans, urban planning, heating planning, etc.) to reduce the burden on local authorities • Network coordination for the development of local plans to build up staff competences • Development of a guidance tool describing the steps to develop local heating plans • Dedicated financing and human resources for small/medium-sized local authorities. Dedicated programmes for rural communities with low population densities
Stakeholders engaged, with an active role	Local authorities, MKM, Competition Authority
Targeted stakeholders, as beneficiary	Local authorities, which will thereafter engage all concerned stakeholders (housing, infrastructure operators, …)
Costs	Medium, administrative costs
Value added for H&C sector	In the long-term, establish cohesive planning with local authorities
Financed via	National budget & local budget
Complexity	A step-by-step approach is recommended, to avoid trying to address completely a potentially highly complex set of concrete actions.
Timeline	Short-term, as this would streamline the long term vision into progressive and concrete actions, engaging progressively all stakeholders
Underlying conditions	• Recognition that local authorities play an important role in H&C decarbonisation; • Develop a comprehensive vision at national level, in which local action would fit
Impact on the infrastructure	Indirectly impact all energy infrastructure (plan DHC refurbishment and deployment, electricity grid, gas supply, storage of heat and/or electricity)
Compatibility with Estonian legal system and public perception	• Little/no conflict foreseen with current Estonian legal system • No concerns about public perception

Best practices in other EU Member States

In the Netherlands, municipalities must create a *heat transition vision*, which provides a step-by-step plan for phasing out natural gas in local heating.[98] The central government provides the municipalities with guidelines on how to develop the plans, particularly on how to analyse and use local data for the planning. The development of the planning also involves a coalition of local stakeholders (housing associations, network operators as well as companies and residents), which ensures that implementation can be effective. Municipalities are also supported with a subsidy scheme for external advice as well as a knowledge centre. Such mandatory heat planning also exists in Denmark, in Germany (Baden Wurttemberg) or in Flanders.

Tailored actions for each pathway

All of the pathways require the empowerment of local authorities to play an active role in H&C decarbonisation. The following table describes how the measure comply with the 5 SMART criteria.

Table 5-19 SMART criteria for each pathway for Action 4.A: Empower local authorities to play an active role in H&C decarbonisation, oblige them to plan H&C decarbonisation

SMART actions	All pathways
Specific (simple, sensible, significant)	• Develop clear guidance (from existing best practices) for local authorities (cities and rural) to plan H&C

[98] RVO (2022). Transitievisie Warmte en Wijkuitvoeringsplan.

	decarbonisation by 2050 considering all physical constraints and available resources • Mandate municipalities with more than 10,000 inhabitants to plan H&C decarbonisation • Attach one person at least with the responsibility to develop heating/energy planning, with all concerned stakeholders • Dedicate financing and human resources for small/medium-sized municipalities
Measurable (meaningful, motivating)	A clear planning is the basis to develop a long term vision to reach out full decarbonisation of the H&C, considering the existing infrastructure and their evolution
Achievable (agreed, attainable)	Such practice exists already in many countries/regions, and could provide good lessons (and baseline guidance)
Relevant (reasonable, realistic and resourced, results-based)	• Developing the guidance is a no regret measure, and will support several local authorities • Providing more resources could become appropriate if the capacity is lacking, in a second phase
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Develop the guidance on the short term (2024) • Assess the capacity of local authorities to manage their heating/energy planning according to the guidance, and foresee the increase of capacity (2026) • Impose any local authority to plan (2030)

5.5 Policy Area 5 – Set up a level playing field and creating a market

Alternative H&C technologies need to have a level playing field with traditional fossil-based H&C technologies to be competitive as well as ultimately achieve economies of scale. To do so, several options exist, such as internalising external costs of carbon emissions (hence increasing the cost of fossil-based H&C technologies, reducing their competitiveness), or incentivising low carbon alternative H&C technologies to promote their uptake.

5.5.1 Existing policies on H&C market

Beyond the planning of the heating and cooling development, the pricing in the electricity, natural gas and district heating market is regulated by the Competition Authority (CA). No regulatory framework applies for the other energy sources or carriers, like bioenergy or other renewable based sources (e.g. geothermal, solar). Under the District Heating Act, the (district) heating company must coordinate the heat price sold with the CA.

5.5.2 Recommended actions

To set up a level playing field and create a market for alternative H&C technologies, the following policy actions are recommended:

- Action 5.A: Incentivise/promote individual HP when most appropriate option;
- Action 5.B: Establish a gradual carbon price; and
- Action 5.C: Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC.

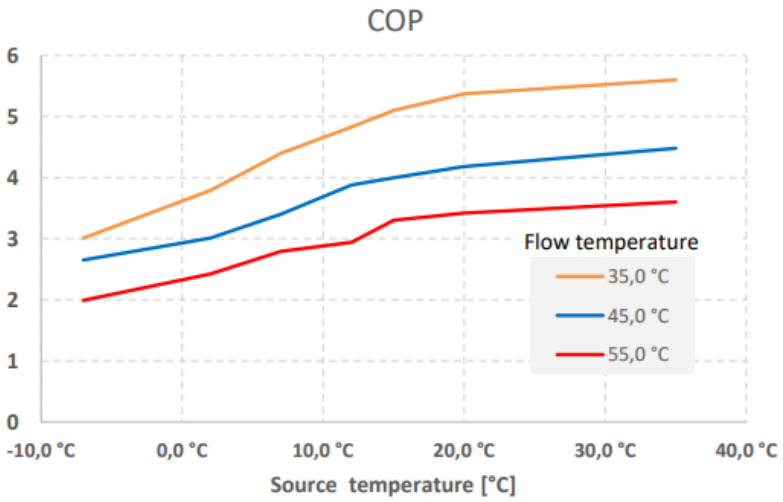
5.5.2.1 Action 5.A - Incentivise/promote individual HP when most appropriate option

As a general rule, where there is no access to district H&C, individual HPs should be promoted/incentivised via grants and/or loan support. This is mainly relevant for rural households and commercial buildings.

A typical heat pump has a Coefficient of Performance (COP) between 2 and 6, within the operating range (in winter season). Such performance is sensitive to operating conditions and other external

factors, and is typically non-linear. Various factors are influencing this performance such as: the source temperature; the expected heat flow temperature; partial load operation; defrosting cycles, when outdoor air is used as a source. Figure 5-5 illustrates the relationship between the source temperature and the COP, Depending on the heat flow temperature.

Figure 5-5 Typical Air-Water Heat Pump COP



The capacity of a heat emitter (usually radiators) depends on the surface of the emitter and the temperature of hot water (flow). This means that a temperature decrease (e.g. from 65C with a boiler to 45C with a HP) may require the refurbishment of the heat emitters to increase their size/surface, in order to maintain the capacity of heat emission. Such refurbishment may not be economically nor technically feasible, jeopardising the installation of a HP.

Additionally, in some areas DHC will be considered more cost-effective and relevant than any local option, including compared to single HPs, while in other areas, DHC will not be deemed relevant. Therefore, determining where HP is the most appropriate option requires to consider various criteria:

- Relevance of DHC, based on heat demand density (and its evolution over time), on the technical feasibility to install or refurbish (e.g. available space in the underground), on the presence of large consumers (that would possibly secure large part of the demand), ;
- Possibility to integrate a HP in a performant building in order to properly dimension the heating system, and maximise its delivery (highest SPF). Given the number of factors influencing the relevance, dimensioning and operation of a single HP, there is no simple set of quantified criteria;
- Capacity of electricity grid to face a massive increase of HPs, at the distribution level. This constraint is also a crucial argument to first decrease the heating needs before installing a heat pump (e.g. an performant single house could operate a 8kW HP with a COP up to 5-6, while the same non-performant house would require a 15kW HP with a COP going down to 3-4). Hence, the capacity of the electricity grid is a crucial factor to consider when deploying HP.

Table 5-20 Overview of Action 5.A: Incentivise/promote individual HP when most appropriate option (e.g. no access to DHC)

	5.A - Incentivise/promote individual HP when most appropriate option (e.g. no access to DHC)
Policy description	• Establish clear rules and conditions under which HP should be promoted, with the baseline being where there is no access to DHC (now and in the future). Of course, these rules will differ from one scenario to another, and the underlying objective. These rules should vary between rural and urban households, for commercial buildings; • Adapt the rules to possible energy building renovation actions • Define and provide financial support specific to the above rules, based on the performance of the HP (and possibly the performance of the building)
Stakeholders engaged, with an 9active role	KredEx; representatives of building owners and occupiers; HP importers, manufacturers and installers (or construction workers); Building energy performance (administration); architects
Targeted stakeholders, as beneficiary	Non-urban households and companies, RES H&C technology sector
Costs	High, depending on the objective (# of HPs and grant amount provided)
Value added for H&C sector	High, as it remains an efficient way to accelerate the deployment of a technology, but it can be really efficient only if other measures are taken at the same time
Financed via	National budget, EU funds
Complexity	Medium, as it would require a good understanding of the local technical constraints, and possibly liaise with the H&C planning (e.g. a good understanding of the electricity grid ability to accept increased HP penetration)
Timeline	Short/medium-term (2023-2024 for deployment)
Underlying conditions	• Individual HPs are still relevant for some residential and/or commercial buildings; • Building energy performance should be high enough to deal with HP installation
Impact on the infrastructure	Installation of HPs in building stock, with possibly reinforced electricity grid
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system No concerns about public perception

Best practices in other EU Member States

Finland is considered a best practise for incentivising heat pumps, with one of the highest levels of heat pump sales in Europe.[99] In Finland, heat pump installation is supported through **tax deductions**, which cover about 60% of the installation costs. In Estonia, this type of financial support could be targeted to certain areas where heat pump installation is most appropriate.

Another form of support could be **grants for installation of heat pumps**, such as in Ireland, where a heat pump grant scheme covers up to €3,500 of heat pump installations.[100] The grant has requirements for minimum energy efficiency. From 2018 to 2020, the scheme has led to almost 3,000 heat pumps installed.[101]

Tailored actions for each pathway

All of the pathways, except for the push towards the DHC pathway will require additional incentives for HP installment. The table below describes the measure per pathway using the 5 SMART criteria.

[99] Kerr N. & Winskel M. (2021). A review of heat decarbonisation policies in Europe.
[100] Kerr, N. & Winskel, M. (2021). A review of heat decarbonisation policies in Europe.
[101] SEAI (2020). Encouraging heat pump installations in Ireland: strategies to maximise heat pump installation and the savings produced.

Table 5-21 SMART criteria for each pathway for Action 5.A: Incentivise/promote individual HP when most appropriate option (e.g. no access to DHC)

SMART actions	All electric	Push towards LHC	Technology neutral
Specific (simple, sensible, significant)	• Develop a guidance establishing where HP are not appropriate (considering HP are the norm), and under which conditions they should be installed (temp, COP, …) • Establish a grant scheme to support HP, particularly in non-urban single houses, as well as non-urban apartments and urban/non-urban service/ commercial buildings.	• Develop a guidance establishing where HP are not appropriate (considering HP are the norm), and under which conditions they should be installed (temp, COP, …) • Establish a grant scheme to support HP installation in all buildings.	• Develop a guidance establishing where HP are not appropriate (considering HP are the norm), and under which conditions they should be installed (temp, COP, …) • Establish a grant scheme to support HP installation particularly in single houses and service/commercial buildings
Measurable (meaningful, motivating)	• Major contribution to install 1.3GW of new individual HPs by 2050 • HP installation are of high quality	• Major contribution to install 1.1GW of new individual HPs by 2050 • HP installation are of high quality	• Major contribution to install 0.6GW of new HP by 2050 • HP installation are of high quality
Achievable (agreed, attainable)	This would require the monitoring of HP installations, to follow up their performance, and verify their installation minimises other impacts (e.g. on electricity grid)		
Relevant (reasonable, realistic and resourced, results-based)	Operate in 2 phases • develop the rules establishing when a small-scale local HP is the most appropriate H&C system (compared to other RES technologies and DHC) • Design the appropriate scheme to incentivise the installation of HP based on the rules (e.g. providing adequate grant, and creating awareness in the frame of the renovation programmes)		
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Develop the rules as soon as possible (2023) • Design the appropriate scheme based on the rules, right after having established the rules (2024)		

5.5.2.2 *Action 5.B -Establish a gradual carbon pricing*

To internalise the external cost of carbon emissions from building heating and cooling systems, a gradual and measured carbon pricing for fuels used in buildings would provide a long-term and stable vision of the transition to alternative H&C technologies. However, this should be addressed globally and not only for the building sector.

A **gradual carbon price** is a very effective way to reduce emissions in the building sector. This recommendation for a gradual carbon pricing only holds if the European Commission does not amend the ETS to include all fuels. In this case, there is no need for the Estonian government to set a national carbon price.

Table 5-22 Overview of Action 5.B: Establish a gradual carbon pricing (if no ETS extension nor ETD)

	5.B - Establish a gradual carbon pricing (if no ETS extension nor ETD)
Policy description	• Introduce a gradual and measured carbon pricing for fuels used in buildings, providing a long-term vision and stability, depending on the expansion of the ETS to the building sector. • The revenue from the carbon pricing can be used to finance renovations (particularly for low-income households).
Stakeholders engaged, with an active role	Ministry of Finance, Environment Agency (Keskkonnaagentuur)
Targeted stakeholders, as beneficiary	Energy consumers
Costs	Low, especially if tied with existing tax system[102]
Value added for H&C sector	Medium/High, creates a level playing field for renewable solutions as fossil-based is more expensive and pushes for adoption of renewable technologies and reduction in heat demand. The benefits depends on how high the carbon price is set.
Financed via	n/a
Complexity	Medium / High – establishing the carbon pricing should be simple, if based on fuel use, but could become complex when considering the additional social policies needed to counteract the risk of energy poverty. Also it would remain complicated (and possibly not relevant) to address the building sector alone.
Timeline	Short/medium-term (2023-2030)
Underlying conditions	• Social policies are in place to ensure that vulnerable households are not negatively impacted by carbon pricing, or that they can manage the renovation of their house properly • Landlords bear some of the cost of carbon pricing to ensure that they are incentivised to renovate
Impact on the infrastructure	No direct impact on infrastructure
Compatibility with Estonian legal system and public perception	• Limited conflict foreseen with current Estonian legal system, as it is similar to the already existing carbon pricing system • Some concerns about public perception, in terms of increasing the relative costs of fuels for heating, in light of already rising fuel prices

Best practices in other EU Member States

Several EU Member States have carbon taxation schemes, which have led to a significant uptake of renewable sources (solar thermal and biomass/waste) in district heating.[103] Table 5-23 provides an overview of the MS carbon tax schemes which cover heating. Estonia does indeed have a carbon tax on

[102] CE Delft (2020). Zero carbon buildings 2050: background report.
[103] Steinbach et al (2017). Policy recommendations to decarbonise European heating and cooling systems.; Kerr, N. & Winskel, M. (2021). A review of heat decarbonisation policies in Europe.

thermal energy except from biofuels, however, it is very low (1.8 EUR/tCO2) and only covers 3% of total GHG emissions.[104]

Table 5-23 EU Member State carbon taxes, covering heating

Country & year established	Explicit carbon tax rate as of 2021 (EUR/tCO2)	% of total GHG emissions covered
Sweden (1991)	108.8	40%
Finland (1990)	62.2	*36%
France (2014)	44.8	35%
Ireland (2010)	25.6	49%
Germany (2021)	25.0	n/a
Denmark (1992)	23.8	40%
Portugal (2015)	23.8	29%
Luxembourg (2021)	20.0	n/a

Source: EC (2022). Energy taxation, carbon pricing and energy subsidies.

Since 2021, Germany has introduced a price on carbon from the transport and building sector via a national emissions trading system (nETS), which runs parallel to the EU-ETS. The German Environment Agency is responsible for running the nETS. The nETS is expected to result in €40 billion in revenues from 2021 to 2024.[105] This revenue will be used to reduce renewable energy costs as well as provide support for consumers (citizens and industry). To support citizens, the German government in parallel has removed the tax on renewable electricity as well as increase support for energy performance improvements and integrating renewables (via (tax) subsidies and improving funding conditions).[106]

It is too early in implementation to observe the impact of the nETS, but some lessons learned from implementation are: (i) need to have a long-term vision for the price to create a signal for investment and innovation, and for the consumer to think about reducing its risks;[107] (ii) preparation for possible legal hurdles; (iii) landlords should bear some of the costs to incentivise renovation; and (iv) *targeted social compensation mechanisms* are needed to safeguard vulnerable households (in the short-term – reduce electricity prices, and in the long term – support renovation).[108]

Tailored actions for each pathway

All of the pathways would have a similar carbon pricing scheme. The following table describes how the measure comply with the 5 SMART criteria.

Table 5-24 SMART criteria for each pathway for Action 5.B: Establish a gradual carbon pricing (if no ETS extension nor ETD)

SMART actions	All pathways	
Specific (simple, sensible, significant)	•	Depending on whether the EU ETS is expanded to cover fuel consumption in buildings, introduce a carbon price to fuels used in buildings, including fossil-based electricity (and biofuels for the All electric pathway). Set explicit carbon tax rate to H&C fuels, starting at around €30-60/tCO2 and increasing to €120/tCO2 by 2030.

