European Commission

Deliverable 3.2

Final report on the analysis of the heating and cooling consumers and recommendations in terms of new business models and regulatory framework

Contract number PP-2041/2014

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Final report on the analysis of the heating and cooling consumers

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(as Subcontractor)

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1 BACKGROUND

The RHC-tender project aims at supporting the activities of the European Technology and Innovation Platform on Renewable Heating and Cooling (RHC-ETIP), by assessing and reporting on the degree of implementation of the various RHC Technology Roadmaps. In WP3 the focus has been on the **analysis of the renewable heating and cooling consumers**. Consumers, in this study, are defined as those individuals or organisations who have the capability and responsibility to make an investment decision on the installation of a heating or cooling system. This WP aimed to extend the available information about the consumer perspective of RHC technologies and business models originating from recent projects like FrONT, Entranze, RESCUE and STRATEGO, partly covering the knowledge gap that remains on consumer aspects. The unique focus of our study was to enhance the qualitative understanding of barriers and opportunities for RHC technologies, addressing multiple levels of analysis: individual decision-making (consumer level), social influences (intermediary level) and other contextual factors (conditional level). The current literature provides only limited insights on those aspects, since RHC technologies are not yet established as 'mainstream' solutions and the end-user perspective only tends to establish itself fully once a technology is actually widely implemented. Because of this lack of literature data, the work of WP3 complemented the available data from literature and relevant projects with additional qualitative research. It drew upon the insights of experts on the different consumer segments in different European countries to present what they believe will be the main barriers/enablers for the adoption of RHC technologies.

It is important to distinguish three levels among the stakeholders which affect barriers and opportunities in the area of heating and cooling:

- The "**consumer level**", which describes attitudes and behaviours of an individual consumer as a function of structural requirements and the players around him/her.

- The "**intermediary level**", which deals with the influence and activity spectrum of actors within the environment of the individual consumers.

- The "**conditional level**", which deals with constraints and opportunities for compliance within technological, political, economic and legal structures.

The analysis draws upon three main sources: 1) findings published in existing literature, 2) the experts' opinions and 3) validation workshops gathering views from various European stakeholders. In the initial stages of our study, a scoping exercise was carried out engaging one key representative for each RHC technology to contribute to a first understanding of key current issues regarding RHC and user acceptance in Europe. This guided us in designing our network of experts and preparing for the literature review. Five main activities have been initiated in the context of WP3 (see Figure 1):

- Activity 1 – establishment of an expert network on consumer barriers and enablers with sufficient coverage of European countries and RHC technologies;

- Activity 2 – Review of existing studies to capture knowledge and insights from previous studies;

- Activity 3 – Development of the final analytic structure as the analytical basis for the expert interviews and data analysis;

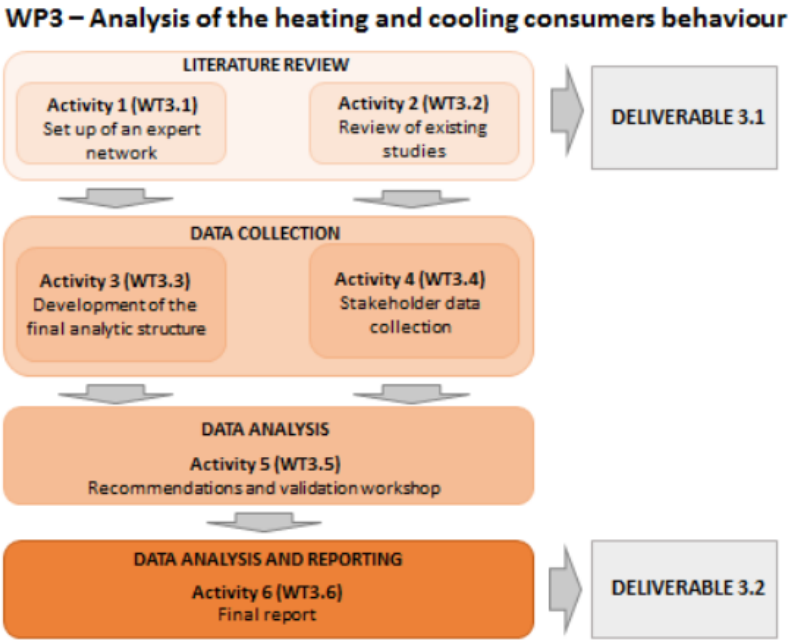
- Activity 4 – Stakeholder data collection by carrying out phone interviews with 34 experts across Europe;

- Activity 5 – Recommendations and validation workshop. Two workshops were organised (for Eastern and Western Europe respectively) to validate our main findings and capture views on policy recommendations feeding into the last part of this study.

The results of the scoping exercise, as well as the results of the selection criteria and design of the expert network (activity 1) and our literature review (activity 2) are reported in a previous deliverable (3.1).

The current deliverable (3.2) builds upon that previous report, first by providing the final analytical structure in Section 2. It then describes in Section 3 the survey methodology and design, including the final coverage of the expert network that was engaged. The results of the expert interviews are presented in Section 4. Section 5 gives a summary of the feedback received in the two European validation workshops, after which the main conclusions of the analysis are summarized in Section 6. Finally, Section 7 integrates findings on consumer aspects into a list of policy recommendations for stimulating the roll-out of RHC technologies in Europe.

Figure 1. Scheme summarising the activities related to WP3



2 THE ANALYTICAL STRUCTURE

2.1 Considerations from previous work (Deliverable 3.1)

The scoping exercise carried out under Deliverable 3.1 contributed to a first understanding of key current issues regarding RHC and user acceptance in Europe. An overview of reported key issues and opportunities emerging from the scoping exercise is presented below. We highlight the main points that guided our further research.

Our initial findings suggested that there is a primary emphasis for RHC on the residential sector and single-family homes in particular, with some relatively new trends towards the multi-family home segments and tertiary sector. Findings for RHC in Eastern Europe were found to be limited, and also detailed information about RHC business models for the RHC sector were largely lacking. Neither the interviews nor the project reports seemed to overly emphasise industrial clients yet. Also because of the importance of the residential market covering the largest share of heating and cooling demand[1], it was decided to further **focus on residential consumers** in this study. This implies a focus on the following RHC technologies:

- Solar thermal: Solar thermal systems for buildings
- Geothermal: Shallow geothermal heat pump systems
- Biomass: Biomass technologies for residential heating
- Heat pumps: Air-source heat pumps at the building level
- District Heating and Cooling: consumer aspects related to connecting to a DHC network

Both the scoping exercise and the literature review stressed similar barriers related to high investment costs, reliability, inconvenience, split-incentives, lack of awareness and competition from incumbent, fossil fuel-based heating and cooling suppliers. Economic aspects clearly emerge from the interviews and literature as influential drivers for RHC deployment, especially when linked with policy support schemes (e.g. subsidies, investment grants, preferential loans, carbon taxation etc.). However, whether the economic balance turns out to be negative or positive for RHC deployment depends on the country, technology-type, policy adapted and many other factors. Similarly, the incumbent infrastructure and energy mix plays a strong role, also able to either delay or support RHC growth.

Consequently, findings show that the **decision context** is important for understanding the consumer's decisions, as related factors will influence the choice to invest in RHC solutions. Besides the geographical context, this also concerns the housing context. For example, private decision-making in the residential sector (most relevant for shallow geothermal, heat pumps, small-scale biomass heating and solar thermal) is different

[1] Residential heating and cooling demand accounts for 45% of total heating and cooling demand, 37% and 18% shares for industry and tertiary sector respectively (state 2012), see https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_autre_document_travail_service_part1_v6_0.pdf

between homeowners and rental contexts, as well as between new buildings vs. renovations, and between single-family and multi-family houses.

Initial findings also highlighted the important role of **intermediaries** or 'gatekeepers': key professional stakeholders like installers, planners, local policy-makers and bankers. A better understanding was required on their role in influencing consumers, as well as the factors that may increase their own awareness and competences, for example by standardizing installation processes and associated trainings, or by enhancing information availability.

These main findings set the stage for developing an analytical framework for analysing consumers' decisions based on three levels: the conditional level reflecting the importance of the context in which decisions are made, the intermediate level reflecting the importance of influencing actors, and the consumer level reflecting the actual decision-making factors.

The Table below presents the key issues and opportunities arising from the scoping exercise (Deliverable 3.1).

Summary of key issues and opportunities emerging from the scoping phase
• Understanding added values and perceived risks for consumers • Understanding of consumer needs via customer engagement
• Understanding and mitigating various locked- in effects: e.g. limited time availability when replacing energy systems
• The *role of regulation*: energy efficiency regulation as a barrier to RHC. Need for an integrated view on regulation, financial support (e.g. credit lines, grants) and other policies (e.g. carbon taxing).
• Integrating RHC technologies into renovation: seizing the windows of opportunity
• Harvesting the 'low- hanging fruit': implementation of RHC technologies that already make (short-term) economic sense (e.g. tertiary buildings combining heating and cooling needs in one system)
• Understanding resistances from the incumbent regime
• Exploiting synergies among RHC technology groups
• Exploring the RHC potential for industrial users
• Increasing awareness and competences among key professional stakeholders: installers, planners, local policy-makers, bankers, etc. – Understanding the long-term benefits of RHC – Standardizing installation processes and associated trainings – Information availability, e.g. heating and cooling maps
• Mainstreaming RHC technologies and creating awareness for the public at large: – Marketing the technologies as affordable and reliable – Focus technological development on market- readiness – Attractive pilots should be made more visible

2.2 Additional findings from latest literature

The literature review of Deliverable 3.1 covered the following projects:

- FROnT (http://www.front-rhc.eu/) analysing existing support schemes and end user decision factors for renewable heating and cooling for different sectors (residential, non-residential, industry);

- ENTRANZE project (http://www.entranze.eu/) addressing the transition to nearly-zero-energy (residential) buildings;

- RESCUE (http://www.rescue-project.eu/) focussing on (tertiary) district cooling;

- STRATEGO (http://stratego-project.eu/) that aims to support national and local authorities in developing enhanced Heating & Cooling plans.

For developing the policy recommendations in Deliverable 3.2, we have used several sources. We drew significantly from additional deliverables of the FROnT project dealing specifically with policy findings (FRONT consortium b), from a recent report on renewable heating and cooling policies from the International Energy Agency (IEA, 2018a), and we included various other sources to underpin and illustrate particular policy recommendations and best practices (DELTA Energy & Environment, 2013; NORDSYN, 2015; NYSERDA, 2017). We also cross-checked the consistency of the interview results with the results from the FrONT project (FRONT consortium a) on the topic of consumer level decision-factors (see Section 6.2).

2.3 Final analytical structure

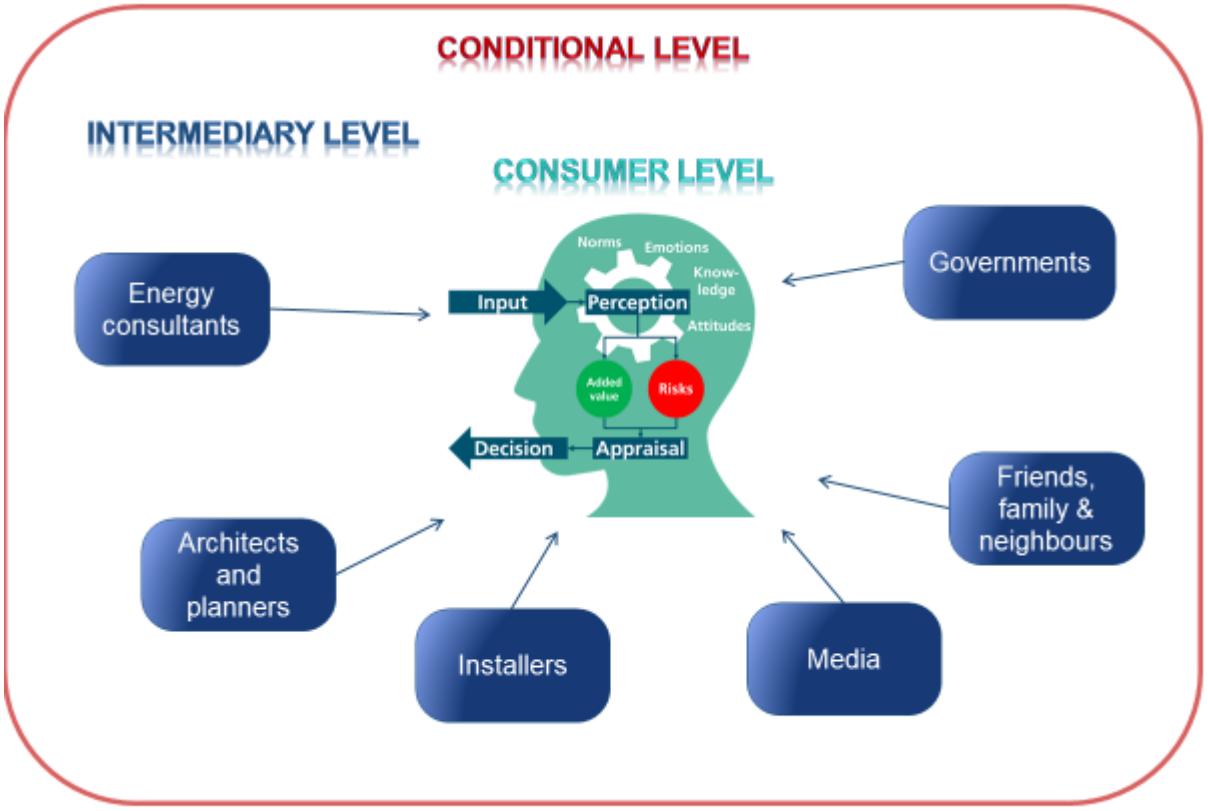
For the purpose of data collection and analysis, an analytical framework was developed. The development of the analytical framework was based on existing findings and theories, supplemented with the findings from the scoping exercise carried out under Deliverable 3.1. According to several theories about decision-making, human decision processes are often unconscious, automatic and less rational than often expected (see for example Jackson, 2005). The impact of those processes depends on how important and costly a decision is. Compared to daily grocery shopping, a private investment in a renewable energy system like a solar thermal system is a complex decision due to high costs, a large effort and the associated uncertainty of the outcome. Decision theories indicate that manifold information is aggregated and considered within the decision process. Yet, implicit influences as emotions or social norms can have a notable impact on it as well.

A decision for an investment in new technologies can be considered as a cognitive demanding process. Literature on investment behaviour reveals several factors that influence the investment behaviour of consumers. There are external factors ("hard factors") such as costs, payback time and government aid, while there are internal factors ("soft factors") such as environmental attitude, social status and social influence. The influence of those external and internal factors can vary depending respectively on the market diffusion level of a technology and on experiences existing in the consumers' personal environment. The consumers' personal environment includes relevant stakeholder (in this paper called intermediaries) which potentially provide information, experiences and/or services to the consumers. In addition, conditional factors like climate condition, renewable resource availabilities and predominant fossil technologies, occasions of decisions and building types affect the personal environment by shaping the potential RHC technologies range. The influence of external factors depends on the strength of internal and conditional factors. For instance, the influence of external factors like the costs or the payback time on the decision process could be smaller in case of a decision maker with a strong ecological attitude towards heating technologies than in case of a weaker ecological attitude.