[104] European Commission (2022). Energy taxation, carbon pricing and energy subsidies.
[105] German government (2020). Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten Ulla Ihnen, Christian Dürr, Grigorios Aggelidis, weiterer Abgeordneter und der Fraktion der FDP – Drucksache 19/21242 - Absenkung der EEG-Umlage und EU-Beihilferecht.
[106] EEB (2022). Lessons from the German Emissions Trading System for buildings and road transport.
[107] Wettengel, J. (2021). Germany's carbon pricing system for transport and buildings.
[108] EEB (2022). Lessons from the German Emissions Trading System for buildings and road transport.

	• Use the revenues from the carbon pricing to finance renovation/H&C replacement, particularly for low-income households.
Measurable (meaningful, motivating)	Increase the cost of fossil-based heating and cooling, and thus make renewable H&C more competitive.
Achievable (agreed, attainable)	There are several carbon pricing schemes developed in EU countries already.
Relevant (reasonable, realistic and resourced, results-based)	Carbon pricing below €30/tCO2 is historically unable to trigger meaningful abatement and €120/CO2 is needed by 2030 to decarbonise by 2050.[109]
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	Set up carbon pricing scheme, which gradually increases (2023-2030)

5.5.2.3 Action 5.C - Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC

Reforming the fiscal system based on emissions intensity of energy carriers, establishing lower tariffs for electricity sourced from energy efficient equipment and creating stimulating schemes for RES-based gas/liquid are additional options to incentivise the installation of HPs and other RES-based heating appliances or DHC. This should be done in a coordinated way, with possibly an overarching strategy (e.g. it could be a fiscal strategy).

Adjustments of fiscal policy should focus on reducing the cost of renewable heating and cooling systems in order to promote 100% carbon-neutral heating and cooling. This means that fiscal policies need to be tailored to promote the replacement of existing fossil-based technologies specifically. Therefore, Estonia should establish the following fiscal measures:

- Establish **lower electricity tariffs for individual heat pump** use to create an even playing field for heat pumps and fossil-based heating; and
- Consider **subsidies based on avoided carbon emissions** in order to incentivise the use of renewable electricity by H&C providers.

As mentioned in Action 1.B and Action 3.A, sufficiently low electricity price for heat pumps is an important measure for creating a level playing field between heat pumps and fossil-based heating. **Heat pump tariffs** provide a lower tariff for electricity used for heat pumps depending on the time of day. This type of **time-of-use (ToU) tariff** not only incentivises adoption of heat pumps, but also further reduces costs for consumers and creates more demand-side flexibility. A similar tariff scheme could also be adopted for other renewable/energy efficient heating equipment.

The aim of the measure is to ensure that renewable technologies for H&C are as (or more) fiscally attractive than fossil-based H&C technologies for households as well as property owners, industry (via lower electricity tariffs) and for the H&C sector (via emissions-based subsidies). Lowering electricity tariffs for heat pumps effectively makes the investment in heat pumps less risky because it lowers the payback period due to the lower heating costs. The use of emissions-based subsidies is expected to drive the use of renewable alternatives instead of fossil-based H&C (including fossil-based electricity).

Table 5-25 Overview of Action 5.C: Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC

[109] EC (2022). Energy taxation, carbon pricing and energy subsidies.

	5.C - Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC
Policy description	• Reform fiscal systems to ensure the tax levels and levies put on different energy carriers reflect the differences in emissions intensity. • Establish lower and or flexible tariffs for electricity fed into renewable/energy efficient equipment, in line with the Power and Heat Purchase Agreement frameworks. • Implement a coherent set of fiscal measures, in the frame of a complete fiscal strategy.
Stakeholders engaged, with an active role	Competition Authority, Environmental Investment Centre, Ministry of Finance
Targeted stakeholders, as beneficiary	Building occupiers (incl. households), DH operators
Costs	Low/Medium, this is a reform but it could take some time and efforts to develop
Value added for H&C sector	Medium / High, it will depend on the effectiveness. Create a level playing field for renewable H&C systems
Financed via	This could decrease state incomes (lowering the tax level)
Relevance	Addresses the following: • Incoherent incentives to decarbonise H&C • Lack of profitability for alternative H&C systems
Complexity	Low / Medium, as there is need to ensure full coherence with other fiscal or financial measures (the holistic approach is required)
Timeline	Short/medium-term (2023-2026)
Underlying conditions	• Ensure the link with an operational Market Design (promoting demand side management, and flexibility). Such adjustment should only complement, and not replace market operation • Link to building renovation (to increase building performance)
Impact on the infrastructure	Installation of HPs, RES-based heating appliances and DHC for urban and non-urban building stock
Compatibility with Estonian legal system and public perception	• Some conflict foreseen with current Estonian legal system, to the extent that public assistance could distort competition (State Aid rules) • Some concerns about public perception if reforms result in higher energy prices for consumers

Best practices in other EU Member States

Emissions-based subsidies: In the Netherlands, subsidies are provided for sustainable energy production (SDE++), where the amount of subsidy is based on the amount of emissions which would be avoided by the subsidised sustainable solution. This covers both renewable heat, such has geothermal and solar thermal energy, as well as industrial heat, such as electric boilers, use of waste heat and industrial heat pumps.[110]

Heat pump tariffs: heat pump tariffs were recently launched by a UK energy company Good Energy,[111] which provide a lower tariff for electricity used for heat pumps depending on the time of day.

Tailored actions for each pathway

As each pathway has a different development of technologies, each pathway has a different approach for this measure. The following table describes how the measure complies with the 5 SMART criteria for each pathway.

[110] RVO (2022). Stimulation of sustainable energy production and climate transition (SDE++).
[111] Lempriere, M. (2020). What will drive the adoption of heat pumps? Tariffs, consumers and the government.

Table 5-26 SMART criteria for each pathway for Action 5.C: Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC

SMART actions	All electric	Push towards DHC	Push towards LHC	Technology neutral
Specific (simple, sensible, significant)	• The Competition Authority could set lower electricity tariffs for heat pump use (using renewable electricity only). • The Environmental Investment Centre (KIK) can either introduce new subsidies or adjust current subsidies for H&C operators to have the amount of subsidy based on the amount of emissions avoided, ensuring that electricity must be from renewable resources to be considered carbon neutral.	• The Competition Authority could set lower electricity tariffs for heat pump use. • The KIK can either introduce new subsidies or adjust current subsidies for H&C operators to have the amount of subsidy based on the amount of emissions avoided, ensuring that H&C systems must be using renewable resources to be considered carbon neutral.		
Measurable (meaningful, motivating)	• Major contribution to install 1.3GW of new individual HPs by 2050 • Ensure that electricity used for heating is actually renewable • Make heat pumps more affordable for households	• Ensure that electricity used for heating is actually renewable • Make heat pumps more affordable for households	• Major contribution to install 1.1GW of new individual HPs by 2050 • Ensure that electricity used for heating is actually renewable • Make heat pumps more affordable for households	• Major contribution to install 0.6GW of new HP by 2050 • Ensure that electricity used for heating is actually renewable • Make heat pumps more affordable for households
Achievable (agreed, attainable)	The emissions-based subsidies are already applied in the Netherlands and an electricity tariff for heat pumps has been introduced in England.			
Relevant (reasonable, realistic and resourced, results-based)	• Consider the Competition Authority setting up Time-of-Use (ToU) tariffs for heat pumps to not only encourage the use of heat pumps but also increase demand-side flexibility. • Consider developing a tendering system for subsidies, similar to the Dutch SDE++ scheme, where energy producers apply for the subsidy (including feasibility study and necessary permits) and the subsidy is rewarded on a first come, first served basis.			

	Technologies which require the highest subsidy intensity are not considered as they do not lead to a cost-effective energy transition.[112]
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Set up lower electricity tariffs for heat pump use in the short-term (2023-2024), to eventually be phased out as heat pumps become more competitive with fossil-based H&C systems. • Develop/adjust subsidies for H&C operators to be based on emissions to encourage the production/use of renewable technology (renewable electricity only for All Electric) in the short-term (2023-2026).

[112] RVO (2021) Features SDE++.

5.6 Policy Area 6 - Empower all consumers, especially households

Beyond the actions of phasing the Renovation Wave in Estonia, all consumers need to be empowered to take on energy renovation activities such that consumers (households and industry) are well-informed and encouraged. This involves targeted measures for engaging industry and households, with a focus on low-income.[113]

5.6.1 Existing policies on consumer empowerment

As mentioned in 5.2.1, KredEx has several support schemes to incentivise households to renovate via grants, loans and information campaigns. For industry, the Environmental Investment Centre provides support for companies to improve energy efficiency, including for energy audits and investment in energy efficiency technologies.[114] Further, with the use of the EU Innovation Fund, there is also support for the production/use of RES, using low-carbon technologies in energy-intensive industries and energy storage solutions.[115]

However, there are limited incentives for energy communities. Estonia's planning conditions are considered unfavourable for small, participatory projects, as there is no institutional or public involvement in creating energy communities.[116]

Additionally, in partnership with the Estonian government and local government, the Estonian Power Plants and District Heating Association provides advice on energy savings and informing on carbon intensity.

5.6.2 Recommended actions

To empower all consumers, particularly households, the following policy actions are recommended:

- Action 6.A: Engage dialogue with industry to analyse best decarbonisation options (at 2050); and
- Action 6.B: Facilitate the renovation of specific market segments to replace heating systems.

5.6.2.1 Action 6.A - Engage dialogue with industry to analyse best decarbonisation options (at 2050)

To decarbonise industrial H&C processes, industry needs to be encouraged to be involved in developing a long-term vision and possible technical solutions for decarbonising these processes. This involves supporting energy audits in industry, promoting energy management systems, as well as stimulating R&D and industrial symbiosis.

The first step for industry to reduce heat demand is to develop an inventory of energy consumption via energy audits. From this audit, industrial companies are provided recommendations to implement energy saving measures. The Estonian government can support industry in terms of **realising energy audits** with supporting measures as well as raising awareness and simplifying administrative procedures.

Table 5-27 Overview of Action 6.A: Engage dialogue with industry to analyse best decarbonisation options (at 2050)

[113] EPHA (n.d.). Energiatark tutvustab energiatarbimise raportit ja energiasäästu saavutamise võimalusi.
[114] KIK (2022). Energy and resource efficiency undertakings.
[115] KIK (2022). Adoption of new and innovative technologies – European Union Innovation Fund.
[116] Sciullo, A. et al (2022). Exploring institutional and socio-economic settings for the development of energy communities in Europe.

	6.A - Engage dialogue with industry to analyse best decarbonisation options (at 2050)
Policy description	• Support the realization of energy audits in industry to define a binding carbon emission reduction target • Involve local industry (as large energy consumers) in the local planning[117] • Promote energy management systems and energy benchmarks in industry • Stimulate Industrial symbiosis and a circular economy through the effective combination of energy recovery and recycling • Policies combining R&D, industrialization, commercialization support and GHG pricing are needed to ensure a coherent and integrated approach to decarbonize industrial processes • Further develop and support the demonstration of renewable and low-carbon heat processes in industry
Stakeholders engaged, with an active role	Environmental Investment Centre , regional authorities, Industry
Targeted stakeholders, as beneficiary	Industrial consumers
Costs	Medium – This is mainly about imposing to the industry to conduct audits, and invest in the appropriate technologies to reach carbon emissions reduction target. But this may require some incentives to implement. It also depends on whether financed via National revenues or funded via co-financing with private financing. It can take some time to iterate with industry representatives, and agree on the appropriate set up.
Value added for H&C consumers	Medium / High, reduce heat demand (via efficiency) and increase renewable integration in industry
Financed via	National tax revenues, EU Innovation Fund
Complexity	Low/medium
Timeline	Short/medium-term (2023-2029)
Underlying conditions	The required low carbon alternatives should be known and accessible to the industry, including the ad-hoc infrastructure
Impact on the infrastructure	• Long-term improvement of efficiency and integration of renewables in industrial heating processes • Energy infrastructure are concerned to ensure energy supply
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system No concerns about public perception

Best practices in other EU Member States

A best practices study by LEAP4SME (Horizon 2020 project) found that a mix of policy instruments can be effective in engaging and supporting small companies, including:

- **Obligation on energy-intensive industry** to conduct energy audits and to meet certain carbon/energy savings targets. Energy audits could serve as reference to set a binding carbon emission target (at sector level or at company level);
- Support via **external energy consultants** to provide energy audits and advice;
- **Subsidies** for supporting energy efficiency and renewable energy measures (ex. SDE++ (subsidy based on emissions avoided, Netherlands) or for energy audits (ex. Promotion of Energy Audits in SMEs, Malta);
- **Raising awareness** using pre-existing networks of energy advisers (ex. Energy Advising Project, Poland), or *top-down* method (ex. Maltese Awareness Campaign, Malta);
- **Simplifying application processes** and providing support in the application process; and
- Support with **capacity building** (ex. National Center for Research and Development for enterprises, Poland).

The annex of the LEAP4SME report includes several EU examples of these policy instruments.

Tailored actions for each pathway

[117] TNO & DBDH (2021). Best practices for planning and construction of thermal networks identified in the EU.

For each pathway, engaging industry depends on the type of industrial technologies of focus (i.e. electric vs. other renewables). The following table describes how the measure complies with the 5 SMART criteria.

Table 5-28 SMART criteria for each pathway for Action 6.A: Engage dialogue with industry to analyse best decarbonisation options (at 2050)

SMART actions	All Electric	Push towards DHC	Push towards LHC	Technology neutral
Specific (simple, sensible, significant)	• MKM can strengthen regulation on energy audits to include not only large companies, but energy-intensive companies in general to perform regular energy audits • Regional authorities, with the help of the Ministry of Economic Affairs, can set up networks of local energy advisors for local industry to use for energy audits and advice. • The Environmental Investment Centre (KIK) can either introduce new subsidies or adjust current subsidies for industry to have the amount of subsidy based on the amount of emissions avoided, ensuring that electricity must be from renewable resources to be considered carbon neutral.			
Measurable (meaningful, motivating)	• Significant co-contribution to install 580MW of electricity-based industrial heating systems by 2050 • Ensure that industry have a long-term vision for decarbonising industrial heat processes	• Significant co-contribution to install 374MW of renewable industrial heating systems by 2050 • Ensure that industry have a long-term vision for decarbonising industrial heat processes		
Achievable (agreed, attainable)	Similar practices exist already in many countries/regions, and could provide good lessons (and baseline guidance)			
Relevant (reasonable, realistic and resourced, results-based)	Consider developing a tendering system for subsidies, similar to what is described for Action 5.C.			
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Adjust regulation on energy audits to include all energy-intensive companies (based on energy intensity by sub-sector (i.e. NACE code) (2023-2024) • Set up regional networks of energy advisors (2024-2026) • Establish mandatory scheme based on the audit results (2027-2029)			

5.6.2.2 *Action 6.B - Facilitate the renovation of specific market segments to replace heating systems*

To ensure that all consumers are empowered, targeted support schemes are needed. The process of renovating a building, including the preparation (e.g. receiving financial support, designing the renovation, contracting the right professionals) and the implementation) is complex. Therefore, households do not only need financial support, but this financial support needs to be mobilised and households also need technical, economic and legal support throughout the renovation process. First, **targeted information campaigns** are needed to make households well-informed of the benefits of energy performance improvements and renewable H&C systems, particularly the long-term health benefits.[118] Secondly, households need advisory tools, such as **one-stop shops, high-quality EPCs and Building Renovation Passports[119] (Action 2.A)**. Additionally, **energy communities** can play a major role in stimulating the involvement of citizens. Particularly, the Estonian EPC should be improved to meet the requirements envisioned in the revised EPBD proposal (Art. 16) (following the template in Annex V of the EPBD revision).

In Estonia, this information should be provided both in Estonian and Russian to ensure that the language barrier does not hinder the Russian-speaking community to participate. This is particularly an issue in the Ida-Virumaa region, where the renovation rate is significantly low and language barrier is high.[120]

Additional important target groups identified for support are: [121]

- Worst-performing buildings, particularly in urban regions (i.e. not expected to fall out of use);
- Low-income communities (pensioners and low-income families);
- Rural communities; and
- Small apartment buildings, where renovation costs per unit are relatively high.

Table 5-29 Overview of Action 6.B: Facilitate the renovation of specific market segments to replace heating systems

	6.B - Facilitate the renovation of specific market segments to replace heating systems
Policy description	• Targeted information campaigns to improve RES heat awareness and acceptance, information campaigns on the advantages of DHC, where appropriate. • For building renovation, a bilingual digital platform[122] with reliable information about renovations, which provides details on the process of a successful renovation, common misconceptions, best practises and potential obstacles and related solutions. A renovation calculator could also be integrated to estimate the actual cost of the renovation, the energy savings and possible financing solutions. • Improve EPCs and integrate heating system metrics • Strengthen KredEx with quick and easily RES H&C system available solutions for urgent replacement; • Support developing renewable energy communities.
Stakeholders engaged, with an active role	MKM, KredEx, Building Authority, local authorities
Targeted stakeholders, as beneficiary	Building owners, households, apartment associations
Costs	Medium to High, depending on the services proposed. Some elements to quantify the cost can be found in a study done by Energy Cities.

[118] MKM (2018). Korterelamute Renoveerimistoetuste Meetme Arendus Lõpparuanne.
[119] See Section 5.2.2.1 for EU examples of BRPs
[120] MKM (2018). Korterelamute Renoveerimistoetuste Meetme Arendus Lõpparuanne.
[121] MKM (2018). Korterelamute Renoveerimistoetuste Meetme Arendus Lõpparuanne.
[122] MKM (2018). Korterelamute Renoveerimistoetuste Meetme Arendus Lõpparuanne.

Value added for H&C consumers	Medium, provide the needed technical support needed to incentivise households to replace heating systems
Financed via	National tax revenues, Social Climate Fund
Complexity	Medium/high
Timeline	Short/medium-term (2023-2026)
Underlying conditions	Sufficient administrative and technical professionals to administer BRPs and strengthen OSSs
Impact on the infrastructure	Impact on building renovation (and replacement of individual H&C systems)
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system No concerns about public perception

Best practices in other EU Member States

References for best practices for information campaigns, one-stop shops and BRPs can be found in Actions 2.A and 2.B.

Tailored actions for each pathway

The facilitation of renovation of specific market segments is the same for all pathways. The following table describes how the measure complies with the 5 SMART criteria.

Table 5-30 SMART criteria for each pathway for Action 6.B: Facilitate the renovation of specific market segments to replace heating systems

SMART actions	All pathways
Specific (simple, sensible, significant)	• Update the current EPC by meeting the new requirements of the revised EPBD and integrating heating system metrics • Targeted information campaigns to improve RES heat awareness and acceptance, information campaigns on the advantages of DHC, where appropriate. • For building renovation, a bilingual digital platform with reliable information about renovations, which provides details on the process of a successful renovation, common misconceptions, best practises and potential obstacles and related solutions. A renovation calculator could also be integrated to estimate the actual cost of the renovation, the energy savings and possible financing solutions. • Targeted local one-stop shops, which fit the needs of the local population (e.g. language barrier, low-income households, addressing worst-performing buildings, rural areas); • Support the development of renewable energy communities (e.g. financing, pilot projects).
Measurable (meaningful, motivating)	Improve awareness of specific consumer groups in order to increase the renovation rate of residential buildings and increase planned replacement of H&C systems.
Achievable (agreed, attainable)	These measures or similar measures already exist in Estonia, just need to be improved/targeted.
Relevant (reasonable, realistic and resourced, results-based)	Consider using digital platforms for EPCs, information sharing and in some cases OSSs, to make services more easily accessible.
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Improve EPCs (2024) • Targeted local OSSs (2024-2026) • Launch information campaigns & digital platform (2024) • Support renewable energy community projects (2023-2025)

5.7 Policy Area 7 - Strengthen professionals' skills and knowledge (along the chain)

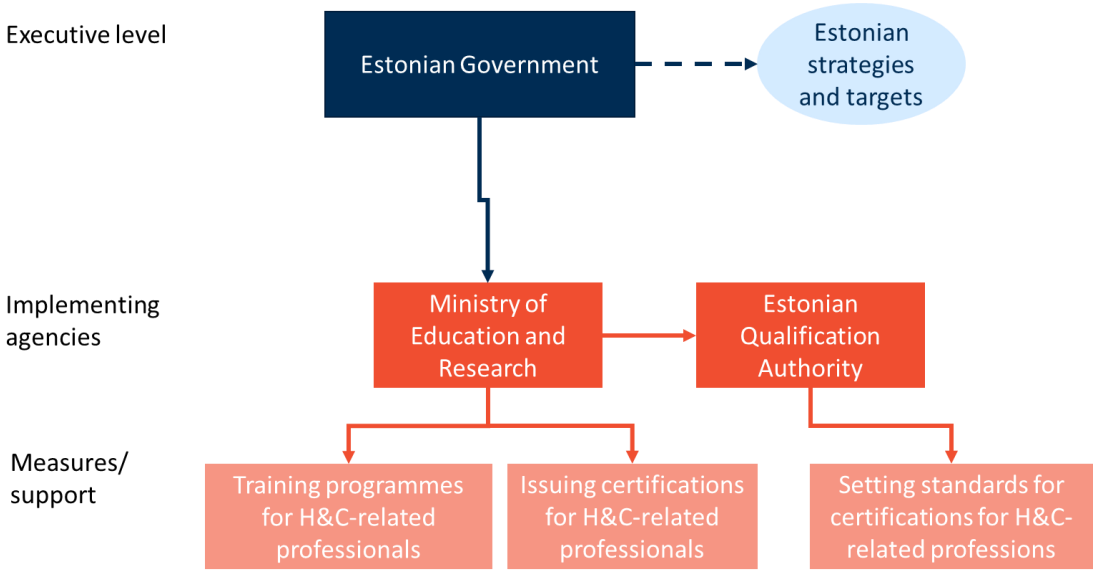
To address the shortage of skilled labour required for decarbonising heating and cooling, support is required for developing professionals' skills and knowledge, training H&C experts as well as supporting R&D of new technological solutions.

5.7.1 Existing policies on H&C labour market

Figure 5-6 illustrates the institutional framework of policies relating to H&C labour market. The **Professions Act** is the legal framework for the organisation of the administrative body responsible for certification of professional qualifications, such as for RES installers and construction professions. The **Ministry of Education and Research** is responsible for organising the issuance of qualifications and the **Estonian Qualifications Authority** is responsible for setting the standards for certification.

In Estonia, there are currently several relevant training programmes/certifications for: heating and cooling system technicians (covers installation and maintenance of A/A heat pumps, A/W heat pumps and ground source heat pumps); thermal engineers; HVAC engineers; building automation engineers; civil engineers in buildings and structures; refrigeration mechanics (installation and maintenance of air conditions and heat pump equipment); architects, spatial planners, energy auditors, and general construction occupations.[123]

Figure 5-6 Simple diagram of the institutional framework for measures related to the H&C labour market



Estonia is slightly below average in terms of R&D support compared to the EU27 average. In 2020, R&D investment in Estonia amounted to 1.8% of national GDP, whereas the EU27 average is 2.3%. The total government budget allocation to Estonia was 0.7% in 2020, which is just below the EU27 average of 0.77%.

5.7.2 Recommended actions

To strengthen professionals' skills and knowledge along the value chain, the following actions are recommended:

- Action 7.A: Supporting developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners);
- Action 7.B: Education, training and certification of energy consultancies and heating installers; and

[123] Estonian Qualifications Authority (n.d.) Estonian Qualifications Authority.

- Action 7.C: Support R&D of new technological solutions.

5.7.2.1 *Action 7.A - Support developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners)*

In the short term, sufficient capacity is necessary to commence the planning and implementation of necessary actions for decarbonising H&C. This is required along the value chain, from local planners, designers and architects, to construction workers, installers, operators and owners. Most of this capacity building will be required internally in companies. Therefore, incentivising companies to build up this capacity amongst their employees is required.

In order to motivate companies to invest in their employees, Estonia's policies will need to **create a stable demand** for energy renovation and refurbishment/installation of H&C systems. Therefore, creating a long-term, clear vision/plan in the context of the other actions recommended in this actions plan is crucial, particularly relating to the renovation wave (incl. the promoted technologies and energy carriers) and development of H&C infrastructure.

Further, employers in Estonia can apply for **training grants** to train employees, which is financed by the Unemployment Insurance Fund.[124] This grant is primarily for recruiting new employees, developing Estonian language skills and improving proficiency in information and communication technology. The grant compensates up to 80% of the total costs (max. €2500 per employee). A similar grant scheme could be developed specifically for companies in the construction and H&C sector, relating to capacity building in energy performance/renewable H&C related skills.

Additionally, capacity building in H&C and construction sector could be partially supported by the RRF investment for *green skills to support the green transition of enterprises*, which supports the development of green skills in sectors impacted by the green transition, including the energy sector.[125] The total funding for this investment is €15 million and will be completed by July 2026.

Table 5-31 Overview of Action 7.A: Support developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners)

	Support developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners)
Concrete actions	• On the short term, a detailed assessment of the capacity required along the chain should be conducted (planners, architects, construction workers, installers, service providers), to update the needs; • Adjust existing capacity building support and programmes to the updated needs; • The most efficient way to make sure that professionals will receive sufficient training is to give a clear and stable signal to the market that fossil-based H&C systems will be phased out and future will depend on renewable and low-carbon systems
Stakeholders engaged, with an active role	Estonian Unemployment Insurance Fund, concerned sectors (construction, architects, infrastructure operators, utilities, energy service providers)
Targeted stakeholders, as beneficiary	Workers in H&C and construction sector and other concerned sectors, building owners
Costs	Medium/high, requires additional funding for training grant
Value added for H&C sector	High, as this is a crucial component of the energy transition to ensure high quality and trust at the adequate pace
Financed via	National tax revenues, RRF funding
Relevance	• Lack of sufficient skilled labour for decarbonising H&C;

[124] https://www.tootukassa.ee/en/services/employers/training-grant-employers
[125] https://ec.europa.eu/info/sites/default/files/com-2021-625_annex_en.pdf

	• Lack of required knowledge and capacity to ramp up the deployment of renewable-based H&C solutions
Complexity	Low
Timeline	Short/medium-term (2024-2025)
Underlying conditions	There is a long-term vision for decarbonising H&C to create a clear and stable signal to companies in order to incentivise investment in required expertise and capacities.
Impact on the infrastructure	No direct impact on infrastructure, increase speed and quality of refurbishment works
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system No concerns about public perception

Tailored actions for each pathway

Based on the technology development of each pathway, the needs for training grants differ. The following table describes how the measure for each pathway complies with the 5 SMART criteria.

Table 5-32 SMART criteria for each pathway for Action 7.A: Support developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners)

SMART actions	All electric	Push towards DHC	Push towards LHC	Technology neutral
Specific (simple, sensible, significant)	The Estonian Unemployment Insurance Fund should create an additional training grant for employers directed towards green skills in the H&C sector. This should focus on skills relating to energy efficiency and renewable electricity in H&C systems as well as building renovation.	The Estonian Unemployment Insurance Fund should create an additional training grant for employers directed towards green skills in the H&C sector. This should focus on skills relating to DHC-related professions as well as energy consulting, and renovation-related professions (designers, architects and construction workers)	The Estonian Unemployment Insurance Fund should create an additional training grant for employers directed towards green skills in the H&C sector. This should focus on skills relating to heat pump installation/ maintenance as well as energy consulting, and renovation-related professions (designers, architects and construction workers)	The Estonian Unemployment Insurance Fund should create an additional training grant for employers directed towards green skills in the H&C sector. This should focus on skills relating to heat pump installation/ maintenance as well as energy consulting, and renovation-related professions (designers, architects and construction workers)
Measurable (meaningful, motivating)	Ensure that the Renovation Wave and decarbonisation of H&C are feasible by increasing the amount of relevant skilled-labour			
Achievable (agreed, attainable)	This measure is an extension of the already existing training grants provided to employers.			
Relevant (reasonable, realistic and resourced, results-based)	Increase funding for the general training grant and include additional option for use of grant to develop green skills in the H&C sector. This can possible be done using RFF funding for green skills development.			
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	Set up training grant for H&C sector (2024-2025)			

5.7.2.2 *Action 7.B - Education, training and certification of energy consultancies and heating installers*

Beyond the current workforce in the field of H&C, education and training programmes need to be adjusted to include capacity building on energy performance/efficiency and renewable H&C technologies.

The current **certifications** in Estonia should be **tailored to have greater focus on specific technologies depending on the pathway technology installation requirements.** This should be aligned with the forecasts for technology development.

Similar to the language barrier issue described in Action 6.B, the language barrier for the Russian population, should also be addressed in the context of education for H&C professions. Not having Russian speaking professionals can be an additional barrier for the Russian-speaking population to renovate. This can be achieved by providing trainings in Russian in regions with greater Russian-speaking populations.

Table 5-33 Overview of Action 7.B: Education, training and certification of energy consultancies and heating installers

	7.B - Education, training and certification of energy consultancies and heating installers
Concrete actions	Identify precise lack of skills. Ensure that education and occupational training programs for building, energy and heat professionals include capacity building on energy performance/efficiency and renewable H&C technologies. Ensure that the language barrier (for the Russian-speaking population) is addressed. This can be done by providing trainings in Russian.[126]
Stakeholders engaged, with an active role	Ministry of Education and Research, concerned sectors (construction and service providers)
Targeted stakeholders, as beneficiary	Energy consultants and heating installers, building owners and occupiers
Costs	Medium, requires administrative costs for deployment and implementation
Value added for H&C sector	Low to Medium, ensure that new professionals in the H&C sector are adequately trained in relevant competencies
Financed via	National tax revenues
Relevance	Lack of sufficient skilled labour for decarbonising H&C
Complexity	Low
Timeline	Short-term (2023)
Underlying conditions	N/A
Impact on the infrastructure	No direct impact on infrastructure
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system No concerns about public perception

Tailored actions for each pathway

For each pathway, training programmes/certification specifications depend on the pathway technology development. The following table describes how the measure for each pathway complies with the 5 SMART criteria.

[126] MKM (2018). Korterelamute Renoveerimistoetuste Meetme Arendus Lõpparuanne.

Table 5-34 SMART criteria for each pathway for Action 7.B: Education, training and certification of energy consultancies and heating installers

SMART actions	All electric	Push towards DHC	Push towards LHC	Technology neutral
Specific (simple, sensible, significant)	Adapt current H&C technician training programmes/certifications to focus on electricity-based H&C technologies, with particular focus for installation/maintenance of air-to-air HPs and ground-source HPs	Adapt current H&C technician training programmes/certifications to focus on district H&C technologies, with particular focus on DHC networks and DHC H&C system installation and maintenance (heat pumps ad biomass CHP)	Adapt current H&C technician training programmes/certifications to focus on local H&C technologies, with particular focus for installation/maintenance of heat pumps	Adapt current H&C technician training programmes/certifications to focus on heat pumps, with particular focus for installation/maintenance of air-to-air HPs, air-to-water HPs and ground-source HPs
Measurable (meaningful, motivating)	Ensure that the Renovation Wave and decarbonisation of H&C are feasible by increasing the amount of relevant skilled-labour			
Achievable (agreed, attainable)	Relevant training programmes/certifications already exist in Estonia, just need to be adjusted to have a particular focus on the relevant technologies			
Relevant (reasonable, realistic and resourced, results-based)	Consider adjusting current curriculum of H&C-related professions to ensure that all new professionals in the field have the required skills for the implementation and maintenance of the relevant renewable H&C technologies.			
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	Adapt trainings programmes/certification for H&C technical professions (2023)			

5.7.2.3 *Action 7.C - Support research and development of new technological solutions*

As mentioned in the Estonian LTRS, R&D is a key element for decarbonising the building stock and will **reduce the problem of the labour shortage** (by finding less labour intensive solutions), via finding digital and prefabricated solutions for renovation, efficiency and renewable solutions for H&C systems, as well as heat storage solutions. Further, these developments in digitalisation and industrialisation will **improve working conditions** in the sector and make the sector more attractive.[127]

Currently, in Estonia, there is a long-term, EU funded project, called LIFE IP BUILDEST, which aims to implement technical, standardised solutions for deep renovation, including prefabricated and digital solutions through pilot renovations. This program also will include training events for professionals in the construction and H&C sector. In the long-term, further research and piloting of these types of solutions will be needed to further stimulate innovation and scale-up these technologies. Additionally, this project mainly focuses on energy efficiency in buildings. **Similar types of pilot projects (possibly using EU funds) should be considered for technologies relating to renewable H&C systems as well as heat storage**.

Further, greater **financial support for R&D** are needed for the following technical areas:

- Digital tools for building renovation;
- Prefabricated materials for building renovation;
- Advanced building materials (nanotechnologies, advanced insulation materials, building integrated photovoltaics);
- Mainstream circularity in the construction (By material reuse, recycling, etc.)
- Efficient/renewable solutions for H&C (depending on pathway); and
- Heat storage solutions.

The aim of the measure is to develop and upscale innovative solutions for renewable-based H&C, which are energy efficient and/or renewable. Supporting R&D for the most relevant solutions for renewable H&C is expected to further reduce heat demand as well as decrease the overall cost of H&C technology deployment. This is due to the development of new technologies which are more resource efficient as well as require less labour (such as prefabrication of building materials and developing digital tools for building renovation).