The analytical framework integrates these conditional, external and internal factors. Following the considerations emerging from our initial analysis (see Section 2.1), the consumers' decision framework is analysed in three levels: Conditional level, intermediate level and consumer level (see Figure 2).

The analytical framework describes the dynamic setting under which consumers take decisions on RHC technologies. The starting point is that consumers base their decisions on their individual appraisal of pro and cons for different renewable and fossil heating and cooling systems. This appraisal results from the evaluation of a concrete set of **decision factors**. Understanding the qualitative differences in the appraisal of decision factors for renewable and competing fossil heating and cooling technologies is key for identifying barriers and opportunities. Consumers hardly distinguish themselves between barriers and opportunities, but they weigh according to their rationality - which might oscillate between economic, ecologic or self-expressive dimensions – the decisions factors towards renewable or fossil options. Barriers towards RHC can be elaborated from consumers decisions factors which finally determine decisions for fossil technologies. Opportunities derive from those decision factors which lead to an investment decision for RHC technologies.

Figure 2: Analytical framework for consumer decisions



The conditional level covers relevant factors which are setting the context for decision. Typical factors would be climate and geomorphology, heating and cooling demand, predominant non-renewable resources (e.g. coal) and gas networks, occasion of decision, building types and building features. Such conditional features have an impact on consumer-level decision factors like functionality of the system, expected comfort, installation work and time, implementation and operation cost and payback time of the investment.

The intermediary level represents those stakeholders who potentially influence the decision of the consumers through their communication, regulation, products and services. Typical stakeholders considered in the analytical framework are installers, architects and planners, governments, energy consultants, family, friends & neighbours,

and media. Their information, policies, advise and service-offers affect consumer appraisal for almost all decision factors, including those mentioned above, and in addition factors like trustworthiness of the technology, energy independence and security of supply, efforts for operational work and maintenance, and visual appearance in / on the building, symbolising social status and ecological orientation.

The consumer level describes the result of this internal cognitive process - (mentally) evaluating the information coming from the intermediate level - and brings it in accordance with the individual knowledge, values, attitudes and emotions - which finally bring one of the three options of decision: investing in a renewable heating or cooling system, investing in a fossil fuelled heating system; no investment and stay with the existing heating or cooling system.

3 SURVEY IMPLEMENTATION: METHODOLOGY

3.1 Recruiting respondents

One of the starting points to prepare the analysis of the RHC consumer is the setting up of a network of experts who can represent the consumers' point of view for the relevant RHC technologies in specific geographical areas. The experts should have a sound understanding of the issues, drivers and barriers perceived by consumers and other relevant stakeholders, and what the implications are for the acceptance and uptake of RHC technologies.

The main challenge in designing the expert network (described in Deliverable 3.1) was to ensure adequate coverage of expertise on different dimensions. These included different stakeholder segments (e.g. consumers and intermediaries), RHC technology groups, geographic contexts, and knowledge domains (e.g. practical versus academic). Regarding geographic contexts, representatives from each of the main country groups (Northern/Baltic, Southern, Western, Eastern) were to be included as a minimum requirement, paying ample attention to including experts for Eastern Europe, as this region appeared underrepresented in literature and relevant projects. Since the number of the selected experts had to be limited, a clear trade-off existed between obtaining in-depth expertise on specific dimensions and arriving at adequate coverage across all relevant dimensions.

To provide a balanced approach, it was decided to focus on establishing a core group of 30-40 experts with a clear national view, spread over 3-4 focus countries per country group, with approximately 3 experts per focus country. Each individual expert preferably (but not necessarily) would cover several RHC technologies and/or a number of stakeholder segments, with full coverage of RHC technologies for each country group. The selection of most relevant countries within the four country groups was based on specific selection criteria listed in Table 1.

Contact details from potential respondents were obtained via the consortium partners. Finally, more than 150 experts from the selected EU member states and Turkey have been identified for interviews. Consequently, each respondent was invited to participate in the study by e-mail invitation followed by phone follow-up for those who did not reply to the e-mail. Whenever an invitation was rejected the contact person was asked for other suitable expert candidates. The overall number of interviews conducted was 34 (solar thermal: 9, biomass: 7, geothermal: 7, heat pumps: 9, and district heating and cooling: 2) as seen in Table 1. Most interviews applied to a Western European context (12 interviews), followed by the Northern / Baltic (9 interviews), Southern (8 interviews) and Eastern European regions (5 interviews). The relatively low response rate for Eastern Europe might be partly attributed to language challenges (as experts from public institutions and national companies felt uncomfortable with giving an interview in English).

Table 1

Table 1: Interview partners per country and RHC technology

Countries		Criteria for selecting the country	Technologies of interview partners					Sum
			Solar thermal	Biomass	Geo-thermal	HPs	Cross-cutting (DHC)	
Northern/ Baltic	Estonia	High per capita shares for heat pumps and solid biomass		1		1	1	3
	Finland	High per capita shares for heat pumps, best performance solid biomass		1		1		2
	Lithuania	High share of ground-source heat pumps (cf. note below)						0
	Sweden	High per capita shares for heat pumps and solid biomass		1	1	2		4
Western	Austria	High per capita shares for solar and solid biomass	1	1				2
	France	Good performance for heat pumps, big market	2					2
	Germany	Good performance for solar, big market	2	1	1	1	1	6
	UK	Weak per capita performance, but big market		1	1			2
Eastern	Czech Republic	Best per capita performance in Eastern/central Europe				1		1
	Hungary	High share of ground-source heat pumps			2			2
	Poland	Weak per capita performance, but big market			1	1		2
Southern	Greece	Good performance for solar	1					1
	Italy	Best performance of heat pumps, big market	1		1			2
	Spain	Average per capita performance, but big market	1	1		1		3
	Turkey	Important market for heat pumps, geothermal and solar thermal	1			1		2
		Totals	**9**	**7**	**7**	**9**	**2**	**34**

3.2 Conducting the interviews

The interviews were conducted via phone between August 2017 and March 2018, taking between 25 to 50 minutes for each. The interviews followed a guideline with open-ended questions, which was developed based on literature review and derived from the analytical framework. All interviews were recorded. In the box below, a summary of the interview questions is given.

Summary of the interview questions

1. About yourself
    - Your role in your company/organisation and your engagement in a specific renewable heating and cooling solution (= [technology X] in the following questions)
    - Details of your expertise on consumer groups
2. Example of a consumer's decision process
    - A real case of a consumer who went through the decision process for renewable heating and cooling technologies
    - Conditions and situations, decision process and decision factors
3. Market situation (your PERCEPTION, no need to provide precise data)
    - Adoption rate of [technology X] in your country
    - Trends in the market for [technology X] in recent years
    - Household type which tends to adopt [technology X] today
4. Factors expected to influence consumers' decisions

4.1. Knowledge agents

- Places or agencies from which consumers get information and advice
- Source of information and recommendations influencing consumers' thinking
- Role of middlemen such as installers, and other implementers
- Influential information in different situations, such as the sudden breakdown of the current system, refurbishment for a foreseeable need, and construction of a new house

4.2. Funding and subsidies

- Funding, subsidies and other programmes promoting [technology X]
- Existence of supporting governmental policies

4.3. Specific marketing/promotion

- Any efforts to raise awareness about [technology X], such as media campaigns, dedicated websites and incentives

4.4. Perceived risks and added value

- Consumers' perception of [technology X], whether positive or negative
- Perceived benefits of [technology X] solutions, which would drive consumers to implement [technology X]
- Perceived risks of [technology X] solutions, which would deter consumers from adopting [technology X]

5. Conclusion
    - The key factors currently driving positive investment decisions for [technology X]
    - Any suggestions on encouraging consumers to adopt/ invest in [technology X]
    - Any other, unaddressed issues relating to the consumer dimension

Figure 3- Summary of the interview questions

3.3 Data processing

After transcribing the recorded interview, each statement from the interviews was paraphrased and coded with different categories using the software package MAXQDA to support the qualitative analysis. The categorisation system was established on the basis of the structure of the interview questions and additional categories have been added whenever needed to keep the quality of statements high. Generally, the interview partner information was kept as an acronym for further analysis. For example, SOL_AT means that it was mentioned by an interview partner from Austria who has expertise in solar thermal technology. Likewise, BIO_, GEO_, HP_, and DHC_ refer to biomass, geothermal, heat pump, and district heating and cooling respectively. The coded data was aggregated to find out both common and country or technology specific influences of conditions and stakeholders on consumer decision-making, as well as enablers, barriers and potential measures for consumers to adopt a RHC technology.

4 FINDINGS

In this section the empirical results from the interviews are presented. The interview study intended to identify those units within a wider context of RHC technologies which determine the perception of consumers and accordingly their decisions concerning heating and cooling technologies.

With respect to previous projects (like the FRonT project) - which measured consumer decision factors and identified key purchasing criteria - we aimed to enhance the qualitative understanding of factors underlying barriers and opportunities for different RHC technologies. The analysis aims to capture relevant stakeholder relations which contribute to the subjective perception of renewable and fossil heating technologies as investment options. In addition, we aim to describe the most relevant decision factors for consumers when facing an investment decision for heating and cooling systems in their premises. This understanding aims to provide the starting point for effective policy measures to increase the number of consumers' investment decisions towards renewable instead of fossil heating and cooling technologies.

Accordingly, we describe in this Section 4 our empirical findings in the three main dimensions of the analytical framework applied: conditional factors, intermediaries, and decision factors. Findings regarding the conditional factors - that set the context for a decision - are given in Section 4.1. In Section 4.2 we present empirical results on the various intermediaries and distinguish – if necessary and possible – between different RHC technologies. In Section 4.3 general results for each individual RHC technology are presented. Section 4.4 briefly describes the most relevant decision factors for consumers that emerge from the analysis. Finally, we discuss regional specific findings in Section 4.5. The findings of Section 4 feed in to the conclusion of our analysis (Section 6) in which we extract main barriers and opportunities.

4.1 Conditional factors for RHC technologies market diffusion

Investment decisions will be influenced by conditional factors. By conditional factors we mean those factors that are beyond the control of the individual decision maker and are often related to specific national or regional contexts. From the interviews, a number of such conditional factors have been raised. First, we describe general regional specific factors of relevance. Afterwards, we present the most relevant conditional factors for consumer decision-making highlighted by the interviewed experts for the case of RHC.

4.1.1 Regional specific factors

Three general conditional factors are typically important to understand European differences in terms of consumers' perception of heating and cooling technologies and generally moderate consumers' perspectives:

- **Geography**: Heating solutions are naturally of greater interest in countries with cold climates and cooling solutions in countries with hot climates. The longer the heating period during a year, the more consumers consider investing in a solution which will significantly save money on the long-term (BIO_SE, HP_EE, HP_SE). Higher heating or cooling demand impacts also on a shorter payback time of the investment (HP_SE). Countries also have different endowments of natural resources, which still influence today the relative prices of energy sources, the existence of domestic industrial competences, and the development effort devoted to related solutions.

- **Infrastructure**: Examples of infrastructures influencing the adoption of RHC solutions include the natural gas grid, district heating systems, and the state of the electricity grid. Heating systems with fossil fuels such as oil and gas (and hard brown coal in some countries in Eastern Europe), and electric heater are still the major competitive solutions in many countries, because of the low price (SOL_AT, SOL_FR, SOL_DE, SOL_ES, SOL_GR, BIO_AT, BIO_DE, BIO_UK, BIO_ES, GEO_HU, GEO_PO, HP_PO, HP_CZ). Whether household level RHC will be installed depends on the availability of alternatives, such as a district heating network (SOL_AT, BIO_FI, BIO_SE, BIO_AT, GEO_DE) and a gas network (SOL_AT, SOL_TR, BIO_AT, GEO_UK, GEO_HU). Other relevant properties of existing infrastructures are the age, size, structure and current condition of the building stock, or the availability of central heating. Energy infrastructures exhibit a high level of path dependency (Fouquet, 2016), which is not only due to cumulative investments in certain physical infrastructures, but also to related investments in knowledge, production skills and capacity, political power, market expectations, network effects, etc. Hence, it is difficult for new energy technologies to compete with the dominant ones, even if they hold large future potential or even once they become cost-effective.

- **History and culture**: Expectations toward energy provision and use in buildings vary both historically and across cultures, even within Europe, as is shown, for example, in literature on the variability of thermal comfort expectations in different countries (Mishra and Ramgopal, 2013). These differences are due to historical experiences, building traditions and building usage practices. Historical and cultural traditions can also influence how buildings and their renovations are typically governed and managed. For instance, Western European countries have a long legacy of energy efficiency policy, which started during the first oil crisis in 1973. In contrast, the countries that were closely linked to the former Soviet Union did not suffer from a similar fuel shortage (IEA, 2018b).

4.1.2 Windows of opportunities

The decision-making processes to install heating and cooling systems are likely to start in specific occasions, here referred to as 'windows of opportunity', which were highlighted as the main conditional factors of influence.

A main window of opportunity arises when new houses are built and consumers decide how to heat and cool the building. In this type of occasion, consumers will have a relatively large amount of time to review and compare different options, and in relation to other windows of opportunities a RHC installation at this occasion is quite frequent. In addition, the consideration on RHC options is partly forced by energy performance and renewable energy regulations for new built housing so that only competition between RHC technologies remains.

A second type of occasion is the replacement of heating and cooling in existing housing. The market of replacement in the existing houses has a much bigger potential than the market for new houses. However, in the existing housing sector, it is generally much more difficult to install a RHC option in a replacement occasion than in the case of new constructions.

Within the replacement market, again three different types of windows of opportunity can be distinguished.

- When people buy a house from the owner or inherit a house is an occasion during which there is sufficient time to gather relevant information on the heating and cooling system and make a decision to improve the system. Consumers will check

what kind of heating and cooling system is installed in the house and may try to remodel or repair the system at this point, particularly if it is an old building. However, this occasion currently does not have much impact on the market, because it is not obligatory to install any renewable technologies and only few consumers' consider installing a renewable heating or cooling system.

- Alternatively, consumers may consider replacing the heating system of the house they currently occupy when the system reaches the end of its lifetime, but before the system breaks down. In such case, consumers foresee the need to change and the replacement makes sense in terms of the cost-effectiveness and energy saving due to the old existing system or increasing fuel cost, or when people renovate the whole building. However, unless there is a significant refurbishment plan of the property owner or clear incentives and benefits for the replacement, in very few cases consumers will think to replace a fossil heating system with a RHC. Interview statements from northern and central Europe indicate that for those climate zones where the demand for heating is very high, consumers are more proactive and will not wait until the system totally breaks down, but rather they want to take care to have a good heating solution. Consumers living in the areas with less demand for heating might not tend to consider the replacement until the breakdown.

- If a system is changed due to a breakdown of the existing system, the decision will be taken very fast and most options from RHC technologies cannot be considered because bigger effort is necessary to change the whole system for the consumers. In such occasions, consumers rather do not spend much time to research by themselves, and most building owners will follow their installers' advice, often resulting in the replacement with the same type of technology, which is the easiest and the least complicated.

4.1.3 Building features

Building features were considered by several experts to be very crucial conditional factors in the refurbishment market. The selection of a new heating or cooling system depends on the existing system. For example, if no hydronic system or pipes are installed, solar thermal and air-to-water and ground-to-water heat pumps installation are more difficult and costly. In addition, some building features such as roof type and existence of a basement for storage would influence certain RHC installations in terms of the feasibility and cost of the installation.