Table 5-35 Overview of Action 7.C: Support research and development of new technological solutions

	7.C - Support research and development of new technological solutions
Concrete actions	Financial support for R&D (including pilot projects) of new technological solutions for renovation (digitalisation and prefabrication), H&C systems and heat storage.
Stakeholders engaged, with an active role	Building authority, Environmental Investment Centre, H&C sector, construction sector
Targeted stakeholders, as beneficiary	H&C sector, construction sector, building owners and occupiers
Costs	Medium/high, requires investment costs - <€5 million[128]
Value added for the H&C sector	Medium on the middle/long term, provides necessary support to initiate innovation in the H&C sector
Financed via	National tax revenues, EU Innovation Fund, private companies and research

[127] Lemoine, P. et. al (2021). The road to energy efficiency.
[128] TalTech & MKM (2020). Long Term Strategy for Building Renovation in Estonia.

Relevance	Addresses the lack of sufficient labour (by reducing the labour-intensity of H&C activities) and supports necessary R&D
Complexity	Low
Timeline	Short/medium-term for actions (2023-2026), impact on H&C sector is long-term
Underlying conditions	To ensure efficiency, there is a need to focus on the most relevant solutions, to avoid spread of money and efforts
Impact on the infrastructure	No direct impact
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system No concerns about public perception

Tailored actions for each pathway

The support for R&D is very similar for all the pathways, with some deviation of which areas of R&D to focus on depending on the pathway technology development. The following table describes how the measure complies with the 5 SMART criteria.

Table 5-36 SMART criteria for each pathway for Action 7.C: Support research and development of new technological solutions

SMART actions	All pathways
Specific (simple, sensible, significant)	The Ministry of Economic Affairs should set up pilot projects and financial support (via KIK) for R&D of new technological solutions for renovation and energy-efficient/renewable H&C systems. This support should be open for both public (i.e. academia) and private (i.e. companies) entities. The R&D to be focused on depends on the pathway: • All Electric: renewable electricity-based H&C • Push towards DHC: efficiency and renewable solutions for DHC • Push towards LHC: local H&C technologies (i.e. heat pumps) • Technology neutral: efficient heat pumps
Measurable (meaningful, motivating)	• Make building renovation and H&C deployment more affordable by development of resource/labour-efficient technologies • Raise awareness and reduce public uncertainty about technical solutions based on best practises from pilot projects.
Achievable (agreed, attainable)	Such practice exists already in many countries/regions, and could provide good lessons (and baseline guidance)
Relevant (reasonable, realistic and resourced, results-based)	• The Building Authority can partner up with public actors (local authorities, universities) and private actors (companies) to carry out pilot projects • KIK could set up grants for specific R&D topics relating to innovation in energy efficiency and renewable energy in heating and cooling.
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	• Set up pilot projects in the short/medium-term (2023-2026) • Set up grants for R&D in the short-term (2023-2024)

5.8 Policy Area 8 - Mobilise and mainstreaming financing and funding

Making sure financing and funding is mobilised and mainstreamed on the long term is a key factor for a successful implementation of the above actions.

5.8.1 Existing policies on mobilising and mainstreaming funding

Although there are several financial instruments in place for the Renovation Wave and decarbonising heating and cooling, these financial instruments need to be strengthened. Table 5-37 provides an non-exhaustive overview of projects in Estonia funded by the EU that are related to renovation and H&C.

Table 5-37 Overview of EU-funded projects in Estonia related to renovation and H&C

	Projects	Funding (MEUR)			
		EU	National	Self-financing	Total
RRF	Supporting the reconstruction of apartment buildings	45	-	-	45
	Supporting the reconstruction of small houses	2	-	-	2
CF 2014-2020*	Supporting the reconstruction of apartment buildings	25	-	39	63
	Renovation and/or construction of district heating boilers and replacement of fuel	11	-	11	22
	Renovation of depreciated and ineffective heat pipeline and/or the construction of a new heat pipeline	4	-	4	8
	Supporting the reconstruction of apartment buildings	18	-	27	45
CF 2021-2027	Support for the reconstruction of apartment buildings; supporting stage-based reconstruction of apartment buildings	331	-	496	827
	Fund for reconstruction of apartment buildings	35	-	53	88
	Supporting and constructing the renovation and construction of district heating systems and boiler equipment (including investment in medium -power combustion plants)	23	-	23	45
	Joining residential buildings with district heating networks or upgrading a heater based on solid fuel	19	-	8	26
	Energy efficiency of health facilities	30	4	2	35
JTF	Supporting the transition to district heating in Ida-Viru county	20	-	20	40
	Funding for renovation	**485**	**4**	**617**	**1106**
	Funding for H&C instalment/refurbishment	**76**	**0**	**65**	**141**
	Total	**561**	**4**	**682**	**1247**

RRF = Recovery and Resilience Facility; CF = Cohesion Fund
**Funding for 2022-2023 estimated based on the total funding, weighted on the average yearly value of the indicator to be completed between 2020-2023.*

There is no clarity whether funding will still be mobilised after 2027 (time horizon of both RRF & CF). A continuity plan is crucial to avoid a sudden stop of the dynamic. This is also key on the short term to provide the industry enough security on the long term (which is essential to building capacities, and investing in the required skills).

5.8.2 Recommended actions

To mobilise and mainstream financing and funding, the following policy recommendations areas are proposed:

- Action 8.A: Ensure adequate and integrated financing of all renovation instruments (e.g. MEPS); and
- Action 8.B: Establish an integrated financial and fiscal strategy for long term decarbonisation of H&C.

5.8.2.1 *Action 8.A - Ensure adequate and integrated financing of all renovation instruments*

It is important to ensure that all obligations for renovation are accompanied with sufficient financial support. This is particularly important for low-income households, where renovation obligations would become an excessive financial burden. Households should also be made aware of all of the available options.

The Estonian LTRS estimates that the government will need to support 30% of the investment for single houses and 40% of the investment for apartment buildings and commercial/service buildings.[129] The **EU funding from 2022-2027 covers about 46% of the renovation support needed in the next decade**, however more support will be needed to fund and incentivise private investment to reach the required €16.7 billion by 2050. Particularly, the EU-funded projects mainly focus on apartment buildings, whereas single houses and service/commercial buildings also require a significant amount of support.

Taking the EU funding into account, the Estonian government will need to fund about €557 million for building renovations in the next decade. 62% of the overall support will be needed for non-urban buildings, mainly single houses. As indicated in the LTRS, the average tax revenue from building renovation activities is 32%.[130] Therefore, **the state budget and EU funding should be able to accommodate for 100% of the support needed for renovation**. For EU funding, the Estonian government should consider using the following funds for facilitating the Renovation Wave: RRF, the Social Climate Fund, Cohesion Policy Fund, InvestEU and auction revenues from ETS.

Table 5-38 Required support from the Estonian government for building renovation from 2021 to 2050

Building type		Renovation support (MEUR) 2022-2030	2031-2040	2041-2050	Total
Single houses	Non-Urban	177	679	1,046	1,902
	Urban	24	91	140	254
Apartment buildings	Non-Urban	217	317	188	722
	Urban	297	433	257	987
Services/ Commercial buildings	Non-Urban	172	484	458	1,115
	Urban	154	433	410	998
Subtotals	Non-Urban	566	1,480	1,692	3,738
	Urban	475	957	807	2,239
Total		**1,042**	**2,437**	**2,498**	**5,977**
Total tax revenues from renovation activities		**887**	**2,155**	**2,315**	**5,356**

Note: the values do not take EU funding into account.

Further, beyond ensuring the necessary financing is provided by the government, households and building owners need to be aware of the financial options and incentivised to use the financial support. This can be done via information campaigns and setting up OSS services.

Table 5-39 Overview of Action 8.A: Ensure adequate and integrated financing of all renovation instruments (e.g. MEPS)

	8.A - Ensure adequate and integrated financing of all renovation instruments (e.g. MEPS)
Policy description	• Ensure that all renovation obligations are coupled with financial support, particularly for low-income households (which could benefit higher support), on the long run (ideally 2050 time horizon, to fit the renovation strategy timeline) • Consider reducing the renovation taxes • Strengthen information campaigns and OSS services to ensure that households are aware of the financial options
Stakeholders engaged, with an active role	MKM, KredEx, financial institutions, building owners
Targeted stakeholders, as beneficiary	Building owners, particularly low-income households
Costs	High – requires investment of €1 billion until 2030; €6 billion until 2050
Value added for H&C consumers	Medium[131] - stimulate renovation (thus improve energy performance of buildings and reduce energy poverty) and stimulate long-term demand for construction and H&C sector (important to stimulate innovation and capacity building in the sector)

[129] TalTech & MKM(2020). Long Term Strategy for Building Renovation in Estonia.
[130] TalTech & MKM (2020). Long Term Strategy for Building Renovation in Estonia.est
[131] Odyssee-Mure & TalTech (2021). Energy Efficiency Trends and Policies in Estonia.

Financed via	National tax revenues, EU funding (RRF, Social Cohesion Fund, Social Climate Fund, InvestEU, etc.), auction revenues from ETS
Relevance	Addresses lack of access to finance
Complexity	Low/Medium
Timeline	Short- to long-term
Underlying conditions	Having concrete objectives and instruments regarding building renovation; there is adequate awareness raising and administrative support to mobilise financing
Impact on the infrastructure	Indirect impact on the renovation of buildings
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system No concerns about public perception

Tailored actions for each pathway

As the renovation needs for all of the pathways are the same, not additional tailored sub-actions are required for the pathways. The following table describes how the measure complies with the 5 SMART criteria.

Table 5-40 SMART criteria for each pathway for Action 8.A: Ensure adequate and integrated financing of all renovation instruments (e.g. MEPS)

SMART actions	All pathways
Specific (simple, sensible, significant)	Ensure that there is enough public funding dedicated to building renovation so that the Renovation Wave is achievable. From 2022 to 2050, this amounts to €5.3 billion. A significant amount of this funding can come from EU funds.
Measurable (meaningful, motivating)	Significant direct contribution to investment in building renovation and indirect contribution to investment via co-financing from private investments
Achievable (agreed, attainable)	Funding can come from EU funds (RRF, the Social Climate Fund, Cohesion Policy Fund, InvestEU and auction revenues from ETS), national tax revenues and possibly revenues from the proposed carbon pricing scheme
Relevant (reasonable, realistic and resourced, results-based)	Financing should be mobilised to targeted consumer groups to ensure that funding is used efficiently and effectively
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	Ensure adequate long-term financial support for renovation activities (2023-2030+)

5.8.2.2 *Action 8.B - Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C*

Fiscal terms should be adjusted to improve the accessibility and attractiveness of investments, such as increasing the payback period and reducing interest rates.

Table 5-41 Overview of Action 8.B: Establish an integrated financial and fiscal strategy for long term decarbonisation of H&C

	8.B - Establish an integrated financial and fiscal strategy for long term decarbonisation of H&C
Policy description	Develop a comprehensive fiscal and financial strategy, to ensure complementary and coherent effect of all related instruments/measures, such as reduced interest rates, reduced renovation taxes, property taxes adapted to the building performance, green mortgage[132], …
Stakeholders engaged, with an active role	MKM, fiscal and financial sectors; MoF
Targeted stakeholders, as beneficiary	Building owners
Costs	Medium, as this would require important coordination between all services and sectors to align all instruments
Value added for H&C sector and consumers	Medium, provides a clear long-term financial vision for H&C sector and consumers on the expected public financing.
Financed via	National tax revenues

[132] World Green Building Council (n.d.). What are green mortgages & how will they revolutionise home energy efficiency?.

Relevance	Addresses the lack of access to finance
Complexity	Medium to high, to ensure full consistency, and long term coherence it may require some time and efforts
Timeline	Short-term (2024)
Underlying conditions	N/A
Impact on the infrastructure	Indirect impact on the renovation of buildings
Compatibility with Estonian legal system and public perception	Little/no conflict foreseen with current Estonian legal system No concerns about public perception

Tailored actions for each pathway

As all pathways require a comprehensive fiscal and financial strategy, particularly relating to financing the Renovation Wave, there are not specific additional sub-actions for the pathways. The following table describes how the measure complies with the 5 SMART criteria.

Table 5-42 SMART criteria for each pathway for Action 8.B: Establish an integrated financial and fiscal strategy for long term decarbonisation of H&C

SMART actions	All pathways
Specific (simple, sensible, significant)	Develop a comprehensive fiscal and financial strategy, to ensure complementary and coherent effect of all related instruments/measures, such as reduced interest rates, reduced renovation taxes, property taxes adapted to the building performance, green mortgage[133], …
Measurable (meaningful, motivating)	Create a clear signal to the financial sector of the fiscal opportunities in the building/H&C sector
Achievable (agreed, attainable)	Building on proposed measures and creating a respective long-term vision
Relevant (reasonable, realistic and resourced, results-based)	Creating a long-term strategy for financing the Renovation Wave and decarbonisation of H&C reduces perceived risks in the sector for the financial sector as well as the H&C sector and consumers
Time bound (time-based, time limited, time/cost limited, timely, time-sensitive)	Develop fiscal and financial strategy (2024)

Best practices in other EU Member States

The ETS Directive obliges MSs to use at least 50% of auctioning revenues for climate and energy-related purposes.[134] According to the COM(2020) 740 Final report, around 78% of revenues in 2013-2019 were used for climate and energy related purposes.[135] While, according to WISE Netherlands[136], a considerable portion of the revenues are used as subsidies for the installation of new fossil-based equipment or to reduce industrial energy prices.[137]

However, there are other examples of carbon and/or environmental tax income which are used for the climate transition.

Previously, carbon taxation was considered from a tax shifting perspective (moving taxation from labour to environment, or using environmental/carbon taxation as a potential source of revenue or an opportunity to substitute for other taxes in line to the 'double dividend' concept). More recently, given the fact that carbon taxation is regressive, and therefore leading to decrease taxation income, governments are reconsidering carbon taxation revenues allocation. There is growing recognition that revenue from carbon taxation should be redistributed in order to neutralize their income effects.

[133] World Green Building Council (n.d.). What are green mortgages & how will they revolutionise home energy efficiency?.
[134] European Commission (n.d.). Auctioning.
[135] European Commission (n.d.). Auctioning.
[136] Euractiv (2022). How EU Member States use carbon market revenues to subsidise fossil fuels.
[137] Sandbag (2022). EU ETS Revenues: who receives what? The trillion euro question.

Therefore, the 'Fit for 55' package includes a proposal for the introduction of a social climate fund (EC, 2021d). The objective of this fund would be twofold: (1) to '*finance temporary direct income support for vulnerable households*' and (2) to '*support measures and investments that reduce emissions in road transport and buildings sectors and as a result reduce costs for vulnerable households, micro-enterprises and transport users*' (EC, 2021e), pledging a socially fair transition (EEA and Eurofound, 2021).[138]

In France, e.g., the carbon fiscal income can serve various purposes, among which to reinforce environmental protection or climate change mitigation actions.[139]

Given the current high share of environmental tax revenues in Estonia (more than 9.5% of total tax revenues[140]), there is an interesting opportunity to allocate part of these environmental revenues to finance the climate transition (e.g. low income households to renovate their house).

[138] European Environment Agency (2022). The role of (environmental) taxation in supporting sustainability transitions.
[139] French Ministry of Ecological Transition and Territorial Cohesion (2017). Fiscalité carbone.
[140] European Environment Agency (2022). The role of (environmental) taxation in supporting sustainability transitions.

PART B - Action plans by pathway

This part presents a pathway-level overview of the actions proposed in part A, highlighting the proposed timeline and main stakeholders involved in the process.

Most of the actions should be implemented to the largest extent possible independently on the pathways chosen but will certainly be adapted according to their importance for a specific pathway.

The pathway-specific action plans should be considered as a comprehensive set of policy measures, complementing each other. All measures should be implemented together to ensure a coherent action plan, considering they have an interlinked role to play in the full decarbonisation. Though, some measures may be less critical, and could possibly be further explored or even postponed, according to the political agenda. We will capture as much as we can these variations.

The first chapter provides an overview of the policy actions for each pathway and the following chapters provide the overview of the pathway and tailor-made timeline for each pathway.

6 Overview of policy actions per pathway

This section provides an overview of the actions in terms of:

- Priority actions per pathway:
- Stakeholder responsibilities/roles per action;
- Barriers addressed per action.

The table below provides an overview of the priority actions for each pathway. *Priority actions* are defined as actions which are considered of most importance for the successful implementation of the pathway, whereas *supporting actions* are important, but less critical. Most of the actions are a priority action, regardless of the pathway.