4.1.4 Building types and tenant-owner gap

The type of building is an important conditional factor, because it determines to a large extent who decides on the heating and cooling investment. For replacing heating and cooling systems in existing homes, the final decision generally lies with the home owner, whether residents, a housing company or private landlord. For new built single-family houses, decision-makers are often professionals involved in the building process (SOL_DE) or home owners coordinating the process of self-built housing (GEO_UK). Notably in multi-family houses and apartment buildings, the residents who live in buildings are rarely the ones who decide on the heating and cooling system. This often relates to the tenant-owner gap, which – in general - explains why in big cities, where there are more apartment buildings and less private homes, RHC (except for areas with district heating and cooling) is less spread (HP_SE).

Various further reasons were mentioned during the interviews why residents of multi-family buildings are less involved in deciding on the installations of heating and cooling systems. Due to the complex work in renovation and replacement of old oil boilers,

residents of multi-family homes are not eager to replace the old system by themselves (HP_EE). The residents of multi-family houses do not often have the power to decide on the use of the buildings' space like the roof in case of a solar thermal installation (SOL_IT). One expert also reported that residents sometimes do not have the mentality to share a central heating and cooling system with other residents (SOL_GR). The heat distribution is more complicated in apartment buildings, and therefore especially domestic hot water production can be a problem with a central technology (HP_DE).

For new built multi-family buildings and real estates, residents are even less connected to the investment decision. The installation is done by professional parties like housing companies, building owners, or real estate developers (BIO_SE, GEO_HU, HP_EE, HP_DE, HP_TR). Those professionals decide which system to install according to their preferences; preferences of (future) residents do not play an important role as the heating system is installed before the residents' purchase (SOL_ES, BIO_SE).

Experts also report that housing companies and other professional building owners are often hesitant to initiate the work of renovation and replacement of the heating and cooling systems (HP_EE). For these building owners, it is a 'hassle' to think about the replacement of heating and cooling systems and typically they do not take into account the preferences of their tenants (HP_TR).

Professional building owners tend to prefer the cheapest solution. RHC solutions are not always cheaper and they need to consider the extra investment (HP_DE). On the other hand, a motivation for real estate developers to install a RHC system is to increase the profit per apartment by adding the value of the renewable system to the sales price of the apartment (GEO_HU). These apartments will be sold to higher income households (GEO_HU) or are preferred by consumers who consider RHC to increase their social status (GEO_SE).

Table 2 summarizes which are the main actors to decide in different building types according to the interview findings.

Table 2: Main actors to decide on the installation of heating and cooling in different building types

Building types	Who decide?
Single-family houses	• Home owners (in replacement of existing heating and cooling systems and self-built process)
Multi-family houses / apartment buildings	• Professional building owner(s) • Housing companies
Real estates	• Real estate developers

4.2 Intermediaries

As described in our analytical framework (Section 2.3), information and suggestions are given to the consumer from different stakeholders which we call in this study "intermediaries". The different types of decision-makers (see section before) are usually mediated by various types of players. Based on the deliverable 3.1 and the interview findings, the following intermediaries are the most relevant for consumers' decisions:

- **Installers** (e.g. installers, chimney sweepers) play a significant role in consumers' decision to choose a heating and cooling system. Although many consumers try to collect more information from other sources for instance from the internet and friends, the installers's advice has often more impact on the customers' decision in the end.

- **Architects and planners** play an important role because the choice for a heating and/or cooling system is often incorporated in the design phase of a new single building or real estate development.

- **Governments** are of course important intermediaries for the adoption of RHC solutions, e.g. by setting up subsidies, standards, green certificates, information campaigns, websites, etc. An additional factor relates to the political aspects of policy making. It is likely that RHC solutions gain more consistent political support if they can convincingly offer other benefits than climate change mitigation, e.g. energy security, air quality and job creation can serve as arguments and issues that maintain consistent political support for the necessary policy measures.

- **Consultants** and other expert professionals (e.g. universities) have an important role in introducing and mediating new ideas such as those represented by RHC. A lack of consensus on what is best practice in RHC solutions can be a factor obstructing public acceptance and creating uncertainty and confusion also among the general public.

- **Family, friends, neighbours** play an important role in providing informal mouth-to-mouth information on heating and/or cooling options, and can provide visible evidence on the performance of RHC technologies that is trusted by their social networks.

- **Media** has an important role not only in raising awareness on energy issues and the need for renovation, but also in highlighting particular issues. In this respect, studies show that the media do not always promote acceptance, but can also fuel controversies.

From these results the relative influence of various intermediaries can be coupled to particular decision occasions (the "Windows of opportunities", Section 4.1.2) and building types (see Table 3). In the next sections we highlight the most relevant findings from the experts on the intermediaries' influence on consumer decision-making.

Table 3: Degree of influence of different intermediaries for different occasions and building types

Occasion	Building Type	Architects and Planners	Governments	Energy Consultants	Family, Friends, Neighbors	Craftmen	Media
New Construction	Single	+++	++	+	+++	+	++
	Multi	+++	++	++		+	++
	Real Estate	+++	++	++		+	
Renovation	Single	+	+		++	++	++
	Multi	++	+	+		+++	+
	Real Estate	+++	+	+		++	
System Breakdown	Single		+		++	+++	++
	Multi		+			+++	+
	Real Estate	+	+	+		+++	

4.2.1 Installers

Intermediaries which interact directly with consumers such as installers, repairmen, plumbers, distributors and local commercials play a significant role in the consumers' decision to choose a heating system. In many countries, they will be the main advisor and the most relevant information source for consumers during their decision-making process (SOL_AT, SOL_FR, SOL_DE, SOL_IT, SOL_TR, BIO_DE, BIO_UK, HP_CZ, HP_ES, HP_TR). Although many consumers try to collect more information from other sources, for instances, the internet and friends, the installers' advice has often more impact on the customers' decision in the end (SOL_GR, BIO_FI, BIO_AT, BIO_DE, GEO_DE, GEO_UK, GEO_IT, GEO_HU, HP_DE, HP_ES).

They have frequent contacts with consumers for maintenance (HP_DE) and consumers typically contact them when they want to replace the existing system or if they have a problem with the system, and ask for available solutions (BIO_AT, BIO_UK, HP_DE).

For many consumers, their knowledge comes very often from installers. Consumers usually trust them (HP_DE) and normally will follow the advice from installers, because they have more professional knowledge (SOL_FR). Especially when it is urgent for consumers to replace their heating system and they do not have any time to do further research on their own, the recommendation by those professionals would determine the choice (SOL_AT, SOL_DE, SOL_ IT, SOL_ES, BIO_DE, HP_ES). Installers would have

stronger influences on people who are less educated regarding heating systems (HP_SE, HP_ES).

According to the interviews, installers will advise what they know and what they can do from their portfolio and particularly the system that they can make the most profit for them (SOL_DE, HP_DE), also depending on the utility network available (GEO_HU, GEO_IT). Except for countries where a certain RHC technology is already a mainstream solution, most installers prefer to recommend other options (SOL_GR). In many cases, they will suggest gas and oil boilers (or coal heating system in some countries), because they are used to installing those heating systems and the installation of those systems will be much easier than other unfamiliar RHC systems (BIO_DE, BIO_ES, GEO_DE, HP_DE, HP_CZ). This is often a problem in the decision process of consumers, because they often get the information from installers who recommend only gas and oil installations (GEO_DE). Another reason why they will not recommend RHC solutions is that low price of fuel oil makes the RHC solutions comparatively more expensive (BIO_UK). In addition, installers have a good connection with the industry, which gains most of the money from gas or oil installation (GEO_DE). Besides, because installers are fully booked and have enough to do, they do not have some additional time to invest to improve their knowledge. Therefore, they do not look for new opportunities, unless they have an innovative idea (HP_DE).

For solar thermal technologies, the following main findings come from the expert interviews:

- Solar thermal has a lower profit margin compared to fossil systems (SOL_FR, SOL_DE)

- The main reason for the unwillingness of installers to install solar thermal systems is that solar thermal is complicated and time-consuming in terms of planning, the calculation of the energy need, and the installation work on roof and pipe construction (SOL_FR, SOL_FR, SOL_DE, SOL_ES, SOL_IT).

- The need of application for a permit or authorization to install solar thermal in some countries will give further burden to installers (SOL_FR).

- In the case of domestic hot water system, installers do recommend the solar thermal option, since it is cheaper (SOL_TR) and already a familiar solution in some countries (SOL_GR, SOL_TR).

Biomass experts see two major issues concerning installers:

- Installers do not recommend biomass in many cases as they see biomass solutions to be complicated for them in countries where biomass has not yet well diffused (BIO_DE, BIO_ES).

- The complicatedness for installers comes from the need to consider storage room availability and subsidy application (BIO_DE).

Geothermal experts express following experiences with installers:

- Installers for geothermal heat pumps must have good knowledge about the geological conditions and the thermal ability for a particular installation in the specific settings (GEO_PO).

- However, compared to the past, more installers recommend heat pumps, though they prefer recommending air-source heat pump instead of geothermal heat pump (GEO_PO).

- Where geothermal heat pumps are already well-diffused, the installation would be perceived rather easy by installers (GEO_SE).

Experts on heat pumps report following aspects:

- Many installers are not so convinced to propose the option of heat pumps, because they do not know the technology of heat pump so well (HP_CZ).

- Heat pumps are installed normally by new installation companies. However, more and more installers are convinced and also recommend heat pumps in order to meet regulation for new buildings (HP_ES).

- If installers have heat pumps in their portfolio, they typically recommend heat pumps, because profit margin of heat pumps would be higher than gas installation due to profit from additional working hours from installation (HP_DE).

If installers recommend a certain RHC, it is because of either financial advantage for their customer such as grant and tax credit for the installation (SOL_ES) or mandatory regulation (SOL_ES, HP_ES). In contrary, the bureaucratic work of application for the financial supports gives additional complexity for their work and distracts them from recommending RHC if possible (SOL_FR, SOL_DE, SOL_IT, BIO_DE, HP_EE, HP_DE, HP_CZ).

Installers will install a certain RHC, if they are a specialist and experts of the system who are personally convinced by the technology (SOL_AT SOL_DE, SOL_ES, HP_CZ, HP_ES) and are educated about the advantages and skilled to install (BIO_DE, BIO_UK, BIO_ES).

4.2.2 Architects and planners

In case of building a new house, architects and planners who deal with the house are the most influential information source for consumers. Consumers usually follow their suggestion (SOL_FR, SOL_DE, SOL_IT, GEO_DE, GEO_HU, GEO_IT), because they are considered as more professional (SOL_FR, BIO_ES), even when consumers would search further information, for example, on the internet (BIO_ES). Especially when consumers meet only those people, they will have big power on consumers' decision (GEO_HU).

- Architects and planners have similar problems as installers with the complexity of solar thermal, and will recommend more simple and easier to install systems such as heat pumps (SOL_IT).

- Since geothermal heat pumps is still a niche market, the majority of architects or builders are likely to be unfamiliar with these systems (GEO_UK).

4.2.3 Energy consultants

According to the experts, energy consulting can be another information source (SOL_DE, GEO_UK). Those consumers who consult with energy consultants might have been already informed about renewable technologies by the internet, friends and installers, and have already some idea about the type of system they want to have (SOL_DE). Consumers who are engaged in large self-built projects will perhaps also employ a consulting engineer, for example to advise on constructing a green building (GEO_UK).

4.2.4 Governments

Governments are of course important intermediaries for the adoption of RHC solutions, e.g. by setting up subsidies, standards, green certificates, information campaigns, websites, etc. In the interviews three main instruments were mentioned repeatedly to be important for the perception of RHC among consumers and their adoption of the technologies: Financial support, taxation of carbon emissions and mandatory regulations.

Financial Support: A central finding is that the availability of financial supports influences positively the consumers' investment decision in a RHC, or is expected to do so if they are available (SOL_FR, SOL_ES, SOL_TR, BIO_EE, BIO_UK, BIO_DE, GEO_DE, GEO_UK, GEO_HU, GEO_PO, GEO_IT, HP_EE, HP_DE, HP_CZ). Specific financial supports such as grants or tax credits for a RHC installation, which are often applicable for other renewables in the same way, exist in many countries. Some financial incentives have been mentioned particularly for switching from fossil-fuel based system to RHC (GEO_PO, GEO_IT). However, the financial supports might be available with some limitations. They might be available only in some regions but not at national level (SOL_ES), only for renovation but not for building new houses or vice versa (SOL_FR, BIO_EE) or only for a certain period of the year but not for the whole year due to the limited budget (SOL_ES, SOL_GR, BIO_ES).

Most experts stated that the amount of money covered by subsidy and existing tax deduction should be sufficient (SOL_AT, SOL_FR, SOL_DE, SOL_IT, HP_DE). However, the reasons why those financial incentives are not effective enough would lie in other points. Firstly, the availability of financial incentives and the good coverage might not be well-known by customers (SOL_DE, SOL_IT, BIO_DE, GEO_DE), in some case caused by a frequent change of the governmental scheme and few advertisements for the incentives (SOL_DE). Their awareness on the financial incentives depends on information campaigns and word of mouth information (GEO_DE).

Besides, the competitive advantage for RHC by the support might not hold, if the governmental financial supports are offered for other systems in the same way (HP_DE, GEO_IT). If the financial support is less attractive in comparison with supports for other renewables that are more favoured in the governmental scheme, consumers would go for the others (SOL_FR, SOL_DE).

In addition, if the initial rapid growth of the market is caused by the subsidies, the market will be swayed by the subsidies and consumers will lose the financial motivation, when the financial supports are cut off (BIO_UK). One expert reported the experience that the rapid expansion of the installation induced by subsidies could also contribute to the access of installers to the market with low expertise and few skills by installers (BIO_UK).

A carbon tax would be an alternative indirect financial support mechanism for RHC. The introduction of a carbon tax by the government would clearly indicate to consumers that the fossil fuel-based heating systems are not good (HP_FI).

Mandatory regulation: When new buildings are constructed there is often mandatory regulation by the government or EU (or both) to require consumers to install a certain renewable system for hot water or space heating. With this regulation, consumers and installers are forced to consider installing RHC (SOL_ES, SOL_IT, SOL_AT, SOL_GR, BIO_AT, BIO_DE, HP_DE). However, it should be noted that, if installers do not have enough knowledge about installation and maintenance, such obligatory installation will cause a risk of malfunctioning (SOL_ES).

4.2.5 Friends, families and neighbours

Findings reveal that word of mouth information is very influential (SOL_AT, SOL_FR, SOL_DE, SOL_GR, BIO_SE, BIO_AT, BIO_DE, BIO_ES, GEO_SE, GEO_DE, GEO_UK, GEO_HU, GEO_PO, HP_FI, HP_SE, HP_CZ). Friends, families and neighbours have an influence on consumers' decision making as consumers generally find it important to consider the experiences of other like-minded people (HP_CZ).

Consumers' decisions are influenced by neighbours especially in rural areas and small towns (SOL_FR, GEO_HU). In communities where a certain shared knowledge regarding heating system exists, the word of mouth information among residents will be very influential (HP_CZ). On the other hand, if a solution is rare in the neighbourhood, the information from the neighbour who adopted the solution will not be enough to convince other residents (HP_CZ).

In general, the impact of familiar people who have already adopted a certain RHC system and are satisfied with it, is very big (SOL_FR, GEO_HU, HP_FI). It means that where the technology is well distributed in society, a lot of information will be shared between relatives, friends and neighbours. This contributes to spreading positive images of the technology (HP_FI). If someone installed a good heating solution, the neighbours or friends would see the system directly and talk about it, and information will be expanded among the neighbourhood, in the community or social network (BIO_FI, BIO_SE, GEO_SE, GEO_DE).

4.2.6 Media

Interviewed experts reported that consumers often get relevant information of heating and cooling systems from the internet (SOL_DE, SOL_IT, SOL_AT, SOL_GR, BIO_AT, BIO_ES, GEO_DE, HP_EE, HP_SE, HP_DE, HP_CZ, HP_PO, HP_ES) and social media (HP_FI), though the internet does not have as big an impact on consumers' decisions as the suggestions from installers have (SOL_FR). Especially those consumers who have higher awareness and are interested to go deeper into the solutions will go on the internet for collecting relevant information (GEO_IT, HP_DE). Besides, younger people tend to use the internet more as an important source of information than older generations do, and therefore the internet would influence younger generations more in their decision than neighbours' advice nowadays (GEO_IT, HP_FI, HP_ES), which remains influential in rural areas.

Consumers often collect the information about different products and prices on the internet (SOL_GR, BIO_AT, BIO_ES). On the internet, relevant information can be found on websites of the manufacturers and installers (GEO_SE). Government-supported websites also give information on different domestic heating technologies (BIO_FI, GEO_UK).

4.3 General findings on consumer perceptions of RHC technologies

In this section we present for each technology the main findings from interviewed experts on the perception of consumers of the RHC technologies.

4.3.1 Findings for Solar thermal technologies

Interviews revealed that, in the countries where solar thermal systems are perceived as cost-effective, saving money for the long-term is the main reason for consumers to choose them (SOL_AT, SOL_GR, SOL_TR). Especially for solar thermal domestic hot water systems, the affordable product and installation cost are the advantage (SOL_GR). In addition, if the residents do not have any burden for the investment cost, for instance

in the social housing sector which can utilize social funding for the installation, solar thermal is an attractive option as a low-consumption system (SOL_FR).

One of the good reputations of solar thermal domestic hot water systems, such as the thermosiphon system, is that the installation takes very little time without many complications, and the operation is easy (SOL_GR).

Interviewed experts stated that one reason why more and more people choose solar thermal system is that it is a solution with a high degree of autonomy (SOL_FR, SOL_DE), which is especially a good argument for consumers in areas where the solar fraction is high enough. Independence from an increasing energy price of fossil fuels is a good feature of solar thermal (SOL_FR, SOL_DE). For those who expect an increase of energy costs in the future, the investment in solar thermal is an investment for energy security, which is perceived as an insurance (SOL_FR, SOL_DE).

According to the interviews, the main limiting factor is the installation cost of solar thermal (SOL_FR). The competitiveness of solar thermal is limited due to the relatively long payback time (SOL_FR). In spite of financial support and small price decreases, it remains still quite a long-term investment (SOL_FR, SOL_DE, SOL_ES).

A reason why consumers do not switch to solar thermal systems is the complicated installation process (SOL_ES). In order to take complete advantage of what solar thermal and heat storage can do, the installation work can be significant and due to the required efforts rather confusingfor consumers (SOL_DE). The technology can suffer from a negative image due to the malfunctioning of solar thermal systems in the past, due to a lack of maintenance or wrong installation by untrained installers, which can happen with the mandatory installation in new buildings (SOL_ES), and during the initial phases of the solar technology market (SOL_AT, SOL_FR). The actual problem is not the quality of the system, but rather the negative image concerning reliability and durability of the installation (SOL_FR).

4.3.2 Findings for Biomass technologies

The main findings for biomass-based heating systems refer to its fairly cheap price, which is one of the main reasons why consumers choose the technology (BIO_EE, BIO_SE, BIO_ES), though the system itself is more expensive than a gas or oil heating system (BIO_DE). In countries where biomass is abundant, the main reason to choose biomass solutions is that consumers are culturally and historically used to using biomass as an energy source (BIO_EE, BIO_FI, BIO_SE). Consumers, who are willing to install a biomass technology, consider the option from an environmental perspective (BIO_FI, BIO_SE, BIO_UK, BIO_DE).

Also, interviews show that consumers who are not using biomass have a perception that the use of bioenergy is expensive, which is true regarding the installation cost, but not regarding the running cost (BIO_AT). They do not know that pellets are cheaper than oil (BIO_DE), and believe it is the other way around (BIO_AT). Some consumers are afraid to install biomass, as it is something still new for them (BIO_DE, BIO_ES). They would think the system might not work as comfortably as the old fossil fuel system does (BIO_DE), or think that the fuel would run out quickly if everybody uses it (BIO_ES). Some people are concerned that it is not sustainable if the heating system burns wood (BIO_UK). Some have a negative attitude about the emission from fire woods and the associated air pollution, though modern boilers have low emissions (BIO_SE, BIO_DE). Some are concerned that biomass might be imported and not domestically produced (BIO_DE).

4.3.3 Findings for Geothermal technologies

One of the positive features of geothermal perceived by more and more consumers is the cost-efficiency in the longer-term (GEO_DE, GEO_UK), and a reduction of the running cost (GEO_UK, GEO_HU). Consumers who invest in geothermal have a long-term perspective and know that the investment will pay back (GEO_UK). Some consumers also think that it would be more cost-efficient in combination with the use of PV for electricity to run the system (GEO_DE) or by using a geothermal heat pump both for heating and cooling (GEO_PO).

Findings reveal that the payback time would be rather short in some countries compared to other RHC technologies. For instance, in Sweden the short payback time of geothermal heat pumps (around 7 years) is a big incentive (HP_SE). Geothermal is considered a low-carbon solution (GEO_SE, GEO_DE, GEO_UK). However, carbon reduction will be the second level consideration for most consumers, though it matches with quite substantial desires among consumers who can also access financial support schemes to reduce carbon and fuel cost (GEO_UK). Geothermal heat pumps can offer both heating and cooling (GEO_PO). Cooling starts to be considered to be important, as temperatures rise (GEO_PO). The installation of geothermal heat pumps adds value to the building (GEO_SE, GEO_HU).

According the interviewees the main barrier for geothermal is the initial cost (GEO_DE, GEO_HU, GEO_PO), which is much higher than for fossil fuel-based boilers (GEO_HU), though the installation cost has started to become more and more competitive (GEO_PO). Even though the electricity price is often reduced for the operator of the geothermal heat pump system, the low operation cost is not an attractive point if the payback time is too long (GEO_HU). Experts highlight that the main issue for consumers is the ability to cover the initial costs for installation (GEO_SE, GEO_DE, GEO_HU). Accordingly, subsidy availability is often a key issue (GEO_HU). Consumers who consider geothermal heat pumps to be too expensive rather tend to invest in air-source heat pumps (GEO_SE).

4.3.4 Findings for Heat pump technologies

The experts share the opinion that the main and most crucial factor to decide for a heat pump installation is the economic reason (HP_EE, HP_FI, HP_SE, HP_DE, HP_PO, HP_CZ). Because of the smaller energy consumption, heat pumps have normally lower operation costs than other alternatives such as fossil fuel-based boilers, direct electric heating, and even district heating in some areas (HP_EE, HP_FI, HP_SE, HP_DE, HP_PO, HP_CZ, HP_ES). If consumers have a PV system and they can use their own generated electricity to run their heat pumps, it will be much cheaper (HP_DE).

Only a small group of consumers are motivated by environmental reasons, which can be an additional argument for the installation, but not the main reason. The main reason for many people would be the financial one (HP_FI, HP_SE, HP_DE, HP_CZ). This is different for, for instance, solar energy, which is considered more "green" (HP_SE). One advantage of heat pumps is the double benefit of offering both heating and cooling (HP_FI, HP_ES), which will be a stronger argument in areas where both heating and cooling are necessary (HP_ES). This multi-function would be a main reason to choose heat pumps, in particular when it is mandatory to use a certain level of renewable energy when building a new house (HP_ES). Consumers acknowledge that a heat pump installation gives the house an added value in terms of a modern and cost-efficient system (HP_FI, HP_SE).

The positive image of low operation costs can be discredited, because of a high price of electricity and a low price of fossil fuels (HP_DE). If the price difference between gas and

electricity is quite high, consumers will tend to decide for the non-renewable system if they are only looking at the cost (HP_DE). Also, the installation cost of heat pumps is higher than the one of fossil fuel-based boilers, which is still a barrier for consumers (HP_ES) in spite of the relatively high subsidies (HP_DE). Although the price of installation of the system started to be much more competitive to other traditional energy source systems (GEO_PO), many consumers, especially those who have less income, think that the technology is still too expensive to invest in (HP_PO, HP_CZ).

For new built houses, the installation of heat pumps will be cheaper and in line with regulations for new buildings (HP_DE). In addition, if the area does not have a gas connection and consumers need to pay for the extra gas connection, the heat pump installation will be cheaper or at least equal to gas installation (HP_DE). There are some rumours that heat pumps are not working correctly, and that the back-up electrical heater is doing the big part of the work if the heat pump is not working (HP_DE). Even in countries where heat pumps are well diffused already, there used to be bad reputations for heat pumps due to some malfunctioning in past (HP_SE).

Regarding air-to-water heat pumps, a serious problem is the noise, even though it has improved in new products. If neighbours hear the noise from cheaper heat pumps, and think that the heat pump is too loud, this creates a negative image of the system (HP_DE).

4.3.5 Findings for district heating and cooling

Experts report that - depending on the energy source availability in the country - district heating can be very affordable. For instance, in Estonia, the use of biomass for district heating and cooling enables the solution to be very affordable, which contributes to the positive image of district heating and cooling (DHC_EE). A reason for consumers to choose district heating is that it does not depend on gas or oil prices (DHC_DE).

Sometimes investors see a risk in the investment, because they do not understand how it works and they have to pay more in the beginning for the investment than for new gas boilers or oil heating systems (DHC_DE). People are often sceptical because of the big construction to introduce the network in the area for the first time. Hence, the first impression of district heating is sometimes negative (DHC_DE).

4.4 Decision factors

The main decision factors, which will be considered by consumers to choose a heating and cooling system cover several dimensions. The **social dimension** is related to factors such as the appearance of systems in / on the building, social status, added value provided to the building, and innovativeness of technology, and energy independence. The **economic dimension** includes factors like implementation and operation cost, which are also associated with the easiness to install and operate a system; and payback time of the investment. The **technology usability dimension** is associated with factors like trustworthiness of the technology, installation work and time, functional quality of the system, expected comfort, security of supply, physical space consumption or efforts for operational work and maintenance. The **ecological dimension**, finally, is typically represented by the consumers' ecological orientation or ambition. The detailed empirical results for the decision factors are given in Annex 1. An overview on decision factors and the barriers and opportunities deriving from decision factors for RHC technologies are presented in Section 6.2.

4.5 Regional findings

Our analysis shows that the market diffusion of RHC technologies depends importantly on conditional factors related to the national or regional context, like historically developed infrastructures, climatic conditions and regulatory support. For the three European regions addressed, the following general findings can be reported:

- In Northern and North-eastern European regions the market diffusion of RHC technologies, mainly heat pumps and biomass, have reached already a significant share. Interviewees report a number of policy and market support measures from Sweden (carbon tax, technology competitions), Estonia (RHC policies, web-based information system for customers and intermediaries), and Finland which might be used for further European diffusion.

- In Southeast Europe a mature Solar thermal market is established. Besides climatic factors (relatively low heat demand), the lack of gas for heating (and hot water) was also one of the main reasons for market development.

- In several central European countries, a wide range of political and financial measures have established a growing diffusion rate for RHC like biomass, heat pumps and solar thermal technologies. Still, all technologies depend on support schemes when in direct competition with fossil technologies.

Regional specific conditional factors are thus important to consider, both for understanding the origin of different barriers and opportunities in different contexts, as well as when 'translating' a specific recommendation to a national or regional context.

5 FEEDBACK FROM EUROPEAN VALIDATION WORKSHOPS

5.1 Aim and workshop structure

The purpose of the validation workshops was twofold:

- To validate the findings of our research on consumer acceptance of RHC solutions in European markets (what are the drivers and barriers towards the installation of RHC technologies);

- To develop recommendations in terms of policy-making initiatives to address the validated barriers.

To this end, relevant outcomes and recommendations from the literature review and the interviews were presented to the workshop participants, to solicit feedback and generate discussion. Based on the discussions, final policy recommendations were drafted (see Section 7).

Two workshops were organised: one in Brussels (24th of May 2018) for the Western and Southern European market, and one in Warsaw (21st of June 2018) for the Central and Eastern European market. Both workshops had a similar approach and structure. As an illustration, the agenda for the Warsaw meeting is represented in Table 4.

Table 4: Agenda for the Warsaw meeting (21st of June 2018)

12:30-13:30	**Welcome lunch**	
13:30- 13.45	Welcome by the host	*Janusz Starościk (SPIUG)*
13:45-14:00	Presentation RHC Project	*Paola Mazzucchelli (EUREC)*
14:00-14:30	Presentation of survey results: - Introduction - Approach of the survey - General results - Technology specific results	*Sebastian Goelz (Fraunhofer-ISE)* *Pieter Valkering (VITO / EnergyVille)*
14:30-15:30	Validation phase of results (open discussion): - What are most important barriers from the national or European perspective - If solutions & recommendations come up, they are documented and put on a board.	*All*
15:30-15:45	**Coffee break**	
15:45-16:00	Presentation of recommendations: - General and technology specific	*Sebastian Goelz (Fraunhofer-ISE)* *Pieter Valkering (VITO / EnergyVille)*
16:00-16:30	Validation & contribution phase on recommendations (open discussion)	*All*
16:30	End of the workshop	

5.2 Results

In general, the analysis was well-received and the results were largely confirmed, even though they were also perceived to be not 'very surprising'. Various points of attention were raised that are useful to refine the results. The qualitative nature of this study was acknowledged, as well as the fact that detailed, specific recommendations (e.g. per country and technology) are out of scope for this study. Nonetheless, the workshop participants highlighted the importance of detailed examples on decision contexts for specific countries and technologies. Also, specific examples of good practices were welcomed.

Two issues were perceived to be very important as enablers for RHC technologies: regulation and pricing of competing options (especially oil and gas heating):

- Regarding regulation, a **ban on fossil fuel burners** in the built environment (or similar: imposing energy efficiency requirements that can only be met by RHC solutions) would be an important enabler for RHC solutions. The (political) feasibility of this option was however questioned, even though some countries (e.g. Denmark and the Netherlands) have taken initiatives in this direction.

- To improve the economics of RHC solutions, a **CO_2-tax** would be a good instrument (though again, political feasibility is questionable for some). Subsidies for RHC solutions would also help, but over-subsidising should be avoided. In the past some countries witnessed excessive government support, e.g. for solar heating. Incentives were given, overheating the market, with high production and prices, and then the market collapsed when support was removed. It is better to let the market grow organically. Over-subsidy leads to loss of trust for innovative solutions. In any case, subsidies for fossil fuels should be phased out.