Table 6-1 Overview of priority actions per pathway

Policy area	Actions	All electric	DHC	LHC	Tech neutral
Streamline integrated H&C planning process	**1.A. Establish integrated infrastructure planning at local level**	**P**	**P**	**P**	**P**
	1.B. Promote cooperation between electricity grid operators and DHC grid operators	**P**	✓		✓
	1.C. Mainstream bioenergy in a complete bioeconomy roadmap/strategy	✓	**P**	**P**	**P**
Phase the renovation wave and integrate renewable supply	**2.A. Incentivise replacement of heating systems when undergoing deep renovation**	**P**	**P**	**P**	**P**
	2.B. Accelerate the renovation of worse performing buildings	**P**	**P**	**P**	**P**
	2.C. Energy efficiency/renewable system mortgages and repayment of investments through property taxes	✓	✓	✓	✓
Development of the required infrastructure	3.A. Incentivise existing DHC refurbishment & shift to geothermal, solar and HPs	**P**	**P**		**P**
	3.B. Combine renovation programmes with DHC refurbishment	✓	✓		✓
Strengthen local authorities' role in H&C decarbonisation	**4.A. Empower local authorities to play an active role in H&C decarbonisation, oblige them the plan H&C decarbonisation**	**P**	**P**	**P**	**P**

Set up level playing field and creating a market	5.A. Incentivise/promote individual HP when most appropriate option	**P**		**P**	**P**
	5.B. Establish a gradual carbon pricing	✓	✓	✓	✓
	5.C. Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC	**P**	**P**	**P**	**P**
Empower all consumers, especially households	**6.A. Engage dialogue with industry to analyse best decarbonisation options (at 2050)**	**P**	**P**	**P**	**P**
	6.B. Facilitate the renovation of specific market segments to replace heating systems	✓	✓	✓	✓
Strengthen professionals' skills and knowledge	**7.A. Support developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners)**	**P**	**P**	**P**	**P**
	7.B. Education, training and certification of energy consultancies and heating installers	✓	✓	✓	✓
	7.C. Support research and development of new technological solutions	**P**	**P**	**P**	**P**
Mobilise and mainstream financing and funding	**8.A. Ensure adequate and integrated financing of all renovation instruments**	**P**	**P**	**P**	**P**
	8.B. Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C	**P**	**P**	**P**	**P**

P = priority action; ✓ = supporting action

Shared priorities are in bold.

The tables below (i) list of the roles of different stakeholders for each policy actions and (ii) identify which main problems and key barriers each policy action addresses.

Action	Role			
	National government	Local authorities	Energy sector	Consumers
1.A. Establish integrated infrastructure planning at local level	**MKM**: Revision of DH act (develop guidance) **RM**: Adapt spatial planning framework	Carry out demonstrations Coordinate local planning	**DHC and electricity grid operators**: participate in local planning	
1.B. Promote cooperation between electricity and DHC grid operators	**MKM**: Revision of DH act (to include link with electricity planning) & support rural municipalities **CA**: impose/recommend coordination	Local energy sector development planning	**DHC and electricity grid operators**: participate in consultation & coordination	
1.C. Mainstream bioenergy in a complete bioeconomy roadmap/strategy	**MKM, KEM & MEM**: Draft & publish bioeconomy strategy		**Relevant stakeholders**: participate in consultation	**Relevant stakeholders**: participate in consultation
2.A. Incentivise replacement of heating systems when undergoing deep renovation	**BA**: Develop digital BRPs **KredEx**: set up grants and information campaign	Increase local awareness		Use of BRPs
2.B. Accelerate the renovation of worse performing buildings	**BA**: Set up MEPS **KredEx**: set up targeted OSS	Support identifying & accompanying the concerned buildings and households		Compliance with MEPS and use of OSS
2.C. Energy efficiency/renewable system mortgages and repayment of investments through property taxes	**KredEx**: set up mortgage scheme **RM**: set up repayment via property taxes			Use of mortgage scheme
3.A. Incentivise existing DHC refurbishment & shift to geothermal, solar and HPs	**MKM**: Revision of DH act (to ensure local heating development plans provide clear LT vision for DHC) **CA**: lower electricity prices for DHC HPs **KIK**: ensure LT funding for refurbishment of DHC	Local heating development plans	**DHC operators**: participate in consultation	
3.B. Combine renovation programmes with DHC refurbishment	**MKM**: Revision of DH act (to include guidance to DHC sector) & support cooperation through pilot projects	Local heating development plans with guidance for combining renovation and DHC refurbishment	**DHC operators:** participate in consultation & pilot projects	**Energy communities**: participate in consultation and pilot projects
4.A. Empower local authorities to play an active role in H&C decarbonisation, oblige them the plan H&C decarbonisation	**MKM**: set up networks; develop guidance tool; dedicate financing and human resources for small municipalities	Involvement in support measures;		
5.A. Incentivise/promote individual HP when most appropriate option	**KredEx**: set up grants			Use of HP grants
5.B. Establish a gradual carbon pricing	**RM & Environment Agency**: set up gradual carbon price			
5.C. Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC	**CA**: adjust electricity tariffs for HPs **KIK**: emissions-based subsidies for H&C sector		Use of subsidies	
6.A. Engage dialogue with industry to analyse best decarbonisation options (at 2050)	**MKM**: adjust audits and set up mandatory targets **KIK**: emissions-based subsidies for industry	**Regional authorities**: set up network of advisors, liaise with the industry		Local industry engagement in local planning; use of subsidies
6.B. Facilitate the renovation of specific market segments to replace heating systems	**BA**: improve quality of EPCs **KredEx**: launch info. campaigns and digital platform **MKM**: support energy community projects	Set up targeted local OSSs		Use of improves EPCs and local OSSs
7.A. Support developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners)	**Unemployment Insurance Fund**: adjust training fund to include trainings for green skills in H&C sector		Use of funding for training	
7.B. Education, training and certification of energy consultancies and heating installers	**Ministry of Education**: adapt training/certification		Use of training programmes	
7.C. Support research and development of new technological solutions	**MKM**: pilot projects **KIK**: grants for RD&I		Involvement in pilot projects/use of grants for RD&I	
8.A. Ensure adequate and integrated financing of all renovation instruments	**MKM**: adequate long-term public financial support for renovation activities			Use of available financing
8.B. Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C	**MKM**: develop fiscal/financial strategy			

LT = long-term; MKM = Ministry of Economic Affairs and Communication; RM = Ministry of Finance; CA = Competition Authority; KEM = Ministry of Environment; MEM = Ministry of Rural Affairs; BA = Building Authority; KIK = Environmental Investment Centre

Table 6-2 Overview of problems and barriers addressed per action

	Main problems addressed				Barriers addressed					
	Low energy performance of buildings	*Biomass sustainability*	*Low performing DHC*	*Limited affordable alt. to replace fossil*	*Policy barriers*	*Market barriers*	*Financial barriers*	*Capacity barriers*	*Technical barriers*	*Social barriers*
1.A. Establish integrated infrastructure planning at local level			✓		✓	✓				
1.B. Promote cooperation between electricity and DHC grid operators			✓						✓	
1.C. Mainstream bioenergy in a complete bioeconomy roadmap/strategy		✓			✓					✓
2.A. Incentivise replacement of heating systems when undergoing deep renovation	✓						✓			✓
2.B. Accelerate the renovation of worse performing buildings	✓				✓		✓			✓
2.C. Energy efficiency/renewable system mortgages and repayment of investments through property taxes	✓						✓			
3.A. Incentivise existing DHC refurbishment & shift to geothermal, solar and HPs			✓	✓		✓			✓	
3.B. Combine renovation programmes with DHC refurbishment	✓		✓						✓	
4.A. Empower local authorities to play an active role in H&C decarbonisation, oblige them the plan H&C decarbonisation			✓							
5.A. Incentivise/promote individual HP when most appropriate option				✓		✓	✓			
5.B. Establish a gradual carbon pricing				✓		✓				
5.C. Adjustment of markets, investments, regulation, taxes, tariffs & levies to promote HPs, and other RES based heating appliances or DHC				✓		✓				
6.A. Engage dialogue with industry to analyse best decarbonisation options (at 2050)				✓						✓
6.B. Facilitate the renovation of specific market segments to replace heating systems	✓						✓			✓
7.A. Support developing the entire supply chain with qualifying companies (design, architects, construction workers, installers, operators, owners)	✓							✓		
7.B. Education, training and certification of energy consultancies and heating installers	✓							✓		
7.C. Support research and development of new technological solutions	✓			✓		✓		✓	✓	
8.A. Ensure adequate and integrated financing of all renovation instruments	✓						✓			
8.B. Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C	✓				✓	✓	✓			

7 All electric pathway Action Plan

7.1 Pathway overview

Indicator	All electric pathway
Technology mix development	
New installed capacity (2022-2050)	3.87 GW
Heat production in 2050	
% district	*24%*
% local	*42%*
% industrial	*34%*
Cooling production in 2050	
% district	*6%*
% local	*94%*
Fuel consumption in 2050	7.1 TWh
Electricity	*6.6 TWh*
Biomass	*0 TWh*
Investment needs	
Total (2022-2050)	€19,066M
H&C technologies	*€2,274M*
DHC infrastructure	*€53M*
Building renovation	*€16,739M*
Socioeconomic impact	
Average heating costs for households in 2050	97 €/MWh
Average cooling costs for households in 2050	112 €/MWh
H&C activities as % of GDP in 2050	3.2%
H&C employment as % of total employment in 2050	2.6%
Avg. change in disposable income	- €389M
Public revenues/taxes in 2050 as % of total taxes	2.6%
Stakeholder perception of risk	
Risk perception	Medium risk scenario. Very exposed to electricity grid development and HP technology investment reduction in Estonia

The All electric pathway presents the **extreme case of electrification of all the heating and cooling infrastructure**. The heating and cooling demand coverage by local and district infrastructure will remain the same. Only a shift in the technology is assumed. Local cooling section which is already based on the electrified solutions (individual/central air conditioners and central chillers) and are not discussed in the scenario as they will overlap with the BAU scenario due to the overarching nature of the scenarios.

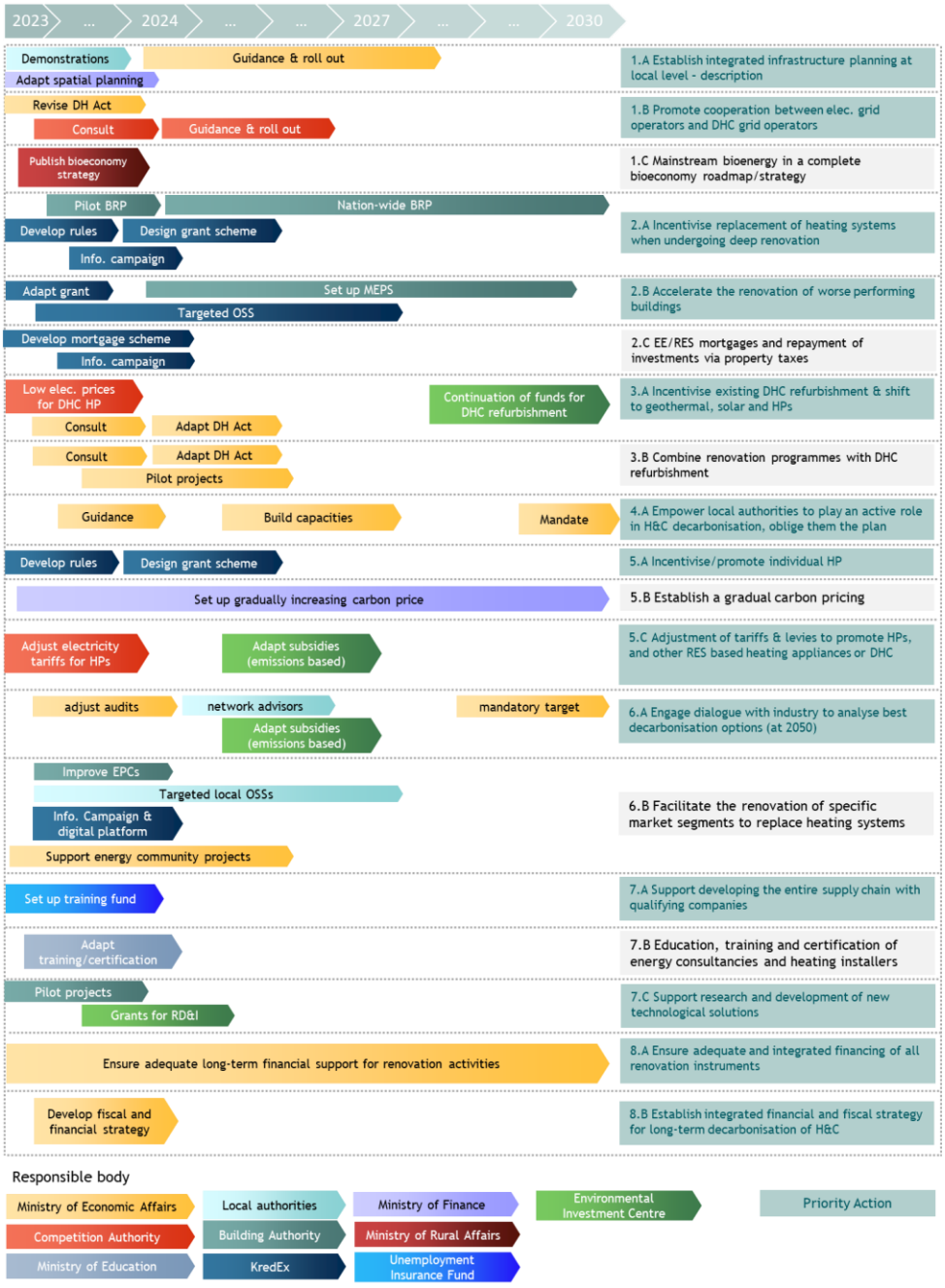
Heat pumps and electric boilers start to penetrate in the overall technology mix and by 2050 the heating system is totally based on the electrical solutions. Air to air, air to water and ground source heat pumps (shallow geothermal; 200-500 m) will penetrate in the local heating market. A/A HPs are to be installed only in single houses while for apartment buildings and services/commercial sector where bigger units of heat pumps (~200kW per unit) will be required, A/A HPs are not considered due to the seasonal efficiency limitations.

As the heat demand coverage is to remain the same, DH network length does not change. Biomass and fossil fuel will fade out by 2050 and electric solutions (A/W, W/W, and mid deep geothermal) HPs will penetrate in the DH technology mix. The large-scale electrification will take place by utilising the waste and excess heat resources present in Estonia.

In industry, the phase out of all fossil fuels and biomass will be based on direct and indirect electrification. Industrial heat coverage for heat less than 100 °C will be fulfilled by conventional/

commercial heat pumps which offers high COPs till 90-95 °C[141], by electric boilers, and by solar thermal industrial deployments. For the temperature segment 100-300 °C, in addition to the conventional HP, electrical boilers, and solar thermal, high temperature HPs (up to 140 °C) are to be employed. As industrial solar thermal and electrical boilers can serve beyond 300 °C, they are the main technologies to be employed for this temperature segment. The industrial heat demand from 300-500 °C and above will be covered by hydrogen boilers, solar thermal and electric boilers. Industrial cooling not considered.

7.2 Timeline for actions for the All Electric pathway



[141] Baltic heat pump report

8 Push towards district heating and cooling pathway Action Plan

8.1 Pathway overview

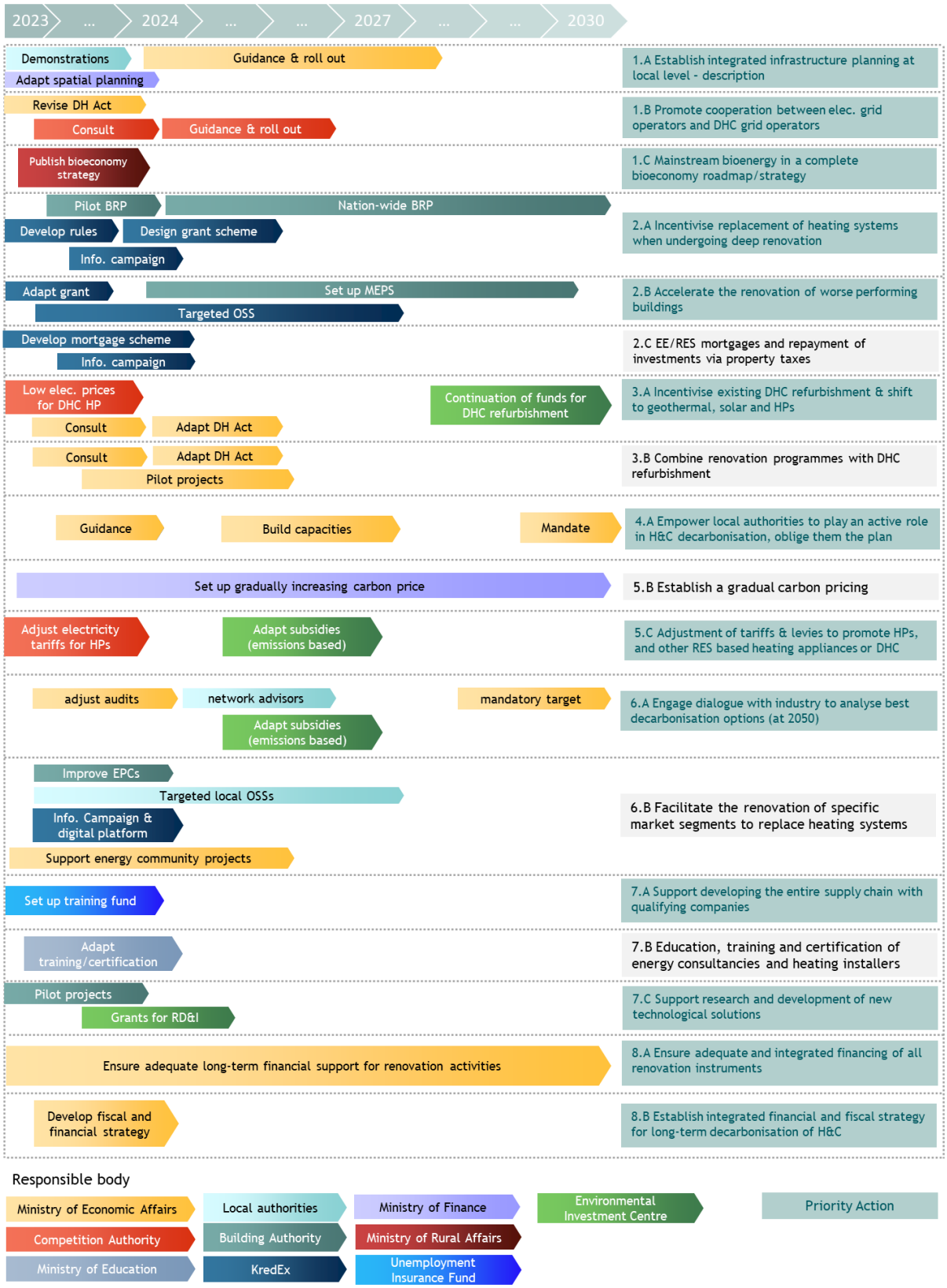
Indicator	Push towards district heating and cooling pathway
Technology mix development	
New installed capacity (2022-2050)	2.20 GW
Heat production in 2050	
% district	*48%*
% local	*18%*
% industrial	*34%*
Cooling production in 2050	
% district	*46%*
% local	*54%*
Fuel consumption in 2050	12.1 TWh
Electricity	*1.9 TWh*
Biomass	*11.37 TWh*
Investment needs	
Total (2022-2050)	**€19,032M**
H&C technologies	*€1,108M*
DHC infrastructure	*€1,012M*
Building renovation	*€16,739M*
Socioeconomic impact	
Average heating costs for households in 2050	€62/MWh
Average cooling costs for households in 2050	114 €/MWh
H&C activities as % of GDP in 2050	3.8%
H&C employment as % of total employment in 2050	3.3%
Avg. change in disposable income	- €194M
Public revenues/taxes in 2050 as % of total taxes	2.9%
Stakeholder perception of risk	
Risk perception	Less risky scenario, overall liked by stakeholders

This scenario presents heating and cooling demand coverage shift from local heating and cooling towards district heating and cooling. The technology mix remains same as the **technology neutral scenario** for each market participant and only the shift of heating and cooling demand from LHC to DHC will take place.