High-level communication and **political vision** were also considered to be very important. A common observation was that, compared to the electricity sector where the need for a transition to a renewable electricity system is now commonly acknowledged, this is not yet the case for the heating and cooling sector (even though a sizeable part of GHG emissions originate from the built environment). A sense of urgency should be created: in 20 years from now the heating sector must be 'de-carbonised' to a large extent, and this means we must start to install low-carbon solutions right now. Installations must be '2040-ready'. In countries where this is relevant (e.g. where coal or fuel oil is commonly used), local air quality can be used as an additional argument in favour of RHC solutions. Such clear political messages regarding the need for a clean-energy transition in the heating and cooling sector was perceived to be an important factor influencing the decisions of home owners.

In addition, the multiple benefits of RHC should be better communicated. For example, people are concerned about the future value of their property, therefore a 'future-proof' RHC solution provides clear added value. The perception is that in the current situation, property developers only look at immediate costs and therefore choose to install conventional technologies. Also, the ability to provide cooling in addition to heating is a great added value of RHC technologies compared to conventional ones, especially in Southern Europe. This should be better exploited in the communication to consumers.

How to communicate about economic benefits was subject to some debate. Some proposed to communicate more clearly about the payback time. A payback time of 7-10 years is known to be sufficient for most people, and policy should ensure such payback times are reached (via subsidies or other means). Others argued that payback time is intrinsically an inappropriate and 'negative' concept to motivate consumers. It suggests a certain large upfront investment with benefits only arriving in the long term. Alternative concepts, like lifecycle cost are more appropriate in this respect. Finally, some argued that the financial implications are generally overstressed, also because RHC solutions often can still not compete with fossil fuel options on this criterion. Using simple and appealing vocabulary - e.g. low operating costs, provision of heating and cooling, property value increase, environmental benefits – may be more effective to convince people. "*There is a need to develop a good 'RHC story' in analogy to the one of 'clean electricity' in the electricity sector*", as a workshop participant said.

For existing buildings, the finding that people only replace their heating or cooling systems when they are broken down was largely confirmed. The suggested recommendation on sending an 'early warning' before end-of-boiler-life therefore received some scepticism, although good practice on pro-actively labelling old boilers and providing information about new systems was suggested. Given the importance of the 'window of opportunity' that arises when the heating system breaks down, installers are

generally perceived to be the most important intermediaries to address for promoting RHC solutions. The problem is that installers often have contracts with specific technology providers and will therefore advocate their solutions. It is therefore important to consider "what's in it" for the installers. The margin of installers may be a leverage point. However, there is a risk that this would increase prices and hence would reduce the attractiveness for consumers. In this context, education, training and adequate information provision was highlighted, in particular during the Warsaw workshop. Although technical training is already provided, this doesn't sufficiently convey the main benefits for installers and for their customers. Also, the need for standardization was stressed, to facilitate technical designs, to avoid design errors, and for performance assessment.

A main barrier for RHC solutions from the consumer point of view is the enhanced complexity compared to conventional solutions. Often, RHC provides only part of the heating solution for homes (e.g. with a heat pump, sanitary hot water still must be provided by a gas or electrical boiler). How to communicate about such enhanced complexity to consumers is not yet clear. Also, RHC service models are relevant in this respect as they may take complexity out of the consumers' hands. Such models are not commonly applied yet, but for large consumers already provide attractive solutions. However, lack of trust and lack of flexibility (i.e. people being attached to long term contracts) are current barriers that need to be dealt with.

Finally, workshop participants suggested to adopt insights from behavioural science to stimulate consumer acceptance. Also, a structure for developing recommendations and for defining possible strategies to pursue RHC was called for. Moreover, the main points raised in the workshop discussions match well with the so-called **EAST methodology** that provides four simple principles for promoting behavioural change: **make it Easy, Attractive, Social and Timely**. This triggered us to adopt the EAST methodology to structure the recommendations for the European diffusion of RHC technologies described in the next chapter.

6 CONCLUSIONS OF THE ANALYSIS

In this section we summarize the conclusion of the analysis in terms of the main barriers and opportunities for consumers, as a stepping stone to the policy recommendations addressed in the last chapter. Our focus is on consumer related opportunities and barriers; other types of barriers like technological ones (e.g. developing more affordable thermal storage solutions) are not included in the analysis. Main conclusions and policy recommendations are grouped based on the four principles of the so-called 'EAST' framework (Section 6.3). We group together those barriers, opportunities and policy recommendations that are influential to, or aimed at, 'making it Easy', 'making it Attractive', 'making it Social', or 'making it Timely' for consumers to invest in RHC solutions.

In this section, we first present the main messages emerging from the overall analysis to highlight key issues most frequently mentioned. Then we briefly summarize barriers and opportunities related to the main consumer decision-factors encountered. Following, we explain the EAST framework and revisit main barriers and opportunities for each EAST dimension.

6.1 Key messages

The key messages are based upon those statements that were most frequently mentioned during the interviews. By systematically connecting the respondents' viewpoints to concrete 'statements', and counting the frequency of these statements, the most important issues were identified. These lead to three main conclusions as follows.

6.1.1 Limited decision time after existing system break-down as a main limiting factor

There are various types of windows of opportunity for investing in RHC technologies: in the process of new built housing, and when replacing an existing system in a newly acquired home or as part of a broader renovation (Section 4.1.2). In those cases, there is sufficient time to make a thorough consideration about which heating or cooling system to choose. However, the process of installing a new heating system often starts when the existing system has a problem or breaks down. In that case, the time for decision-making is limited. This results in the replacement with the same type of technology, which is the easiest and the least complicated (Statement "Breakdown").

We conclude that more time for decision-making can enhance deliberative decision making, in which decisions are based on a sound evaluation of the pro's and con's of different alternatives.

6.1.2 RHC still not able to compete at scale due to high upfront investment, and despite financial support

For many consumers, the main decision factor is the economic factor, both regarding installation and operational cost (see also FRONT consortium a). However, despite financial support and generally lower operational costs, the long-term character of the investment is one of the main barriers in RHC (Statement "Economic perspective and payback time"). Heating systems with fossil fuels such as oil and gas (and hard brown coal in some countries) are still the major competing solutions, because of the low fossil fuel price. This postpones consumers' decision for replacement and prevent them from choosing RHC in the replacement (Statement "Competing alternatives").

We conclude that there currently is an unequal playing field between RHC and fossil HC, concerning both the cost division between up-front costs and operational costs, as well as the currently low fossil fuel price and lack of external costs (CO_2 emissions) pricing. The current incentive structure does not give a clear advantage to RHC professionals and consumers.

6.1.3 Installers are important but not RHC ambassadors yet

Installers play a significant role in consumers' decision to choose a heating and cooling system. Although many consumers try to collect more information from other sources for instance from the internet and friends, the installers's advice has often more impact on the customers' decision in the end (Statement "Installers").

As we have seen that notably installers generally have negative views and preferences on RHC technologies and advise consumers accordingly, we conclude that current practice among installers and other installers constitutes a main barrier to RHC adoption. Moreover, we conclude from additional studies that the trustfulness of the source of information is important: Existing (informal) relations and social proximity provide trust. Therefore, installers, installers and the direct social surrounding like neighbours and friends have a strong influence on the technology perception people have.

6.2 Decision factors: barriers and opportunities

As described in Section 4.4, consumers apply a set of decision factors when choosing among the different RHC technologies. In Table 5 and Table 6 the relevant decision factors and the extent to which they provide opportunities or barriers to the diffusion of the RHC technologies are shown[2]. For most decision-factors, both opportunities and barriers were mentioned. Economic factors, for example, can be considered an opportunity when focussing on the relatively low running costs. However, they are equally considered a barrier, because of the high installation cost and because the lower running costs are often perceived as being not large enough to compensate for the higher upfront investment The latter can relate both to misperceptions (as is the case for biofuels) and real-life circumstances (as is the case for heat pumps in areas with high electricity prices). Also the ecological impact, functional quality of the system, and the easiness of installation and operation can be considered both a barrier and opportunity, depending on the specific aspects and technologies at hand. In some cases, opportunities (like for 'independence', 'social status', 'added value to the building') or barriers (like for 'physical space consumption', 'appearance of the system', and 'well-known and trustworthiness') are dominant. The interview results suggest that the trustworthiness of RHC technologies strongly correlates with the extent to which these technologies are well-known and is sometimes compromised by negative experiences in the past. To some extent, trustworthiness is a barrier for all technologies, depending amongst others on the adoption levels of technologies in the specific regional context at hand.

The interview findings on decision-factors are generally consistent with previous findings from the FrONT project (FRONT consortium a). For example, our findings confirm the general view that the initial investment is an important barrier, while lower operation costs provide the economic opportunity. Both studies show that ecological reasons are generally seen as an opportunity, while visual impact and space needs can be a barrier. Yet, our findings equally highlight that the perception of lower operating costs are not always shared by consumers. We also find environmental concerns related to emissions

[2] The ones listed for DHC are omitted since the interviews revealed only little information on this topic. See Annex 1 for results.

and source fuels of RHC technologies. Such nuances are important to take into account when developing policies and instruments for stimulating RHC adoption.

Table 5: Current opportunities for RHC technologies based on the interview results

Decision factor	Relevant opportunities				
		Solar thermal	**Biomass**	**Geo-thermal**	**Heat pumps**
Economic factors	Saving money in the long-term	✓	✓	✓	✓
Economic factors	Affordable product and installation costs	✓*			
Economic factors	Low running costs	✓	✓	✓	✓**
Easiness to install and operation	Fast and easy installation & operation	✓*		✓	✓***
Independence from heat supply	Independence from increasing prices of fossil fuels and fuel import	✓	✓****	✓	✓
Ecological impact	Environmental benefit as a major motivation	✓	✓	✓	✓
Social status	Consumers are proud of having a RHC system			✓	✓
Added value to the building	The RHC system provides an added value to their building			✓	✓
Functional quality of the system	Multi-functionality for both heating and cooling			✓	✓

* for solar thermal domestic hot water system

** especially in combination with PV

*** in case of air-to-water heat pump

**** especially in countries with large internal biomass resources

Table 6: Current barriers for RHC technologies based on the interview results

Decision factor	Relevant barrier				
		Solar thermal	**Biomass**	**Geo-thermal**	**Heat pumps**
Economic factors	Installation cost is higher than for fossil systems	✓	✓	✓	✓
Economic factors	Running costs perceived as not significantly lower than for fossil systems		✓*	✓	✓**
Economic factors	Payback time is longer than for other fossil systems	✓			
Easiness to install and operation	Complicated installation process (e.g. concerning the installation of pipes and boreholes)	✓***		✓	
Easiness to install and operation	Perceived as less comfortable in operation than fossil systems (e.g. due to removal of ash and occasionally cleaning of fuel storage)		✓		
Physical space consumption	Space consumption for storage (Hot water / Bio-fuel)	✓	✓		
Appearance of system	Aesthetic perception of the system is partly negative	✓			
Ecological impact	Concerns about the emission from fire woods/ about air pollution		✓		
Ecological impact	Concerns about the source of fuel (imported biomass) or electricity (generated from fossil fuels)		✓	✓	✓
Well-known and trustworthiness	Lack of trust due to negative experiences in the past and / or a general unawareness with the technology	✓	✓	✓	✓
Functional quality of the system	Operational problems like noise				✓

*related to misperceptions of the price of pellets compared to oil

**depending on electricity price

***only for existing housing

6.3 The EAST framework

The consumer's decision whether or not to install a RHC technology is ultimately influenced by the individual judgement on the balance of perceived benefits and risks associated with that particular technology. The process leading up to this decision is a cognitively demanding one, as it is influenced by a broad range of factors pertaining to the conditional, intermediate and consumer level (see Section 2.3). There is no agreement on the relative strength of the different levels and factors on consumer decision-making. Nor is there an easy (context-free) answer to the question which policies will stimulate the uptake of RHC technologies by consumers. A nuanced, yet simple and easily applicable view on consumer behaviour is required, taking factors at different levels into account.

Therefore, we have adopted a pragmatic approach for clustering barriers and opportunities and developing recommendations based on the EAST framework (Behavioural Insights Team, 2012). This framework was developed and extensively tested by the UK 'Behavioural Insights Team' (BIT) – a team specifically dedicated to inform government on how to include insights from behavioural science in the policy design process. The core idea of EAST is that policy measures that are designed to "make it Easy, Attractive, Social and Timely" for people to adopt certain behaviours or decisions have a higher likelihood of being successful (Behavioural Insights Team, 2012)[3], see the box below.

[3] The examples in the box are taken from this publication.

The EAST framework

Source: Behavioural Insights Team (2012)

Make it Easy, for instance:

- Harness the power of defaults. Making an option the default makes it more likely to be adopted.
- Reduce the 'hassle factor' of taking up a service. The effort required to perform an action often puts people off. Reducing the effort required can increase uptake or response rates.
- Simplify messages. Making the message clear often results in a significant increase in response rates to communications. In particular, it's useful to identify how a complex goal can be broken down into simpler, easier actions.

Make it Attractive, for instance

- Attract attention. We are more likely to do something that our attention is drawn towards. Ways of doing this include the use of images, colour or personalisation.
- Design rewards and sanctions for maximum effect. Financial incentives are often highly effective, but alternative incentive designs also work well and often cost less.

Make it Social, for instance

- Show that most people perform the desired behaviour. Describing what most people do in a particular situation encourages others to do the same. Similarly, policy makers should be wary of inadvertently reinforcing a problematic behaviour by emphasising its high prevalence.
- Use the power of networks. We are embedded in a network of social relationships, and those we come into contact with shape our actions. Governments can foster networks to enable collective action, provide mutual support, and encourage behaviours to spread peer-to-peer.
- Encourage people to make a commitment to others. We often use commitment devices to voluntarily 'lock ourselves' into doing something in advance. The social nature of these commitments is often crucial.

Make it Timely, for instance

- Prompt people when they are likely to be most receptive. The same offer made at different times can have drastically different levels of success. Behaviour is generally easier to change when habits are already disrupted, such as around major life events.
- Consider the immediate costs and benefits. We are more influenced by costs and benefits that take effect immediately than those delivered later. Policy makers should consider whether the immediate costs or benefits can be adjusted (even slightly), given that they are so influential.
- Help people plan their response to events. There is a substantial gap between intentions and actual behaviour. A proven solution is to prompt people to identify the barriers to action, and develop a specific plan to address them.

The BIT does not claim that the EAST framework addresses all complexities and nuances of behavioural sciences, but it is supported by academic findings and has proven its usefulness in actual policy-making contexts. The BIT has found that policy makers and practitioners find it useful to have a simple, memorable framework to think about effective behavioural approaches. In sum, the EAST framework is both informed by behavioural science insights (though it does not claim to provide any 'hard-and-fast' rules to influence human behaviour in any particular direction) and practical advice (in the sense that it connects to the 'lifeworld' of policy makers), which makes it a very useful 'tool' for our purposes. Furthermore, as it turned out, most of the feedback received during the two workshops could be conveniently organised within the categories of the

EAST framework. Table 7 gives an overview of main barriers and opportunities clustered under the EAST categories. Also, the correspondence with the key messages of Section 6.1, and with the main decision-factors of Section 6.2 and other intermediary related and conditional factors describes in Section 4 is shown. In the following, the barriers and opportunities are further described.

Table 7: Overview of barriers and opportunities for RHC technologies

	Key message	**Barriers and opportunities**	**Related factors***
Easy	-	Easiness to install and operate (for consumers and installers)	Easiness to install and operation (D)
Attractive	**RHC still not able to compete at scale due to high upfront investment, and despite financial support**	The business model	Economic factors (D) Added value to the building (D)
		Non-monetary costs and benefits	Physical space consumption (D) Ecological reasons (D) Independence from heating supply / energy security (D) Function and quality of the system (D) Appearance of the system (D)
		Awareness and trust	Well-known and trustworthiness (D)
Social	**Installers are important but not RHC ambassadors yet**	Role of installers Social status and proximity	Influence from installers (I) Social status (D)
Timely	**Limited decision time after existing system break-down**	Windows of opportunity of RHC installation RHC policy vision and regulatory frameworks	Windows of opportunity (C)

***D= decision-factor, I = Intermediary-related factor, C = Conditional factor**

6.4 Barriers and opportunities related to Easiness

6.4.1 Easiness to install and operate

The first dimension of the EAST framework ('Make it Easy') relates mostly to the easiness to install and operate RHC technologies, which can be a barrier (Table 6). For solar thermal, for example, the complicated installation process and concerns about dirt if pipes have to be installed in existing buildings plays a role. For biomass, the use of biomass fuel requires removal of ash and occasionally cleaning of fuel storage. For Geothermal, the planning and installation process takes a few months, making it practically impossible in urgent cases. During the validation workshops, the enhanced complexity compared to conventional solutions was considered a main barrier for RHC solutions from the consumer point of view is. Often, RHC provides only part of the heating solution for homes (e.g. with a heat pump, sanitary hot water still must be

provided by a gas or electrical boiler). Also for installers, RHC is not an easy technology to deal with. As described in Section 4.2.1, installers find the installation of RHC systems relatively difficult. They are generally not familiar with RHC technologies, are hesitant to participate in trainings about RHC installation, and find the bureaucratic work of applying for financial support complex. During the validation workshops, the need for standardization to facilitate technical designs, to avoid design errors, and for performance assessment was stressed.

On the other hand, some features of RHC technologies are considered easy, thus providing opportunities as well (Table 5). For example, air-to-water heat pumps and in many cases solar thermal boilers are considered easy to install and operate, and geothermal is relatively easy in maintenance. For creating leverage, it is thus important to relieve barriers, but also to make use of these opportunities to create a positive perception on the easiness of the technology.

6.5 Barriers and opportunities related to Attractiveness

6.5.1 The business model

The second dimension of the EAST framework ('Make it Attractive') relates to a variety of decision factors. We first discuss a viable business model as a key feature of attractiveness, which relates mostly to the economic decision factors, as well as the added value to the building. For most technologies, the economic factors are considered a barrier (Table 6) as extensively discussed during the validation workshop (Section 5.2) and reflected in our second key message (Section 6.1.2). For all technologies, the relatively high upfront investment compared to fossil fuel options and long payback time is considered a barrier. For biomass, there is often a misperception about the operational costs which are misperceived as being expensive, while for heat pumps, the high price of electricity and low price of fossil fuels discredits the positive image of cheap operation costs.

Considering the opportunities (Table 5), the low running costs and the long-term benefits stand out across the RHC technologies considered. For air-to-heat and geothermal heat pumps, this benefit is enforced in combination with PV for supplying the heat pump electricity demand. For those technologies, the added value of the building further adds to the business case.

6.5.2 Non-monetary costs and benefits

Attractiveness is more than a viable business model. RHC technologies entail a variety of non-monetary benefits that support the business case. This relates to a variety of decision factors, some of which are considered barriers for RHC (physical space consumption, appearance of the system), opportunities (independence from heating supply / energy security) or both (ecological reasons, function and quality of the system) (see Tables 5, 6).

During the validation workshops, for example, the ability for air-to-heat and geothermal heat pumps to provide cooling in addition to heating (part of the function and quality of the system) was highlighted as an important added value of RHC technologies compared to conventional ones, especially in Southern Europe. However, for air-to-water heat pumps noise is still perceived to be a problem. During the validation workshops, also the environmental benefits of RHC technologies in general were highlighted as an important feature to convince people. This includes using local air quality as an additional argument in favour of RHC solutions, notably in countries where coal or fuel oil is commonly used. Yet, the benefits may be off-set by concerns over unsustainable biomass production, or fossil-fuel based electricity production for heat pumps. Finally, we mention independence as a relevant non-monetary benefit emerging from the interview results. This covers the larger autonomy consumers may experience, the use of more local resources, and the lesser dependence of fossil-fuel energy prices as main drivers for consumers to adopt RHC technology. In sum, although some drawbacks still need to be overcome, a number

of non-monetary benefits over fossil-fuel based HC apply that can be exploited to persuade consumers to adopt RHC technologies.

6.5.3 Awareness and trust

What is also important for the perception of attractiveness is awareness and trust. In the end what counts is the *perception* of consumers on how RHC solutions perform on the different decision factors, which is strongly mitigated by awareness and trust. In markets where technologies like solar thermal and heat pumps have already significantly penetrated the market, trust in the technology performance is generally high. Moreover, consumers are historically familiar with biomass as an energy source creating a positive perception around this RHC technology.

However, in cases where the technology is new on the market some scepticism occurs. For biomass technology, for example, some consumers fear that biomass systems might not work as comfortably as old fossil fuel systems do. In countries where heat pumps are still new in the market, many consumers consider investing in heat pumps as risky. Finally, the positive perception of function and quality for solar thermal and heat pumps is to some extent compromised by negative experiences in the past due to lack of maintenance or inadequate installation. This illustrates the important impact pioneering applications may have on the perception of RHC technology.

6.6 Barriers and opportunities related to Social dynamics

6.6.1 Role of installers

The third dimension of the EAST framework ('Make it Social') relates strongly to the intermediate level of the analytical framework, representing the potential influence of intermediary actors on the decision of the consumers. As discussed in Section 4.2.1 and reflected in our third key message (Section 6.1.3), the negative views and advise among installers and other installers constitutes a main barrier to RHC adoption.

6.6.2 Social status and proximity

'Make it Social' also relates to the decision factors of social status, and – indirectly - innovativeness of technology as a main contributor to such status. Both for air-based and geothermal heat pumps, consumers are often proud of having the technology and talk to friends and neighbours about it (Table 5). These positive associations with RHC technology can be embraced as an opportunity to enable RHC roll-out.

A common insight is that existing (informal) relations and social proximity provide trust. Installers, installers and the direct social surrounding like neighbours and friends have a strong influence on the technology perception people have. Mouth-to-mouth – whether positive or negative – has a significant influence on the spread of technology perception. More so if the technology itself is visible – for example in the case of geothermal heat pumps – the impact of social proximity can be high. These social dynamics offer an opportunity to spread a positive perception around RHC technologies, which can be more actively harnessed, for example by stimulating local action initiatives.

6.7 Barriers and opportunities related to Timeliness

6.7.1 Windows of opportunity of RHC installation

The fourth dimension of the EAST framework ('Make it Timely') relates mostly to the conditional level of the analytical framework, in particular regarding the windows of opportunity for RHC installation. As reflected in our first key message (Section 6.1.1), limited decision time after existing system break-down is considered as a main limiting factor. However, as described in Section 4.1.1, other windows of opportunity exist, for example as part of an (energy-related) renovation of an existing building or when a new building is constructed. The main lesson learned is to be aware of the (im)possibilities

particular windows of opportunity offer and to adapt to those windows in the timeliest fashion.

6.7.2 RHC policy vision and regulatory frameworks

Another feature of Timeliness relates to the development of a RHC policy vision and legal frameworks. In the validation workshops, the lack of urgency for a heating and cooling transition was recognised as a relevant barrier to the deployment of RHC needed to meet long-term climate and decarbonisation goals. Vice-versa, the current consensus on long term goals legitimates creating such a sense of urgency and provides an opportunity for developing a clear long-term policy vision on RHC connected to short-term actions. Concerning regulations – like the implementation of a CO_2 tax, or imposing a ban on fossil fuel HC – political feasibility was reported as a barrier. However, examples from countries like Denmark and the Netherlands do show that 'when the time is right' initiatives can be taken in this direction. For developing subsidy schemes, finally, over-subsidy followed by support removal was reported as a main barrier leading to market collapse and loss of trust for innovative solutions. Thus, also for implementing support schemes, the element of time needs to be reckoned with.

7 RECOMMENDATIONS FOR THE EUROPEAN DIFFUSION OF RHC

To allow RHC solutions to become competitive and to be deployed substantially on the heating and cooling markets, several policies need to be established to drive consumers' choices towards renewable solutions. In the final section of this report we formulate a range of policy recommendations aimed at removing the barriers and seizing the opportunities towards adoption of RHC technology.

The policy recommendations have been developed and are reported in a systematic way:

- Policy recommendations are grouped based on the four principles of the EAST framework (Section 6.3) We group together those policy recommendations that are mainly aimed at 'making it Easy', 'making it Attractive', 'making it Social', or 'making it Timely' for consumers to invest in RHC solutions.

- As shown in Table 8, each main barrier and opportunity corresponds to a main policy recommendation or 'policy message'. Under each main policy message, several concrete recommendations are developed through which the main policy message can be made operational. For each individual recommendation we identify in a series of recommendation tables:

    - which intermediaries the recommendation is mainly targeted at,

    - any conditional factors that might be of influence on the effectiveness of the policy recommendation, and that therefore have to be taken into account when considering the application of the recommendation in a (country-)specific context,

    - where applicable, concrete 'good practice' examples revealed in the interviews or available in the literature.

Table 8: Overview of policy recommendations to support the adoption of RHC technologies

	Barriers and opportunities	**Recommendations**
Easy	Easiness to install and operate (for consumers and installers)	*Make it easy for consumers* • Introduce a 'one-stop shop' for energy retrofits (E1) • Develop standardised 'RHC (package) products' for the residential and small commercial sector (E2) • Promote ESCO (Energy Service Company) approaches (E3) • Develop clear energy labelling for heating & cooling solutions, including for standardised package products (E4) *Make it easy for professionals* • Provide project development support for larger projects (E5) • Improve and extend training for heating and cooling professionals (E6) • Develop and promote the use of tools that allow for easier customer targeting (E7)
Attractive	The business model Non-monetary costs and benefits Awareness and trust	*Improve the business case* • Introduce a carbon tax (A1) • Reduce the tax on electricity for heat pump usage (A2) • Give upfront rebates for RHC solutions (A3) • Make offers with life-cycle costs and stress the 'future-proof' character of buildings with RHC systems (A4) *Communicate multiple benefits* • Emphasize the capacity of RHC technologies to provide heating AND cooling (A5) • Stress the beneficial health impacts of RHC solutions (A6) *Improve trust* • Leading by example (A7) • Organise public RHC technology procurement (A8) • Assured quality of RHC solutions (A9) • Set up a customers' complaint board (A10)
Social	Role of installers Social status and proximity	*Engage the installers* • See E5-E7 *Stimulate local action* • Develop local RHC transition plans (S1) • Implement procurement programmes at the local community level (S2) • Harness the power of cooperatives (S3)
Timely	Windows of opportunity of RHC installation RHC policy vision and regulatory frameworks	*Seize the windows of opportunity of RHC installation* • System failure prevention (T1) • Promote or mandate RHC technologies as part of energy retrofits (T2) • Include renovation roadmaps in EPC certificates (T3) *A timely RHC policy* • Develop and communicate a long-term decarbonisation plan for the heating and cooling sector, including intermediate milestones (T4) • Start as soon as possible with the obligation to install RHC technology in new buildings (T5) • Gradually phase out fossil fuels in the built environment (T6) • Adapt government incentive programs to the development of the RHC market (T7)

7.1 Make it easy

A main barrier for RHC technology adoption is its complexity compared to the fossil technologies. There are multiple RHC technologies on the market, and usually they only form a partial solution for the heating and cooling demand with often unclear information about what is the most suitable technology to adopt. Installers generally lack experience with RHC technology installations and applying for subsidy schemes also adds to the complexity. The main policy recommendation is thus: make it easy, both for consumers and installers.

7.1.1 Make it easy for consumers

To make it easy for consumers to adopt RHC technologies, a number of concrete policies can be pursued. For example, introducing a 'one-stop-shop' for energy retrofits (recommendation E1) could make consumer decision-making easier by offering a complete solution for heating and energy efficiency facilitated by a neutral point of contact. Another example is to develop standardised 'RHC (package) products' for the residential and small commercial sector (E2). Such package products should combine space and/or water heating products into a complete heating and cooling solution, thus avoiding the complexity of customizing for each individual home. Energy Service Company (ESCO) approaches may be promoted (E3). These have the dual advantage of transferring both the decision about the most effective RHC solutions, as well as concerns about performance, durability and maintenance to a specialized firm. Finally, we identify clear and efficient energy labelling on heating and cooling systems as a powerful way to inform and empower end users in the most easy and accessible way (E4).

Recommendation E1	Introduce a 'one-stop shop' for energy retrofits
Description	For households in particular, objective choices regarding energy retrofits to dwellings are often not always possible due to unclear/contradictory information. There is still a lot of uncertainty about the optimal combination of heating system and energy efficiency measures for each specific situation. A possible leverage here would be the introduction of a local 'one-stop-shop' for energetic renovations, i.e. a neutral contact point for households that coordinates the entire process of energetic renovation - from consultancy to contacting contractors to following up on the works. This could be in the form of a public-private partnership. The government could play a pioneering role in compiling a consortium of stakeholders (from knowledge institutions, administrations, the construction sector, installers of heat and cooling technologies, etc.) that would provide the design of a digital knowledge platform for energy efficient renovation and heating and cooling solutions.
Intermediaries	Local and regional governments in the lead; consultants, installers and the construction sector as main partners.
Conditional factors	Platform must be developed by trusted institutes and supported by sound scientific advice. Quality assessment is crucial.
Good practice	The Ile-de-France region in France has set up a public service, acting as a one-stop-shop, backed by Energies Posit'if, aimed at advising, supporting and helping to fund a private individual's home energy improvements. Energies Posit'if is a public/private company used by French local authorities to manage urban development projects particularly energy related projects. It aims at increasing the number of energy retrofits in the Ile-de-France region by providing comprehensive technical services (energy advice, retrofits and energy performance guarantees) and third-party financing to thermally upgrade multi-unit buildings. (FRONT consortium b) The Danish Energy Agency has established a free and independent advice service for consumers who want to replace old oil and gas fired boilers with heat pumps. The advice service includes a telephone-service open every day and the possibility to have questions answered via e-mail. Also information meetings are held. (NORDSYN 2015)

Recommendation E2	Develop standardised 'RHC (package) products' for the residential and small commercial sector
Description	The installation of RHC systems in buildings is a highly customised process (especially for ground-source heat pumps and solar thermal systems). This customised design and installation approach increases costs of RHC systems relative to more standardised conventional heating systems. While customisation is necessary for most large, commercial- or industry-scale systems, there are opportunities to establish standardised design and installation approaches at the residential and small commercial level. This standardization can extend to 'package products'. Package products are a combination of space and/or water heating products sold as a package. Any combination of heat pump space heaters or water heaters, temperature controls, solar devices, and any supplementary heating device can be sold together as a package product. In new buildings or in the case of substantial energy retrofits it can be beneficial to follow a 'whole system' approach for the building.
Intermediaries	Manufacturers to develop standardized package products; installers, architects and planners to market them.
Conditional factors	Installations in residential new construction are expected to have the greatest potential for standardisation, as current building codes dictate the calculation of the heating load and the design of the heating system to a high level of uniformity.
Good practice	Heat pump installation (mainly air-source heat pump) is often included in the package for building a prefabricated house in Germany. In the current financial situation this is the most preferred option, so many people decide to adopt this package.