All residential (single houses and apartment buildings) and services/commercial sector consumers in urban and non-urban areas will be connected to DH networks except single houses in non-urban areas. DC will cover the overall cooling demands in urban areas only.

Since this scenario discusses the shift towards DHC from LHC infrastructure, industrial heating demand coverage remain same as technology neutral and is not discussed again because of the scenario's overarching nature.

8.2 Timeline for actions for the DHC pathway



9 Push towards local heating and cooling pathway Action Plan

9.1 Pathway overview

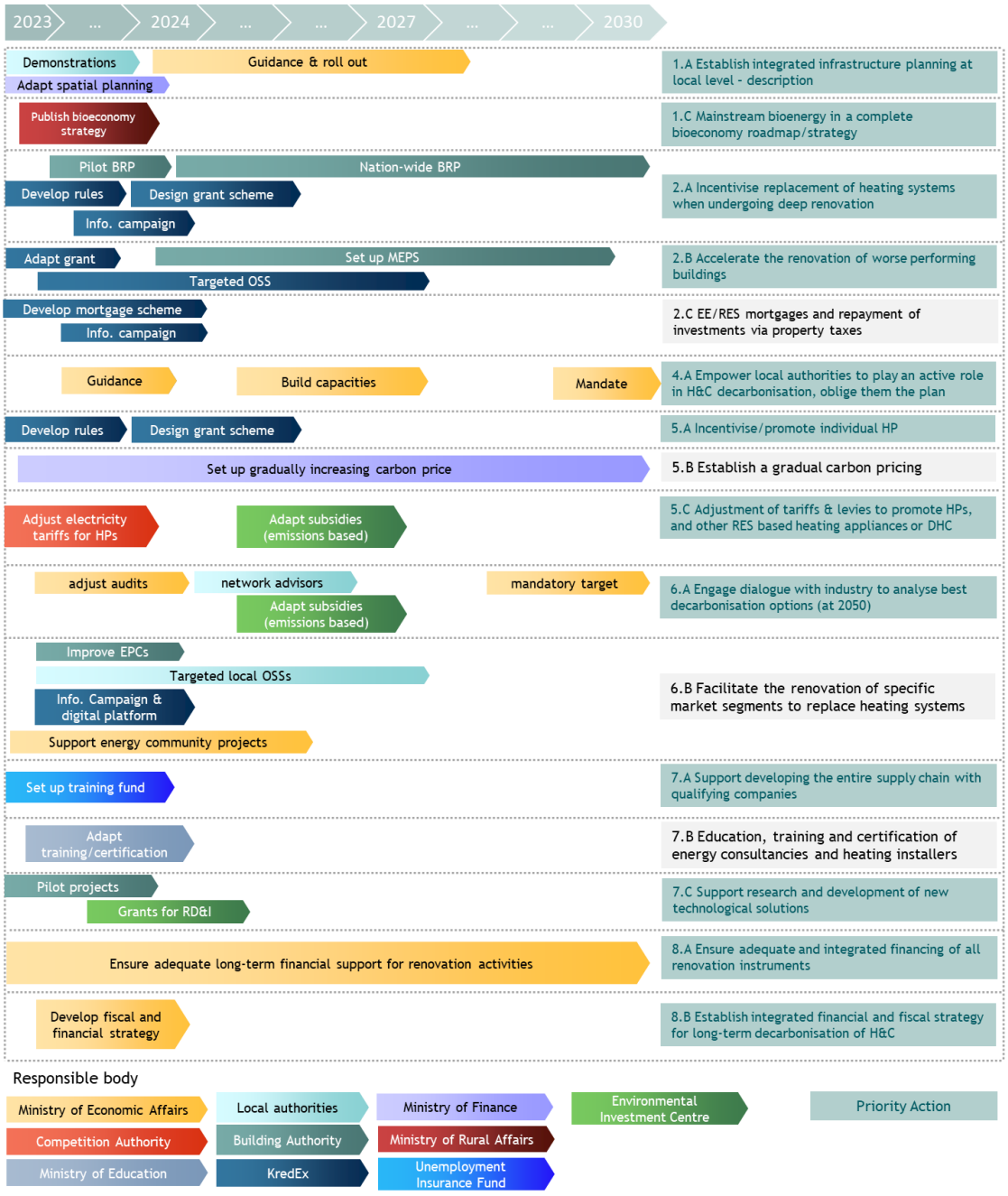
Indicator	Push towards local heating and cooling pathway
Technology mix development	
New installed capacity (2022-2050)	2.70 GW
Heat production in 2050	
% district	*2%*
% local	*64%*
% industrial	*34%*
Cooling production in 2050	
% district	*6%*
% local	*94%*
Fuel consumption in 2050	10.6 TWh
Electricity	*2.8 TWh*
Biomass	*7.93 TWh*
Investment needs	
Total (2022-2050)	**€18,027M**
H&C technologies	*€1,236M*
DHC infrastructure	*€52M*
Building renovation	*€16,739M*
Socioeconomic impact	
Average heating costs for households in 2050	74 €/MWh
Average cooling costs for households in 2050	113 €/MWh
H&C activities as % of GDP in 2050	3.0%
H&C employment as % of total employment in 2050	2.4%
Avg. change in disposable income	- €236M
Public revenues/taxes in 2050 as % of total taxes	2.4%
Stakeholder perception of risk	
Risk perception	Riskiest scenario, stakeholders moderately negative about it. Main risks are energy market related (security off supply in economically vulnerable areas and, electricity grid development, and unexpected fuel price increase)

This scenario presents heating and cooling demand coverage shift from district heating and cooling towards local heating and cooling. The technology mix remains the same as the **technology neutral scenario** for each market participant. Only a shift of heating and cooling consumers from **DHC to LHC** will take place.

All residential (single houses and apartment buildings) and services/commercial sector consumers in urban and non-urban areas will be connected to the DH networks. Limited DH network will remain which is already being operated with high temperature industrial waste heat. DC infrastructure would remain as limited as it is today. All new cooling demand in urban and non-urban areas will be covered by local cooling solutions. Hence cooling scenario under local infrastructure push scenario remains the same as BAU scenario and the technology distribution is not discussed due to the scenario's overarching nature.

Since this scenario discusses the shift towards LHC from DHC infrastructure, industrial heating demand coverage will remain same as the **technology neutral scenario** and is not discussed again because of the scenario's overarching nature.

9.2 Timeline for actions for the LHC pathway


2023
...
2024
...
...
2027
...
...
2030
Demonstrations
Guidance & roll out
Adapt spatial planning
1.A Establish integrated infrastructure planning at local level - description
Publish bioeconomy strategy
1.C Mainstream bioenergy in a complete bioeconomy roadmap/strategy
Pilot BRP
Nation-wide BRP
Develop rules
Design grant scheme
Info. campaign
2.A Incentivise replacement of heating systems when undergoing deep renovation
Adapt grant
Set up MEPS
Targeted OSS
2.B Accelerate the renovation of worse performing buildings
Develop mortgage scheme
Info. campaign
2.C EE/RES mortgages and repayment of investments via property taxes
Guidance
Build capacities
Mandate
4.A Empower local authorities to play an active role in H&C decarbonisation, oblige them the plan
Develop rules
Design grant scheme
5.A Incentivise/promote individual HP
Set up gradually increasing carbon price
5.B Establish a gradual carbon pricing
Adjust electricity tariffs for HPs
Adapt subsidies (emissions based)
5.C Adjustment of tariffs & levies to promote HPs, and other RES based heating appliances or DHC
adjust audits
network advisors
mandatory target
Adapt subsidies (emissions based)
6.A Engage dialogue with industry to analyse best decarbonisation options (at 2050)
Improve EPCs
Targeted local OSSs
Info. Campaign & digital platform
Support energy community projects
6.B Facilitate the renovation of specific market segments to replace heating systems
Set up training fund
7.A Support developing the entire supply chain with qualifying companies
Adapt training/certification
7.B Education, training and certification of energy consultancies and heating installers
Pilot projects
Grants for RD&I
7.C Support research and development of new technological solutions
Ensure adequate long-term financial support for renovation activities
8.A Ensure adequate and integrated financing of all renovation instruments
Develop fiscal and financial strategy
8.B Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C
Responsible body
Ministry of Economic Affairs
Local authorities
Ministry of Finance
Environmental Investment Centre
Priority Action
Competition Authority
Building Authority
Ministry of Rural Affairs
Ministry of Education
KredEx
Unemployment Insurance Fund

10 Technology neutral pathway Action Plan

10.1 Pathway overview

Indicator	Technology neutral pathway
Technology mix development	
New installed capacity (2022-2050)	2.25 GW
Heat production in 2050	
% district	*24%*
% local	*42%*
% industrial	*34%*
Cooling production in 2050	
% district	*6%*
% local	*94%*
Fuel consumption in 2050	11.5 TWh
Electricity	*2.3 TWh*
Biomass	*9.99 TWh*
Investment needs	
Total (2022-2050)	**€18,128M**
H&C technologies	*€1,164M*
DHC infrastructure	*€53M*
Building renovation	*€16,739M*
Socioeconomic impact	
Average heating costs for households in 2050	68 €/MWh
Average cooling costs for households in 2050	110 €/MWh
H&C activities as % of GDP in 2050	3.4%
H&C employment as % of total employment in 2050	2.9%
Avg. change in disposable income	- €162M
Public revenues/taxes in 2050 as % of total taxes	2.6%
Stakeholder perception of risk	
Risk perception	Moderately more risky. Exposed to high energy market risk

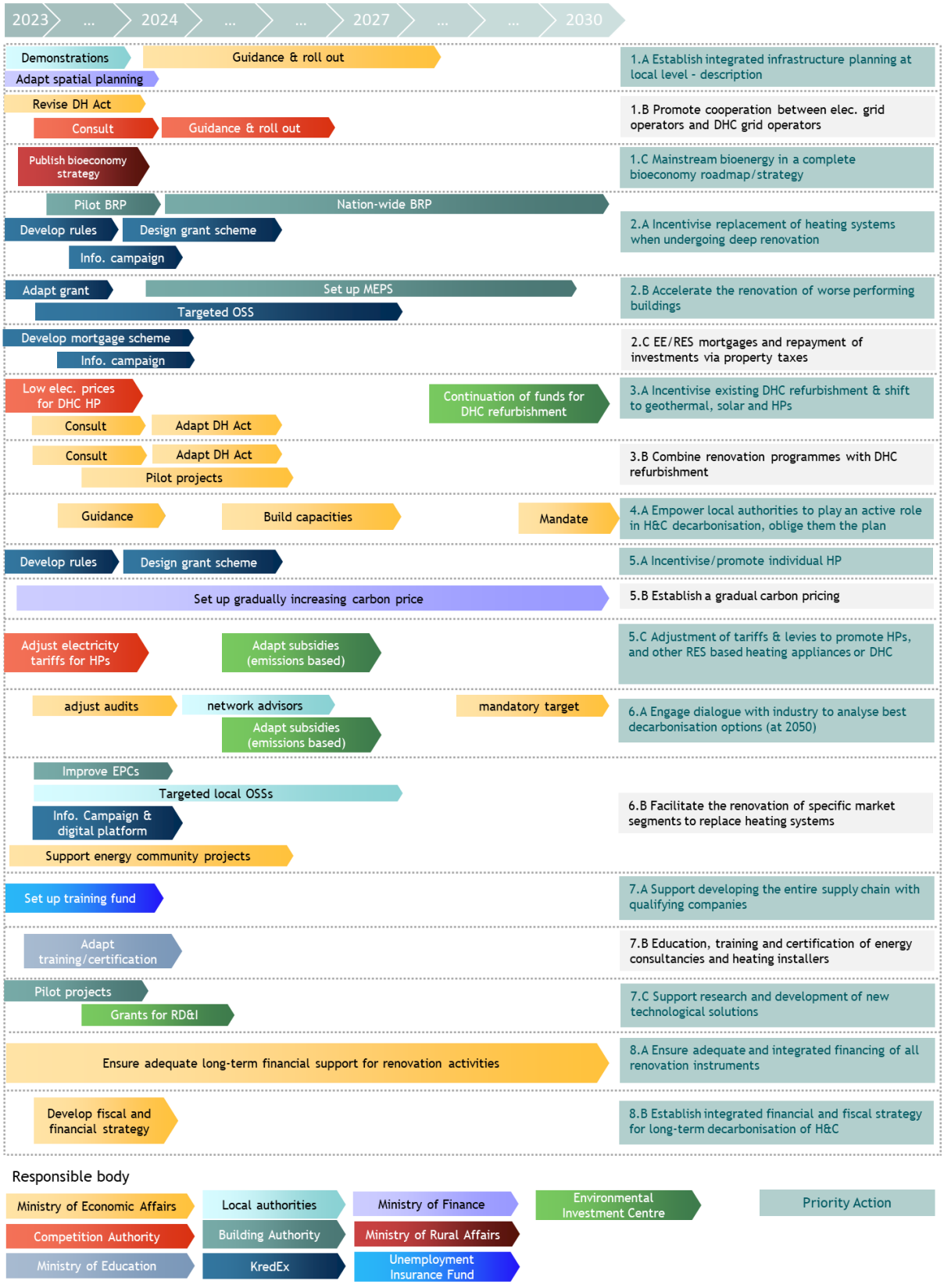
This scenario presents the heating and cooling technology shift to achieve a well-balanced technology share. It does not consider heating and cooling infrastructure shift, so heating and cooling demand coverage by local and district infrastructure will remain the same and only technology shift will take place. The local cooling technology solutions are based on the electrified solutions (individual/central air conditioners and central chillers) and hence will remain the same. For this reason, the technology mix is not discussed again in this scenario as they will overlap with the BAU scenario.

There will be an increased use of heat pumps in single houses and apartment buildings present in urban areas. There will be a preference towards biomass-based heating for single houses and apartment buildings in non-urban areas due to high biomass availability.

In DH, biomass share will remain the main fuel, while electric solutions (heat pumps in combination with waste heat sources) and direct use of waste heat from electrolysers and chemical process industries will make up for the rest of the demand. Use of waste/excess heat from industries, electrolysers, power plants, sewage water systems, and utilization of ambient resources (e.g., water bodies) via heat pumps is also assumed.

Heat coverage will mainly take place by biomass boilers, heat pumps (air to water and water to water heat pumps), solar thermal and electric boilers for industry that operates less than 300 °C. The heat demand for the industrial temperature segments beyond 300 °C will be covered by biomass boilers in conjunction with small capacities of electric and hydrogen boilers as supporting technologies. Industrial cooling is not considered.

10.2 Timeline for actions for the Technology Neutral pathway



11 Recommendations to reduce the negative and increasing the positive environmental, social and economic impacts

The decarbonisation of heating and cooling in all pathways have negative and positive implications on the local environment, society and economy. In this chapter, the environmental, social and economic impacts are described broadly, with details on the relevance for each pathway. All these considerations should be taken into account when deciding which pathway to support on the long term.

11.1 Environmental impact

Overall, the pathways should have a positive impact on the environment. This is due to the **decrease in local/global emissions** with the replacement of fossil-based H&C with renewable/bio-based H&C and the reduction of total energy use from the energy efficiency improvements.[142] However, this environmental benefit can be hampered when electricity is sourced from bio-based energy. The massive **use of biomass for heating may have negative consequences for the environment**. The use of forest timber for energy leads to a reduction in biodiversity, soil erosion and reduction of carbon sink.[143] Depending on the type of biomass (virgin material, by-products, waste, …), its use may not be climate-neutral, as the full emissions taking the life-cycle into account suggest that it could have an overall negative climate impact. Restrictions on the use of biomass for heating may be necessary to prevent this negative impact on the environment.

Additionally, the use of heat pumps (which is implemented in all pathways) can lead to the **emission of hydrofluorocarbons (HFC)** due to refrigerant leakage, which can occur during operation and demolition.[144]

11.2 Social and economic impact

The required construction for the refurbishment of the DHC grid, instalment of HPs and building renovation can be a **spatial and auditorial nuisance for residents** of the renovated buildings and near the construction site. To reduce this nuisance, clear communication to relevant residents of the place and time of construction is important. Further, construction of heating systems can particularly be disturbing for residents during the winter period and therefore construction should be avoided during this season.[145] This is particularly a greater issue in the DHC pathway, which involves greater expansion of the DHC networks and heat storage. Further, **installing individual heat pumps in households will possibly reduce the amount of living space.** Therefore, the installation of individual heat pumps could be avoided in densely populated areas. This is particularly an issue in the LHC pathway, where a significant amount of heat pumps are installed in urban areas. The pathways have a positive social impact such that the reduction of fossil-based H&C will lead to **long-term health benefits**, such as reduction of respiratory diseases.

[142] Ravina, M. et al (2018). District heating system: evaluation of environmental and economic aspects.
[143] Wu et al. (2018). Bioenergy production and environmental impact.
[144] EC (n.d.). Heat pumps – technology and environmental impact.
[145] TNO & DBDH (2021). Best practices for planning and construction of thermal networks identified in the EU.

While the pathways have a positive impact on value added, the higher costs of renovation costs leads to an **overall short term negative impact on disposable household income** and also increases heating costs for companies. For low-income households, this is a greater concern in terms of **possibly exacerbating energy poverty**. Although, the increase in economic development will lead to both **indirect and direct employment**. Additionally, the transition to renewables/bioenergy removes Estonia's dependence on imported gas for heating purposes.

11.3 Overall impact by type of region

For most of the impacts, the degree of impact is similar for urban and non-urban areas. However, the impact of deforestation will only directly impact non-urban areas. The negative impact of reduction of living space due to the installation of heat pumps is greater due the denser population. Additionally, the increase in economic development and consequential employment is greater in non-urban areas where the required installation of heat pumps is greater in non-urban buildings.

Table 11-1 Environmental, social and economic impacts by type of region

		Urban	Non-urban
Environmental	Decrease in local emissions	+	+
	HFCs emissions via HPs	-	-
	Deforestation – decrease in biodiversity	0	-
	Deforestation – soil erosion	0	-
	Deforestation – Reduction in carbon sink	-	-
Social	Nuisance during construction	-	-
	Reduction in living space via HP installation	-	0
	Long-term health benefits	+	+
Economic	Decrease in disposable household income and increase in H&C costs for companies	-	-
	Decrease dependence on gas imports	+	+
	Increase in economic development and direct/indirect employment	+	++

Very unfavourable (--); Unfavourable impact (-); neutral/no impact (0); favourable impact (+); very favourable impact (++)

11.4 Recommendations to reduce negative impacts and increase positive impacts

The table below provides a summary of the recommendations on how to reduce the negative impacts and increase the positive impacts described for this pathway.

Table 11-2 Recommendations to reduce negative impacts and increase positive impacts

Type of impact	Time of impact	Impact	Relevant for	Recommendation
Environmental	O	Decrease in local/global emissions when replacing fossil-based H&C and/or reducing total energy use	All pathways, particularly the All electric pathway (i.e. no biomass use)	Ensure that renewable H&C solutions are competitive and energy efficiency improvement is incentivised
	O&D	HFC emissions from HPs	All pathways	Adopt strict guidelines for regular maintenance

Type of impact	Time of impact	Impact	Relevant for	Recommendation
				Address illegal trade of HFCs[146]
	O	Deforestation via biomass use – decrease of biodiversity, soil erosion, reduction of carbon sink	DHC, LHC and Technology neutral	Adequate regulation and management of the use of forest timber for energy (cascading principle) Establish clear limits to biomass quantities that can be extracted Increase the share of alternative sources, such as geothermal energy, or more HP in DHC
	O	Biomass use for heating may not be a climate-neutral, when taking the life-cycle into account	DHC, LHC and Technology neutral	
Social	C	Spatial, auditorial and thermal nuisance for residents nearby construction/renovation	All pathways, particularly DHC due to expansion of DHC	Ensure that residents are given clear communication of when and where construction is occurring Ensure utility providers are well coordinated to reduce disruptions[147] Avoid construction during the winter period[148]
	O	Reduction of living space due to the installation of local HPs	Mainly LHC	Avoid installing local HPs in urban, densely populated areas
	O	Health benefits from reduced air pollution from fossil fuel use (e.g. reduction of respiratory diseases, heart attacks, death) [149]	All pathways	Ensure that RES H&C solutions are competitive with fossil-based H&C solutions
Economic	O	Decrease in disposable household income (can lead to energy poverty) and increase in H&C costs for companies	All pathways, most significant for All electric	Ensure sufficient financial measures to support low-income households and SMEs
	O	Decrease dependence on gas imports	All pathways	Ensure that RES H&C solutions are competitive with natural gas H&C solutions
	C&O	Increase in economic development and direct/indirect employment	All pathways, most significant for DHC	Ensure that, nationally, there are enough highly skilled professionals in the H&C and construction sector

C= construction; O=operation; D=demolition

Positive impact ; negative impact

[146] Nordic Council of Ministers (2021). Illegal trade of HFCs.
[147] TNO & DBDH (2021). Best practices for planning and construction of thermal networks identified in the EU.
[148] Ibid.
[149] Buonocore, J. et al (2016). Health and climate benefits of offshore wind facilities in the Mid-Atlantic United States.

12 Conclusions and general recommendations

This final section provides an overview of the project outcomes and the resulting recommendations based on these outcomes. These recommendations include no-regret actions, pathway selection and areas for further analysis.

12.1 Outcomes of the project deliverables

Table 12-1 provides an overview of the results of each pathway, including the modelling results, the socioeconomic impact assessment, the risk analysis, sensitivity analysis and the action plans.

Table 12-1 Summary of the pathway results

Indicator	DLV	All Electric	DHC	LHC	Technology neutral
Summary		*This is the most ambitious pathway with a full-scale deployment of electricity-based H&C, which results in the highest investment costs for H&C technology development. This pathway has is carbon neutral and completely phases out biomass use. Key actions focus on ensuring adequate, integrated H&C planning, promoting of electricity based solutions in industry and buildings as well as strengthening capacity in the H&C sector.*	*The pathway is categorised by a focus on district heating and cooling. The pathway is the second most expensive pathway due to the high investment requirements for DHC infrastructure development. Although the pathways results in no carbon emissions by 2050, the pathway has the highest reliance on biomass. The pathway has overall positive socioeconomic impacts and leads to the lowest H&C costs for households. However, the pathway is considered risky by stakeholders as it is considered economically not feasible.*	*The pathway is categorised by a focus on local heating and cooling. The pathway has the second lowest investment needs. Although the pathways results in no carbon emissions by 2050, the pathway is highly reliant on biomass. There are feasibility concerns due to the high spatial requirements and waste of resources due to decommissioning of the existing DHC system.*	*Based on the technology neutrality, different technologies emerge, with a greater deployment of local H&C solutions. Although the pathways results in no carbon emissions by 2050, the pathway is highly reliant on biomass. The pathway has the lowest investment requirements.*
Model description	3	All infrastructure and technologies are based on electric solutions (both district & local). The electricity needs will be covered by renewable electricity and will be added progressively depending on the resource availability, TRL, financial feasibility and access. The technology development mainly consists of heat pumps (A/A, W/W and ground-sourced HPs) in district and local systems. Biomass is faded out by 2050	All possible H&C requirements will be based on district H&C solutions. Energy sources are based on technologies that are considered sustainable and usable for district heating systems. Local heating solution are as limited as possible (only placed where district solutions are not in line with the balance of the pillars).	Mainly single house-based solutions and local autonomous systems. The district grid will be phased out while shifting all the possible demand towards local solutions. Industry needs are integrated through industrial clusters, which allows local solutions to be integrated with industry.	No preference towards any type of infrastructure (local and district) with the flexibility of using any kind of renewable technology, in accordance with the sustainability pillars.
New installed capacity (2022-2050)		3.87 GW	2.20 GW	2.70 GW	2.25 GW
Heat production in 2050					
% district		*24%*	*48%*	*2%*	*24%*
% local		*42%*	*18%*	*64%*	*42%*
% industrial		*34%*	*34%*	*34%*	*34%*
Cooling production in 2050					
% district		*6%*	*46%*	*6%*	*6%*
% local		*94%*	*54%*	*94%*	*94%*
Fuel consumption in 2050		7.1 TWh	12.1 TWh	10.6 TWh	11.5 TWh
Electricity		*6.6 TWh*	*1.9 TWh*	*2.8 TWh*	*2.3 TWh*
Biomass		*0 TWh*	*11.37 TWh*	*7.93 TWh*	*9.99 TWh*
CO2 emissions in 2050*		0 ktCO2	0 ktCO2	0 ktCO2	0 ktCO2
Expansion of DH network		0 km	764 km	0 km	0 km
Expansion of DC network		33 km	315 km	33 km	33 km
Increase in heat storage		1311 MW	2610 MW	114 MW	1311 MW
Total investment needs (2022-2050)	4	**€19,066M**	**€18,789M**	**€18,027M**	**€17,837M**
H&C technologies		*€2,274M*	*€1,038M*	*€1,236M*	*€1,045M*
DHC infrastructure		*€53M*	*€1,012M*	*€52M*	*€53M*
Building renovation		*€16,739M*	*€16,739M*	*€16,739M*	*€16,739M*
Average heating costs for households in 2050		97 €/MWh	62 €/MWh	74 €/MWh	68 €/MWh

Indicator	DLV	All Electric	DHC	LHC	Technology neutral
Average cooling costs for households in 2050		112 €/MWh	114 €/MWh	113 €/MWh	110 €/MWh
H&C activities as % of GDP in 2050		3.2%	3.8%	3.0%	3.4%
Employment in 2050 due to HC activities (jobs)		15216	18064	14133	16004
Avg. change in disposable income		- €389M	- €194M	- €236M	- €162M
Public revenues/taxes in 2050 as % of total taxes		2.6%	2.9%	2.4%	2.6%
Risk analysis	5	Medium risk scenario. Very exposed to electricity grid development and HP technology investment reduction in Estonia	Less risky scenario, overall liked by stakeholders	Riskiest scenario, stakeholders moderately negative about it. Main risks are energy market related (security off supply in economically vulnerable areas and, electricity grid development, and unexpected fuel price increase)	Moderately more risky. Exposed to high energy market risk
Sensitivity analysis - Impact of fuel prices on H/C prices (Elasticity)**	6	0.53	0.54	0.62	0.58
Sensitivity analysis - Impact of technology investment costs on H/C prices (Elasticity)**		0.14	0.10	0.08	0.09
Priority actions (shared priorities in bold)	7	**1.A. Establish integrated infrastructure planning at local level** 1.B. Promote cooperation between electricity and DHC grid operators **2.A. Incentivise replacement of heating systems when undergoing deep renovation** **2.B. Accelerate the renovation of worse performing buildings** 3.A. Incentivise existing DHC refurbishment & shift to RES **4.A. Empower local authorities to play an active role in H&C decarbonisation & planning** 5.A. Incentivise/promote individual HP when most appropriate option **5.C. Adjustment of markets and fiscal mechanisms to promote RES H&C** 6.A. Engage dialogue with industry to analyse best decarbonisation options (at 2050) **7.A. Support developing the entire supply chain with qualifying companies** **7.C. Support research and development of new technological solutions** **8.A. Ensure adequate and integrated financing of all renovation instruments** **8.B. Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C**	**1.A. Establish integrated infrastructure planning at local level** 1.C. Mainstream bioenergy in a complete bioeconomy roadmap/strategy **2.A. Incentivise replacement of heating systems when undergoing deep renovation** **2.B. Accelerate the renovation of worse performing buildings** 3.A. Incentivise existing DHC refurbishment & shift to RES **4.A. Empower local authorities to play an active role in H&C decarbonisation & planning** **5.C. Adjustment of markets and fiscal mechanisms to promote RES H&C** 6.A. Engage dialogue with industry to analyse best decarbonisation options (at 2050) **7.A. Support developing the entire supply chain with qualifying companies** **7.C. Support research and development of new technological solutions** **8.A. Ensure adequate and integrated financing of all renovation instruments** **8.B. Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C**	**1.A. Establish integrated infrastructure planning at local level** 1.C. Mainstream bioenergy in a complete bioeconomy roadmap/strategy **2.A. Incentivise replacement of heating systems when undergoing deep renovation** **2.B. Accelerate the renovation of worse performing buildings** **4.A. Empower local authorities to play an active role in H&C decarbonisation & planning** 5.A. Incentivise/promote individual HP when most appropriate option **5.C. Adjustment of markets and fiscal mechanisms to promote RES H&C** 6.A. Engage dialogue with industry to analyse best decarbonisation options (at 2050) **7.A. Support developing the entire supply chain with qualifying companies** **7.C. Support research and development of new technological solutions** **8.A. Ensure adequate and integrated financing of all renovation instruments** **8.B. Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C**	**1.A. Establish integrated infrastructure planning at local level** 1.C. Mainstream bioenergy in a complete bioeconomy roadmap/strategy **2.A. Incentivise replacement of heating systems when undergoing deep renovation** **2.B. Accelerate the renovation of worse performing buildings** 3.A. Incentivise existing DHC refurbishment & shift to RES **4.A. Empower local authorities to play an active role in H&C decarbonisation & planning** 5.A. Incentivise/promote individual HP when most appropriate option **5.C. Adjustment of markets and fiscal mechanisms to promote RES H&C** 6.A. Engage dialogue with industry to analyse best decarbonisation options (at 2050) **7.A. Support developing the entire supply chain with qualifying companies** **7.C. Support research and development of new technological solutions** **8.A. Ensure adequate and integrated financing of all renovation instruments** **8.B. Establish integrated financial and fiscal strategy for long-term decarbonisation of H&C**
Environmental and social impacts		Decrease in local/global emissions and no biomass-related environmental impacts. Increased health benefits due to reduced air pollution	Decrease in local/global emissions and increase in related health benefits. However, risk of deforestation due to biomass use and possibly not carbon-neutral when taking the life-cycle into account. Local nuisance for residents due to expansion of DHC.	Decrease in local/global emissions and increase in related health benefits. However, risk of deforestation due to biomass use and possibly not carbon-neutral when taking the life-cycle into account. Reduction in living space due to installation of local HPs.	Decrease in local/global emissions and increase in related health benefits. However, risk of deforestation due to biomass use and possibly not carbon-neutral when taking the life-cycle into account.

*Biomass use for heating may not be climate-neutral when taking the life-cycle into account. The risk of deforestation from biomass use for heating could lead to reduction in the carbon sink
**Elasticity: Sensitivity result parameter e.g., Elasticity 0.5 means that, when the fuel prices increase by 1% the price for H/C will increase by 0.5%

12.2 Recommendations

Based on the outcomes of the project deliverables and the action plan in this report, the project team proposes a number of recommendations, including: no-regret actions, scenario selection and recommendations for further analysis.