Recommendation E3	Promote ESCO (Energy Service Company) approaches
Description	Customers may typically perceive larger risks associated with RHC solutions than traditional systems, e.g. concerns over quality and durability, overall performance, and availability of maintenance services. In addition, larger commercial and industrial entities may be wary of investing in RHC technologies that require new staff or additional training to maintain. The ESCO approach effectively deals with such concerns, as the (perceived) risks of RHC installation and operation are transferred to a specialized firm. Stimulated by ambitious and clearly defined policy goals, new players (such as energy suppliers, installers or producers of heating and cooling equipment) can launch new ESCO business models on heating and cooling market. For example, it may be possible in the future for these players to establish themselves as suppliers of heating and/or cooling services (as a 'heating and/or cooling broker') instead of as sellers of heating and/or cooling installations. Such a supplier of heating and/or cooling services then chooses the combination of the most suitable heating and/or cooling techniques adapted to the building, the needs/desires of the user and the policy framework (also in the long term – cf. Recommendation T4), while remaining the owner of the heating and/or cooling installations. The heating and/or cooling service is then offered in the form of, for example, a leasing contract, with all additional services (repair and maintenance) included. Governments can support the creation and growth of an energy services market for RHC solutions by e.g. allowing tax deduction credits for leasing contracts.
Intermediaries	Manufacturers, installers, energy companies to provide energy services; governments to facilitate such services.
Conditional factors	Development of a market for RHC solutions is needed. Recommendation probably most applicable to multi-apartment buildings, offices or public buildings.
Good practice	In Switzerland, there are close to a thousand municipal utilities. It is common practice for these municipal utilities to have "heat contracting" models where the utility plans, install and operate and maintain heat pumps at their cost on customer sites. The heat is sold to the property owner at a set price. The model is mostly employed for commercial scale heat pumps in multi-family homes – i.e. a large heat pump would be installed in a plant room within a block of flats and the heat sold to the building owner – who would have their own contractual agreements with individual dwellings.

	(DELTA 2013) The Danish government has funded a suite of demonstration projects investigating innovative business models which it hopes will unlock market growth in heat pumps. Projects include a district heating company installing heat pumps on customer sites and selling the heat under a heat contract, an independent ESCO doing heat contracting with heat pumps, and an energy supplier leasing heat pumps. (NORDSYN 2015)

Recommendation E4	Develop clear energy labelling for heating & cooling solutions, including for standardised package products
Description	A powerful way to inform and empower end users is to promote clear and efficient energy labelling on heating and cooling systems. Member States should implement energy labelling requirements as required by EU regulations and make sure clear and harmonised labels give sufficient and sufficiently clear information to inform end-consumers choices (e.g. by using clear colour coding). Overall, the energy label should send out a message in support of RHC technologies. The granting of support should also be made conditional to the best performing heating and/or systems. Package products are a combination of space or water heating products sold as a package. Any combination of heat pump space heaters or water heaters, temperature controls, solar devices, and any supplementary heating device can be sold together as a package product. The package products are covered by EU regulation (2013/811/EU and 2013/812/EU) and have to display energy labels designated for package products.
Intermediaries	Governments
Conditional factors	-
Good practice	EU Ecodesign regulations

7.1.2 Make it easy for professionals

Also for professionals, RHC technologies are often relatively complicated to work with as it concerns a still relatively new technology. Various ways exist to make their work with RHC technologies easier. Larger projects, for example, could benefit from project development support (recommendation E5), ranging from initial feasibility studies, to design support and evaluation. This could improve project quality and mitigate financial risks. Another recommendation (E6) is to improve and extend training for heating and cooling professionals. This can increase professionals' awareness and level of proficiency on RHC installations, which is currently often lacking. Moreover, the development of a comprehensive customer-targeting tool for installers (E7) would allow for easier customer targeting. Such a tool – encompassing for example geological maps, building-by-building fuel usage and heating appliance age maps, educational materials, a lifecycle cost calculator, and an installer identification service – would equally be an important resource for consumers enabling a first assessment of the potential of RHC in their home and offering a channel to reach out to installers.

Recommendation E5	**Provide project development support for larger projects**
Description	Governments could make funding available to provide support for larger projects in strategic market segments (such as state and municipal buildings, new real estate developments, social housing sites, large commercial sites) to reduce the risk of pre-development costs. Support could include (NYSERDA 2017): • Initial assessments, including site suitability assessments; • Feasibility studies to establish lifecycle costs for RHC as compared to a traditional 'business-as-usual' solution; • Design support to ensure the RHC systems are designed by RHC professionals; • Measurement and verification to increase the confidence in outcomes and replicability of success.
Intermediaries	Governments to provide funding; architects and planners to provide project development support.
Conditional factors	Substantial government funding needed.
Good practice	-

Recommendation E6	Improve and extend training for heating and cooling professionals
Description	The RHC sector faces challenges with many traditional installers having a limited understanding of how to sell, install, or price RHC technologies. In addition, conventional installers often lack the proper knowledge to inform customers on lifecycle product performance and long-term cost savings potential (cf. Recommendation E7). Similar challenges are seen among traditional planners, architects, and engineers. Installers might prefer selling conventional technologies because new technologies like RHC require new training and/or installation practices, and a different sales approach, both of which require investments in time and money for their staff. Because of this, installers face higher risks of installing a poorly performing project when using new technologies, which can further increase their costs. For these reasons, conventional installers will often mark up the cost of RHC installations to cover these (real or perceived) business risks. In order to increase professionals' awareness and level of proficiency on RHC installations, the number of installers trained and the quality of these trainings should be largely improved. Training can be coupled to certification of qualified RHC installers, e.g. by the national RHC industry association. In particular, more training on the local level is needed, with a special emphasis on the local benefits of RHC solutions. RHC technologies being new and innovative technologies, a qualitative installation is crucial to maximise its economic and environmental benefit, building therefore a positive reputation for the technology (cf. recommendations on 'making it social'). The EU RES Directive referring to certification and qualification schemes should be reinforced and better implemented by member states.
Intermediaries	Governments and RHC industry associations as the driver and coordinator of quality assurance and training, consultants offering training; installersinstallers to enrol in training programs.
Conditional factors	NORDSYN (2015) stresses that quality – both of the RHC technology and the installation process – is an absolute precondition for RHC market take-off. This report recommends the establishment of strong RHC trade associations as the driver and coordinator of quality assurance, training, testing and dissemination activities as a key enabler for market take-off. With the necessary quality assurance in place, governments should then take appropriate initiatives to stimulate market growth through a set of policy measures and building codes (cf. recommendations on 'making RHC attractive). Such a growing market would in turn incentivise

	installers to get voluntarily trained to supply a growing demand for RHC installations.
Good practice	The growth of the heat pump market in Switzerland was driven by an intensive government-led heat-pump promotion campaign (over the period 1993-2001) with a focus on quality assurance, training and extensive testing campaigns. The Norwegian Heat Pump Association (NOVAP) recognizes and approves dealers with a qualified professional competence. Customers are encouraged to choose NOVAP-certified dealers when purchasing heat pump products and systems, as they are then better ensured against technical mistakes in sizing and installation of the system. Quality assurance is put in place in other Scandinavian countries as well. (NORDSYN 2015)

Recommendation E7	Develop and promote the use of tools that allow for easier customer targeting
Description	Given the fact that the market for RHC solutions is still in the emerging phase in many countries, installers typically do not invest in or do not have the resources to invest significantly in customer acquisition, and typically therefore only reach a small part of the potential customer base. For their part, customers are often unaware of RHC as an option when considering the replacement of their heating and/or cooling system. The development of a comprehensive customer-targeting tool for installers, which would also offer the necessary resources for customers, could help in addressing these barriers. Such a tool could include (NYSERDA 2017): • A variety of technology, resource, and load maps that would assist installers, such as geological maps, building-by-building fuel usage and heating appliance age maps, utility load maps, existing RHC installations, customer credit and home turnover maps, etc. (all subject to data protection issues of course). This would enable installers to market RHC systems directly to highest-potential customers (e.g. geographically clustered, high-potential residential customers). • Educational materials and a lifecycle cost calculator, link to tools that can provide general guidance on a building's suitability for each of the RHC technologies, and potentially provide an installer identification service that enables customers to reach out to installers.
Intermediaries	(Local) governments to provide funding and support; installers as the main users of customer targeting tools; consultants for developing the tools.
Conditional factors	Development of the tool (and the database supporting it) would hinge on aggregating existing public data sources, accessing aggregate data from third-parties, and working with web developers to enable contractor and consumer accessibility.
Good practice	On the Danish consumer's website SparEnergi.dk, there is information concerning many aspects of appropriate installing of heat pumps. The consumers can obtain cost savings and payback periods from an online calculator, choose a product from a (government approved) list of available heat pump designs, find the approved installers from a digital too installers's list) as well as read case studies and good advice. (NORDSYN 2015)

7.2 Make it attractive

A main barrier for RHC technology adoption is the high upfront investment cost. Nonetheless, there are various benefits associated with RHC technologies - like low operating costs, provision of heating and cooling, property value increase, and environmental benefits – that provide good arguments to persuade consumers to adopt RHC. Our analysis does suggest that awareness and trust in RHC technologies and the benefits it provides still needs to be improved. Main policy messages are thus: improve the business case, better communicate multiple-benefits, and improve trust.

7.2.1 Improve the business case

To improve the economics of RHC solutions, one can adopt a variety of financial incentives (subsidies, taxation) that improve economic attractiveness for RHC relative to fossil fuel technologies. A concrete recommendation is to introduce a carbon tax (A1), such as the one in place in Sweden. A carbon tax internalizes the external costs of CO_2 emissions, thereby creating a more equal playing field between RHC and energy efficiency, and fossil-fuel-based HC solutions. An alternative recommendation (A2) is to reduce taxes on electricity used for heating purposes specifically. As the examples of Denmark and Switzerland show, this provides a competitive advantage for heat pumps specifically. To reduce the barrier of high upfront investment, direct rebates on investment costs or zero-interest loans for RHC solutions can be adopted (A3). Such policies are often effective because people are generally more influenced by immediate over long-term costs and benefits.

Besides improving the financial specs for RHC solutions per se, it may be equally important to create a mind shift towards a higher appreciation of the long-term benefits over the short-term costs. Architects and planners, consultants, installers should therefore more often create offers with life-cycle costs and stress the 'future-proof' character of buildings with RHC systems (A4). An important requirement is that RHC do outperform fossil fuel alternatives on this criterion, possibly requiring the use of recommendations (A1-3).

Recommendation A1	Introduce a carbon tax
Description	Negative externalities created by the use of fossil fuels are not internalized and create a burden for the society. The 'Polluters Pays Principle' should be adopted through the introduction of a carbon tax or other levies. This system would have the advantage to put pressure on fossil fuel based heating. A carbon tax will therefore indirectly support all other alternatives, including energy efficiency and a switch to RHC solutions. This system would also progressively limit the need for direct financial support. It will help the RHC sector to become a market-oriented competitive sector, which offers economically viable solutions for operators willing to avoid paying taxes on their polluting activities. An important first step in the direction of a carbon tax is phasing out any remaining subsidies for fossil-fuel based heating.
Intermediaries	Governments
Conditional factors	Broad public and political acceptance needed. Gradual introduction of carbon tax (starting at a low level and increasing in a predictable way) can be a solution. In addition, the tax revenues can be recycled into the economy to support RHC solutions or other clean energies. The impact on vulnerable customers, who often do not have the means to switch to RHC solutions, should be carefully considered and if needed, flanking measures should be put in place for this target group.
Good practice	In Sweden, there are no direct subsidies for renewable heating and cooling installations (though there is tax reduction for all repair and maintenance work, refurbishment work and retrofit work, and therefore including the installation work of renewables). A main reason why customers have already switched from fossil fuels to some other systems such as biomass and heat pumps (including geothermal heat pumps) is the high carbon tax.

Recommendation A2	Reduce the tax on electricity for heat pump usage
Description	Heat pumps often cannot compete with fossil-fuel alternatives even when taking into account the lifecycle perspective, because electricity is much more expensive than gas or oil in many countries. Because of this situation, customers are faced with a negative investment case when comparing heat pumps to traditional fossil-fuel alternatives. Governments can intervene by reducing taxes on electricity used for heating purposes.
Intermediaries	Governments
Conditional factors	Only relevant for heat pumps
Good practice	Denmark promotes the use of heat pumps by reducing the taxes paid on electricity for electric space heater and heat pumps users. For customers whose energy consumption is typically over 4,000 kWh, there is a tax reduction. Therefore, the unit price for electricity used for space heating and heat pumps is reduced (NORDSYN 2015). In Switzerland, customers can profit of lower electricity tariffs from their local grid operator if they agree to give control over the heat pump operation (within specified comfort limits) to the grid operator for grid management purposes.

Recommendation A3	Give upfront rebates for RHC solutions
Description	Direct rebates on the investment costs for RHC solutions are an effective means to partly overcome the barrier of high upfront cost for most RHC solutions. Zero-interest loans are also a good policy option. Compared to tax rebates, they have the advantage that the rebate is paid immediately. Behavioural research has shown that we are more influenced by costs and benefits that take effect immediately than those delivered later.
Intermediaries	Governments to coordinate and provide funding; banks to provide loans.
Conditional factors	Used mostly for emerging markets, as policy costs raise with an increasing application level.
Good practice	Denmark offers financial support for some emerging RHC options, including: • 13-25% investment subsidies for large-scale heat pumps for district heating systems chosen through tenders; • Premium tariff payments for biogas used in heating and for biomethane for grid injection. The tariff is paid per GJ of biogas used and increases or decreases annually depending on the price of natural gas. In France, a zero-interest loan (with a maximum of EUR 30 000) is available for renewable heat installations in the course of building renovation if combined with energy efficiency measures. Biomass boilers and air-source heat pumps being the most successful technologies are most frequently installed as a consequence of this incentive (IEA 2018a).

Recommendation A4	Make offers with life-cycle costs and stress the 'future-proof' character of buildings with RHC systems
Description	RHC technology options face challenges with conventional installers lacking the proper training to educate customers on lifecycle product performance and long-term cost savings potential. Similar challenges are seen among traditional designers, architects, and engineers. As a result, during a bid process, designers and contractors may not offer RHC as an option to commercial or residential customers. Professionals that set up bid structures also often over-emphasize initial costs and de-emphasize life-cycle costs (NYSERDA 2017). To avoid decisions only based on initial investment costs, all offers have to include the expected life cycle costs. Furthermore, architects and real estate developers should stress that RHC represents the 'technology of the future', so that potential buyers can be convinced that they are buying a 'future-proof' dwelling.
Intermediaries	Architects and planners, consultants, installers to include expected life-cycle costs more explicitly in their offers and advise to consumers.
Conditional factors	Life-cycle costs have to be effectively lower than fossil-fuel alternatives. For the time being, this implies that usually some form of support will be needed for RHC solutions or that the external costs of the fossil-fuel alternatives are taken into account, e.g. through a carbon tax or removal of subsidies (cf. Recommendation A1-3).
Good practice	-

7.2.2 Communicate multiple benefits

A number of non-monetary benefits over fossil-fuel based HC apply that can be exploited to persuade consumers to adopt RHC technologies. A main example is the capacity of heat pumps to provide heating AND cooling, which is recommended to emphasize more strongly, especially in southern- and central European countries where this benefit applies most (A5). In addition, the beneficial health impacts of RHC solutions can be stressed more (A6), notably in countries where coal or fuel oil heating is commonly used. Improved local air quality has a clear benefit for individual consumers, but also has a broader societal relevance (e.g. reducing health care costs) legitimizing the support in RHC from a governmental point of view.