Disclaimer: *the different pathways have been designed on the needed infrastructure rather than on the resources used to produce heat and cold. For each of these "infrastructure scenarios", we had to make a choice on the energy mix behind (cf. DLV3). However, an energy mix is not bound to its "infrastructure scenario", and can evolve to decrease the negative impacts. Hence, the analysis of socio-economic impacts must take these aspects into consideration. E.g. the DHC scenario is now built on a massive use of bioenergy, while DH supply could also be provided by large heat pumps (ideally geothermal systems). Negative impacts, if they are not linked to the infrastructure, should not be considered inherent to the scenario(s).*

12.2.1 No regret actions

Across all of the pathways, there are a number of actions that are necessary to enable the decarbonisation of the H&C sector, including:

- **Actions to streamline the H&C planning process**. The same intensity and commitment is required for all pathways, as this is a central piece for a long term decarbonisation. Of course, planning should be tailored to the selected pathway(s), for instance, focusing on integration of planning for H&C and electricity in the All electric pathway and mainstreaming bioenergy in the bioeconomy strategy in the pathways reliant on bio-based heating.
- **Mainstreaming bioenergy in a complete bioeconomy strategy**. The current energy system in Estonia relies massively on bioenergy, hence, whatever the expectations in the future, the use of biomass resources should be regulated and/or promoted in coherence with a global bio-economy vision.
- **Phasing the renovation wave and integrating renewable supply**. All pathways require the Renovation Wave to be effectively implemented in order to make buildings sufficiently energy efficient (to lower H&C demand) and integrated with renewable H&C systems. Synchronisation of energy performance action and switch to renewable is key, and should be tailored to each pathway to ensure appropriate design and heating system efficiency.
- **Actions to refurbish the existing DHC infrastructure, where feasible**. For the pathways where DHC is still relevant (all but the LHC pathway), refurbished DHC infrastructure is required to reduce heat/cool demand as well as increase renewable integration in the DHC system.
- **Actions to develop the required new DHC infrastructure, where appropriate**. For the pathways where DHC is still relevant and further developed (all but the LHC pathway), highly performant infrastructure (4th or 5th generation) is required to reduce heat/cool demand as well as increase renewable integration in the DHC system.
- **Empower local authorities to play an active role in H&C decarbonisation**. All local authorities (cities, municipalities) play a crucial role in the planning of H&C systems. Empowering them with clear guidance on H&C decarbonisation planning, dedicated financing and administrative support plays a key role in encouraging them to play an active role in H&C decarbonisation.
- **Set up a level playing field and create a market for renewable alternatives**. These actions should be tailored to the pathways' focused alternative H&C technologies to create a level playing field with traditional fossil-based H&C technologies (and possibly bio-based heating

system for the All Electric pathway) in order for these alternative technologies to achieve economies of scale. Market development on the Estonian territory is crucial for some technologies to compete (e.g. HP in Estonia are still costly, only a market ramp up would lead to prices aligned with international markets).

- **Actions to empower industry and household consumers to decarbonise H&C systems**. H&C consumers (industry and households) require empowerment, beyond the energy renovation activities, in order to be well-informed and encourage to participate in H&C decarbonisation. They should all be provided technical assistance to ensure well-informed choices, in line with their needs and socio-economic situation. Dedicated actions would be required for low-income households.
- **Actions to strengthen professional skills in the H&C market**. The shortage of skilled labour required for decarbonising heating and cooling needs to be addressed in terms of improving skills within the existing H&C supply chain. All professionals should be considered.
- **Mobilise and mainstream financing and funding**. Given that various actions include different financing schemes for the H&C sector and consumers, actions are required to ensure that the necessary financing and funding are efficiently mobilised and mainstreamed, on the long term (and not only until 2027, end of the RRP).

12.2.2 Government needs to establish a clear, long-term strategy for heating and cooling decarbonisation

In all of the pathways, heating and cooling decarbonisation requires a roll-out of a significant amount of new H&C capacity as well as building renovation, which also entails a significant amount of public and private financing. In order for the H&C sector, consumers and local authorities to make well-informed decisions on renovation and H&C decarbonisation, the government needs to create a clear, stable and long-term vision for heating and cooling. This strategy does not need to mirror this action plan, but it should provide a clear set of objectives, policies and financing schemes.

12.2.3 Pathway selection

The detailed results for each pathway can be found in Table 12-1.To support selecting the most appropriate pathway, we recommend using the following criteria described in the table below. Scenario performance is quantified by the overall scenario performance score. For the overall scenario score, the performance indicators scores are multiplied by the given performance indicator's weight and then the sum of these scores is divided by the total number of the performance indicators. Indicator weights have a range 1-5 (indicator with weight 5 being the most important one) are assigned based on their sensitive nature to the scenario deployment (weights assigned by project teams' expert opinion).

Table 12-2 overview of indicators for pathway selection

Indicator	BAU	All electric	DHC	LHC	Tech. neutral	Weights
New installed capacity (GW) (2022-2050)	1.9	3.866	2.197	2.7	2.248	1
Input energy/Fuel consumption (TWh)	13.4	7.1	12.1	10.6	11.5	5
Biomass dependency (use) by 2050 (TWh)	12.99	0	11.37	7.93	9.99	5
GHG emissions in 2050 (kt $CO_{2eq.}$)	12	0	0	0	0	5
Total investment requirements (2022-2050)	€17,621M	€19,066M	€18,789M	€18,027M	€17,837M	1
Average heating costs for households in 2050 (EUR/MWh)	62	97	62	74	68	5
Average cooling costs for households in 2050 (EUR/MWh)	113	112	114	113	110	3
Impact of fuel prices on H/C prices (*Elasticity)	0.59	0.53	0.54	0.62	0.58	5
Impact of technology investment costs on H/C prices (*Elasticity)	0.08	0.14	0.10	0.08	0.09	2
H&C activities as % of GDP in 2050	3.5%	3.2%	3.8%	3.0%	3.4%	2
Employment in 2050 due to HC activities (jobs)	16367	15216	18064	14133	16004	2
Scenario risk perception by stakeholders	Low to medium	Medium risky	Less risky	Riskier	Moderately more risky	5
Overall score	**10.8**	**13.1**	**12.8**	**10.7**	**12.3**	
Overall scenario ranking	**4th**	**1st**	**2nd**	**5th**	**3rd**	
CAPEX vs. Fuel driven options						
Average heating costs for HH in 2050 (EUR/MWh) - 2021** fuel prices	62	97	62	74	68	
Average heating costs for HH in 2050 (EUR/MWh) - 2022** fuel prices	94	105	87	102	92	
Increase in average heating costs based on fuel cost increase (EUR/MWh)	**32**	**8**	**25**	**28**	**24**	
Legend (Indicator score by colour)						
Colour						
Score	**1**	**2**	**3**	**4**	**5**	

**Elasticity: Sensitivity result parameter e.g., Elasticity 0.5 means that, when the fuel prices increase by 1% the price for H/C will increase by 0.5%*

***Electricity (based on average Nord pool prices for the first 2 quarters of 2022): 137 EUR/MWh*

***Biomass (growth rate based on the firewood price comparison of 2022 2nd quarter data with 2021 2nd quarter data): 2.5 times price*
increase (22 EUR/m3 in 2nd quarter in 2021 vs. 55 EUR/MWh in 2nd quarter in 2022)

On **carbon emissions**, all scenarios, except BAU, rely on a fully decarbonised electricity system by 2050, and on zero emitting bioenergy. None of the scenarios relies on fossil energy in 2050. Hence, they should all have the same score. Of course, the All Electric scenario relies on the complete decarbonisation of the electricity system, while the other scenarios are less sensitive to the achievements of electricity decarbonisation. If the electricity system faces difficulties to decarbonise on the long term, it would probably be cautious to slow down the trend towards the All Electric scenario. On the other side, the zero emission of the other scenarios relying more on bioenergy are built the assumption that all bioenergy remains sustainable and is still considered carbon neutral. This could possibly evolve in the future, and therefore leading to increase the interest of the All Electric scenario.

The **use of bioenergy** is a major concern for the DHC and Technology neutral scenarios, as its use would be massive. It would also be a concern for the LHC, as a more local use is less controllable and could lead to adverse socio-environmental effects. Assuming the fully decarbonised electricity system does not rely on bioenergy, the only scenario without impact on a bio-based economy would be the All Electric. The use of bioenergy is a major concern given the emerging bioeconomy which will progressively increase the use of biomass for other purposes than energy, possibly increasing the pressure on this limited resource. If biomass consumed today may be considered to be sustainable, the increased pressure on the resource due to increasing consumption, exacerbated by its use as bio-material, will possibly compromise its sustainable character.

Energy efficiency or fuel consumption of the All Electric depends also on the Primary Energy Performance (PEF) of the electricity system. Assuming this PEF is high (high conversion efficiency), then the All Electric is by far the most efficient, if and only if HPs are appropriately designed, installed and operated (leading to high SPF >3). Such high efficiency is only possible with a performant building stock, emphasising the crucial need to combine building renovation to significantly improve its energy performance and the switch to renewable-sourced heat pumps (renewable-based electricity and renewable heat sources, such as air, geothermal, sea or river water). The efficiency of the other scenarios depends on the level of HPs penetration (the more HP the more efficient).

The **consumption of electricity** indicates the level of intervention required to adapt the electricity grid. The more electricity is consumed, the more potential grid reinforcement or adaptation will probably be needed. Even though there are no quantitative figures regarding the cost of electricity grid adaptation, it is assumed that the All Electric scenario will require more adaptation than the others.

Regarding the **average heating cost**, deploying largely HPs is more costly than using local bioenergy (LHC) or large scale bioenergy plants (DHC and Tech neutral). Hence, the All electric is the most expensive solution, also since HP deployment depends on market maturity, and electricity price depends on the electricity system. However, an important parameter which is currently difficult to factor in is the possible price volatility (and increase) of bioenergy. Its current price is very low, but could significantly increase if bio-economy deploys at EU scale according to the current expectations. Scenarios relying on bioenergy could also face heating cost hurdles.

Regarding the **average cooling cost**, there is no major difference between the scenarios.

Regarding **H&C employment rates**, the DHC scenario creates the higher number of new jobs, for the installation, refurbishment, operation and maintenance of DH networks. HP (in All Electric and Local scenarios) installation also offers a lot of local jobs during the installation phase, but, since the day-to-day management of these systems is carried out by the owners of the systems (mainly households), there are not many jobs created for operation, except when it is necessary to order seasonal maintenance from specialised companies.

Risk perception seems to be lower for DHC scenario and it was perceived less risky by most of the stakeholders. Stakeholders perceive the BAU scenario (maximum use of bioenergy) of low to medium risk, where the conventional heating systems will not pose any new risks, but bioenergy's future climate and economic impacts will result in challenges. All-Electric scenario was projected as a medium

risk scenario as it is very exposed to electricity grid development and HP technology investment reduction in Estonia.
Technology Neutral scenario was announced as moderately riskier as it is exposed to high energy market risks. LHC scenario was found to be the riskiest scenario as stakeholders were in general negative about it. As its main risks are energy market related (security of supply in economically vulnerable areas and, electricity grid development, and unexpected fuel price increase) and the abandonment of the well-developed DHC infrastructure. In conclusion of risk perception, the mix of DHC and All-Electric scenarios will serve better to achieve a carbon-neutral H&C system in Estonia.

The **investment required for heating systems** is important for massive HP deployment. This would require a cautious and adequate approach to be cost-effective. Preparation is required to ensure a smooth and adapted roll out, possibly increasing the coordination efforts.

The **investment required for the infrastructure** is important for both refurbishment and new network deployment. This would also require a cautious and adequate approach to be cost-effective. Preparation is also required to ensure a smooth and adapted deployment of DHC, increasing the coordination efforts.

The **negative environmental and social impacts** are higher for scenarios relying more on bioenergy. Particularly, for the DHC pathway, the extension of DHC networks is a nuisance for residents in affected areas and for the LHC pathway, the installation of local heat pumps reduces living space.

Lastly, each scenario may integrate differently the **7 guiding principles** or pillars for carbon neutral heating and cooling :

Table 12-3. Pillars and their integration in the model

Pillar	Scenario integration
Sustainability	All scenarios are renewable-based, and hence a similar impact on sustainability. However, the scenarios relying more on bioenergy have a higher likelihood to compromise sustainability
Economically reasonable model	This pillar should encompass the average energy cost for households, but also the more macro employment criteria, to consider the global economic balance.
Energy market integration	All scenarios should implement actions towards more energy system integration, but with different intensities. E.g. DHC in the DHC scenario should play a bigger role in system integration, compared to local units in the local scenario.
Energy efficiency	Cf. point above
Security of supply	All scenarios rely on local/national resources, and hence have the same impact on SoS from a feedstock perspective. The All Electric scenario, given the seasonal impacts, is probably more sensitive to electricity SoS, as supplying H&C does not solve the balancing issue without flexible assets and storage. Hence, significantly increasing electricity demand for Heating during the winter period may impact SoS
Reducing energy poverty	The more Energy efficiency, the more “protection against” energy poverty (reducing the need will sustainability reduce the energy bill). Hence the All Electric is better placed. It

	should also come with an accelerated renovation of worse performing buildings (mostly occupied/owned by vulnerable households).
High level of digitalisation	All scenario should see the same level of digitalisation, but the DHC scenario will probably digitalise the DH network and its operation and not the end consumer, while the other scenarios will probably ensure more households digitalisation.

Overall pathway recommendation

To **conclude at this stage**, we recommend basing the Estonian H&C decarbonisation strategy on the **All Electric**, but also **partially on the DHC scenario**, which would mean:

- Electrifying the existing DHC, by integrating large scale heat pumps;
- Deploying new DHC, mainly in urban areas with high energy use density, but also in some semi-urban areas or more dense rural areas (e.g. village centrums);
- Complementing the supply with individual HP, in urban areas (where DHC are not applicable) and in non-urban areas;
- Leveraging the highest mix of energy sources, by using:
  - Massive RES-electricity for efficient DHC & individual HP (assuming a ramp up of RES in the electricity mix);
  - A mix of solar, geothermal and bioenergy to supply DHC (complemented by large HP);
  - Bioenergy for small share of individuals (where neither DHC, nor HP are applicable), based on locally produced resources.

Even though the All Electric may seem to be the most expensive when looking at the cost for final consumers, its combination with the DHC scenario allows to leverage several advantages:

- Adapting to the local situation and specific needs, as none of the scenarios could by its own comply with all specific needs (consumer heat consumption profile, temperature levels, etc.) and constraints (such as space constraint, disturbance during installation, etc.). In some places it may be more effective to deploy new DHC, or to refurbish existing DHC, while in other places deploying heat pumps may be more appropriate and cost-effective option;
- Increasing the number of options to decarbonise DHC, by speeding up the improvement of their performance, deploying large scale heat pumps to supply DHC and leveraging the use of low temperature energy sources (solar, geothermal or waste heat). The availability of local RES resources should also be used as a criteria for the deployment or refurbishment of DHC;
- Strengthening the resilience of the energy mix, given the fact that the All Electric is mainly CAPEX-driven, while the other 3 scenarios rely mainly on bioenergy, and are therefore fuel-driven. Fluctuations of energy prices on international markets will have a higher impact on bio-based scenarios. In the current context of the Ukraine-Russia crisis, prices have increased significantly, especially for bioenergy. Electricity prices have also increased significantly, but given the higher efficiency of heat pumps and hence lower electricity use, the price volatility has a higher impact on bio-based scenarios, while All Electric is less sensitive to price shocks;
- Combining different types of employment, with activities in installing new systems (e.g. new heat pumps) and at the same time operation and maintenance of large scale systems (e.g. DHC);

- Reducing significantly the pressure on biomass feedstocks, giving leeway to the deployment of a bioeconomy, and use of the same resource for material purposes, in order to maintain or improve the sustainability impact of its use;
- Improving the air pollution, and health conditions by reducing the number of bioenergy heating appliances (stoves and boilers);
- Building on existing assets, by refurbishment of the existing DHC, where improving their performance is technically feasible;
- Maximising the energy efficiency principle, thanks to the high share of heat pumps (which is the most efficient regarding primary energy use);
- Reducing the electricity grid reinforcement, by deploying DHC to reduce the distributed installations of heat pumps, but also thanks to the fact DHC can provide more effective flexibility services to the electricity system than a portfolio of small scale systems;
- Keeping the lowest cost for energy consumers on the long term, thanks to the flexibility to choose the most cost effective option (between DHC and All Elec), and given the fact that an increasing use of biomass feedstock due to a raising bio-economy will increase the pressure on bioenergy prices.

This mix of All Electric and DHC scenarios will require important investments, compared to the two other scenarios (LHC and Technology neutral) relying on the existing heating appliance stock, and therefore requiring lower investment on the short term. However, the replacement of these existing heating appliances will become inevitable over the 30 coming years, consequently reducing the difference between investment needs of the All Electric/DHC scenarios and the other scenarios. We assume a full decarbonisation of the electricity system by 2050. If for the climate neutral electricity strategy, a less renewable pathways is selected for electricity generation, we would then recommend increasing slightly the share of DHC (moving more from All Electric to DHC).

12.2.4 *Further analysis required*

In order for Estonia to reach it's overall decarbonisation targets, this study's analysis should be supplemented with further analysis which considers the integration of other sector decarbonisation plans (electricity, agriculture & forestry, transport, buildings and industry). This analysis should consider how the preferred H&C pathway impacts the other sectors. Further analysis is also required to assess the potential for renewable resources, which could be locally available and support the deployment of specific H&C options. Additionally, the present study should be repeated regularly to ensure that the preferred infrastructure is the optimal pathway to decarbonise H&C, given future developments such as changes in technology development and internal migration.

Regarding the decarbonisation of industrial H&C, a closer look should be given to direct electrification technologies (to replace high enthalpy processes) and to using renewable hydrogen and its derivatives as energy carrier, rather than bio-based sources.

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