Recommendation A5	**Emphasize the capacity of RHC technologies to provide heating AND cooling**
Description	Heat pumps can provide a high-efficiency source of cooling compared to many conventional air-conditioning units. The lack of air conditioning is an increasing health and safety risk for vulnerable populations, such as the elderly and low-to-moderate income residents, especially in Southern parts of Europe. This fact should be brought under the attention of the public, for instance through broad media campaigns.
Intermediaries	Manufacturers and RHC industry associations in their outreach activities; governments in their information portals; installers and consumer organisations in their advice to consumers.
Conditional factors	Only relevant for heat pumps. Especially relevant for hot climate zones (e.g. Central and Southern Europe).
Good practice	-

Recommendation A6	Stress the beneficial health impacts of RHC solutions
Description	The investments in energy efficiency and RHC lead to a reduction of both GHG emissions and air pollutants, which translates into a favourable impact on the environment and on health. The reduced emissions of particulate matter and the improvement of the indoor air quality will reduce the cost of health care. The quantification of this additional positive impact on the cost of health care can also provide the government with additional legitimacy for higher policy ambitions. In addition, an increase in energy efficiency also has a favourable impact on the security of supply (and thus on the trade balance and the independence of foreign suppliers), something that can also be played out as a legitimizing factor.
Intermediaries	Manufacturers, RHC industry associations and civil society organisations in their outreach activities; governments in their information portals and for underpinning policies; installers and consumer organisations in their advice to consumers; consultants and other experts by further investigating and underpinning such health benefits.
Conditional factors	Availability of adequate data and sound scientific support by trusted scientific institute.
Good practice	-

7.2.3 Improve trust

Where RHC technology is new on the market – or where flawed pioneering applications have left behind a negative perception – the level of trust may be low. We therefore recommend a number of ways through which trust can be created or restored. Governments and the social housing sector, for example, should 'lead by example' (A7) by implementing an ambitious renovation programs encompassing RHC solutions. A specific procedure is worth mentioning is the Public Procurement of Innovative solutions (PPI) demonstrated for the case of heat pumps in Sweden (A8). With PPI, the public sector uses its purchasing power to act as early adopter of innovative solutions which are not yet available on large scale commercial basis, supporting commercialisation and creating visibility for the product.

A second feature of trust is assuring the technology works 'as promised'. Assured quality of RHC solutions (A9) can be achieved by government-initiated performance testing to support consumers in their investment decision, such as in the heat pump tests the Swedish Energy Agency performs. Offering insurance packages or working with ESCO approaches are further ways to take the risk of malfunctioning or unexpected low performance out of the consumers' hands. Also, setting up a dedicated RHC technologies complaint board (A10) gives consumers confidence that potential problems with RHC performance will be adequately resolved, while at the same time providing an incentive to installers and manufacturers to improve quality and service.

Recommendation A7	**Leading by example**
Description	Governments can 'lead by example' by developing and implementing an ambitious renovation program for public sector buildings. In addition, the social housing sector can act as a 'launching customer' on the market for energy renovations and RHC solutions.
Intermediaries	Governments, social housing sector.
Conditional factors	It could be required that the improved (energetic) quality of the social housing dwellings may be passed on to the rent after the renovation. This increased rent should however be compensated by savings on the energy bill.
Good practice	-

Recommendation A8	Organise public RHC technology procurement
Description	Public Procurement of Innovative solutions (PPI) happens when the public sector uses its purchasing power to act as early adopter of innovative solutions which are not yet available on large scale commercial basis. PPI provides a large enough demand to incentivise industry to invest in wide commercialisation to bring innovative solutions to the market with the quality and price needed for mass market deployment, thus also creating visibility for the innovative product. This enables the public sector to modernize public services with better value for money solutions and provides growth opportunities for companies.
Intermediaries	Governments and other public sector organizations as main procures; energy agencies to coordinate the procurement process; manufacturers and consultants to provide innovative solutions.
Conditional factors	For PPI to happen, a critical mass of purchasing power on the demand side needs to be formed (one large enough buyer or several smaller buyers in a buyers group). This critical mass needs to be large enough so that industry is incentivised to scale up the production to bring solutions to the market with the price and quality requirements for large scale deployment. If technologies are already well-developed (i.e. mass markets already exist), the benefits of PPI will be smaller than in the initial stages of diffusion.
Good practice	The market growth of heat pump in Sweden is partly a result of technology procurement. The 'Nordic Heat Pump Competition' organized by the Swedish National Board for Technical Development (NUTEK) (in the mid-1990s) on heat pumps got quite a lot of attention and interest on the technology giving people opportunities to learn about it, and the sales started to increase rapidly. The competition was organized to stimulate development of a new generation of heat pumps for existing homes. A specification for the heat pumps was developed with NUTEK which was based on the end-user and market needs: more efficient, reliable and lower cost than (at the time) existing market solutions; and a product which did not use CFC or HCFC refrigerants (in response to the Montreal protocol). (NORDSYN 2015)

Recommendation A9	Assured quality of RHC solutions
Description	Customers typically lack confidence in the reliability and performance of RHC solutions. This may be due to a historical focus by policymakers on incentivizing high-efficiency fossil fuel systems, lack of effective marketing by industry, and/or an absence of government-led consumer education programs, to give a few examples. Customers have to be assured of the sustainable quality of the RHC solutions they are installing in their dwellings. Another recommendation concerns the development of insurance packages that provide a 'safety net' against unexpected disfunctions of RHC solutions. It would facilitate the customers' decision that the heating system is covered by insurance. The ESCO approach (cf. recommendation E3) would also provide effective quality assurance for customers, as the risks of malfunction are effectively transferred to the company offering the RHC solution.
Intermediaries	Governments and expert laboratories to develop product testing; banks and insurance companies in providing insurance; installers to communicate about these possibilities to consumers.
Conditional factors	Insurance costs can be kept under control on the condition that good quality solutions are available on the market. The insurance provider has to trust the technology based on thorough knowledge of performance.
Good practice	The Swedish Energy Agency has been testing heat pumps since 2004. The purpose of these tests is to help customers to choose a heat pump that best fits their needs with regards to energy efficiency, noise levels, price and quality. The tests are published on the Energy Agency's website and are frequently used in marketing by manufacturers. As these tests are highly valued by customers because of their objectivity, their marketing value to manufacturers is high. In this way the tests work as a sort of competition between manufacturers (NORDSYN 2015). Also in Sweden heat pumps are covered by house insurance, and it is common to get an extra insurance when purchasing a heat pump. In single-family houses, the house insurance can cover the malfunction of heat pumps easily.

Recommendation A10	Set up a customers' complaint board

Description	It is recommended to install a complaints board separately from a more generic complaint board (for general customer products), specifically to deal with litigation matters for RHC installations. It is a mechanism through which to deal with the problem of false claims about RHC performance by installers, an issue which can be particularly damaging to customer confidence in RHC solutions. Claims can be brought against installation companies for a number of issues – e.g. comfort levels being lower than required, or energy bills being higher than expected. If an installer is found 'guilty', it must pay back the customer's court fee, and fix the problem (e.g. remove, re-install or fix the system) (cf. Swedish practice). Setting up a customers' complaint board is likely to have the following effects on intermediaries: • **Installers**: The existence of a complaint board is an incentive to quickly fix problems with RHC solutions they have installed. • **Manufacturers**: The fact that the board decision is made public means that a poor installation will reflect badly on the manufacturer. This gives the manufacturer an incentive to go one step further in ensuring the quality of their installers. • **Customers**: a complaint board gives consumers confidence that if there are any problems with RHC performance, they have an easy and affordable route to resolve the conflict.
Intermediaries	RHC industry associations in setting up a complaint board; installers as main partners.
Conditional factors	Most useful in the early stages of RHC market development. Dedicated resources (time, money) should be available for running the board. Buy-in of the RHC industry and installers is needed; both have to be convinced that the board is necessary to drive customer confidence.
Good practice	Setting a customers' complaint board in Sweden (where customers can file complaints about the heat pump installations and can get the ruling from the committee and recommendations how the installers should help customers) was helpful in the beginning of the heat pump market, until the market became mature. Such complaint board plays a big role for customers, because they have a place to go to solve some issues before the issues are brought to court (NORDSYN 2015).

7.3 Make it social

We previously identified the negative views and advise among installers and other installers as a main barrier to RHC adoption. At the same time, we saw that social status and proximity – making use of visibility and word of mouth to spread positive stories

around RHC technology – can be an important opportunity. Main policy messages are thus: engage the installers and stimulate local action to harness the opportunities of social status and proximity.

7.3.1 Engage the installers

To engage the installers, all recommendations for making it easy for installers and other professionals apply (E5-E7).

7.3.2 Stimulate local action

Local action can be stimulated in different ways. First, it is important that the boundary conditions and context for local action are set by developing local RHC transition plans (S1). Local authorities – with participation from other local stakeholders - are best placed to integrate the local social, environmental and economic aspects, for example via local heat zoning plans geared towards an overarching regional or national long-term vision. A local RHC vision sets the stage for local action, for example via procurement programmes at the local community level (S2). Such programs aim to aggregate customers within a community to purchase a renewable energy technology, allowing for an efficient and cost-effective installation process. Another option is to stimulate cooperative organizational forms for installing and operating RHC (S3), for example in multi-family houses or neighbourhoods. In this way, larger scale RHC solutions can be shared among multiple parties (homeowners, tenants) creating a shared responsibility and learning interactions along the way.

Recommendation S1	Develop local RHC transition plans
Description	Local authorities have an important role to play in the development of sustainable RHC solutions for the built environment. Local authorities are best placed to gauge the local social, environmental and economic aspects. In addition, many RHC technologies have a local character and range, e.g. in the case of a ground source heat pump, a local chain for energetic biomass valorisation or industrial residual heat valorisation. The principle of subsidiarity thus seems to work to the advantage of the local authorities, who, for example, can be assigned the responsibility for working out local heat zoning plans, based on a local assessment framework, geared to the overarching long-term national or regional long-term vision.
Intermediaries	Local governments in the lead; the construction sector, installers, and consultants as main partners.
Conditional factors	-
Good practice	In the Netherlands, the draft climate agreement of 2018 states that local heating plans should be available for all neighbourhoods by 2021, describing how the transition to a gas-free system will be implemented.

Recommendation S2	Implement procurement programmes at the local community level
Description	Such programs aim to aggregate customers within a community to purchase a renewable energy technology. With an aggregated demand pool in a single community, contractors can develop an efficient installation process based on the geographic location of campaign participants. Programs can also be designed to take advantage of network effects—for example, providing additional discounts to homeowners that sign their neighbours up, thus enabling the contractors to coordinate activities for clustered installations. Aggregating the demand for individual installations through local authorities or consumer organisations could not only have a positive impact on the price of the RHC installation thanks to group purchase, but also provide technical advices to maximise the economic and environmental benefits of the installation. It can also play the role of a consumers' awareness campaign. (FRONT consortium b)
Intermediaries	Local authorities and consumer organisations to organise procurement programmes; installers and manufacturers to submit offers.
Conditional factors	Benefits of geographical clustering are probably the largest for ground-source heat pumps.
Good practice	-

Recommendation S3	Harness the power of cooperatives
Description	A grass-roots level promotion programme focused on and involving local communities can most effectively build confidence in RHC solutions.
Intermediaries	Local governments and NGOs to develop promotion programmes and provide support; local project ambassadors to initiate and manage cooperatives; local installers and energy companies to provide heating and cooling services.
Conditional factors	Strong community dynamics are preferably already in place.
Good practice	Many multi-family houses in Sweden are managed by a tenant-owner cooperative, which takes a role for different activities including improvement of energy efficiency of the buildings and therefore facilitates the process to diffuse mainly heat pumps in the sector.

7.4 Make it timely

It is important to be aware of the (im)possibilities that particular windows of opportunity offer for stimulating the adoption of RHC. Also we have seen in Section 6.7.2. that creating a sense of urgency and a long-term perspective on RHC, as well as various time related aspects are important to support the roll-out of RHC. Main policy messages are thus: seize the windows of opportunity of RHC installation and develop a timely RHC policy.

7.4.1 Seize the windows of opportunity of RHC installation

A main window of opportunity is the break-down and replacement of an HC system in an existing building. To overcome the barrier of limited time availability on such an occasion, system failure prevention (T1) can be considered. The essence is that consumers should be notified well in advance that the lifetime of their system comes to an end to allow for more time to collect information and evaluate various options in deciding on investing in a replacement system.

Another window of opportunity is when a broader energy retrofit is planned. In such cases, promoting or mandating RHC technologies (T2) is a recommended way ahead, in particular for situations where RHC systems meet a reasonable payback time. The German state of Baden-Württemberg provides an example, having implemented legislation which requires existing buildings to have 15% of their heat supplied from renewable sources when a heating system is replaced.

A third window of opportunity is when people acquire a new home. For such cases, including renovation roadmaps in EPC certificates (T3) is a way to make transparent how the current HC system performs, and which investments are needed to bring the dwelling up to energy performance standards. This creates an incentive for RHC adoption, as the required investment costs will be reflected in the sale price of the dwelling.

Recommendation T1	System failure prevention
Description	In many countries heating installations are subject to annual quality reviews. This is a good occasion for the installers performing the review to inform the customer of the expected lifetime of his/her current heating system, and inform them of the RHC options that are currently on the market. Installers could e.g. start to provide options for system replacement 2 years before the average life time of the system is passed**.** The effect would be that customers have more time to collect information and evaluate various options, and hence to plan for the replacement of their heating system. This would also be the occasion to compare different options based on lifecycle costs (cf. recommendation A4).
Intermediaries	Governments to set guidelines for annual quality reviews; installers to inform customers on the remaining lifetime of systems and replacement options.
Conditional factors	Quality control of existing heating systems should be put in place first
Good practice	In Germany, the introduction in 2016 of an energy label for existing installed heating appliances (*Energielabel für alte Heizungsanlagen*) should raise awareness of the inefficiency of old heating appliances. This is expected to increase the replacement rate of heating appliances and promote the installation of renewable heating technologies (IEA 2018a).

Recommendation T2	Promote or mandate RHC technologies as part of energy retrofits
Description	Energy retrofits of existing buildings provide an excellent 'window of opportunity' for the introduction of RHC systems. By mandating RHC in major retrofits of a certain size, building owners and developers would gain experience with RHC technologies. The increased uptake of RHC will also help the governments meet long-term energy and climate goals.
Intermediaries	Governments to set standards for energy retrofitting installers; architects and planners to comply with standards and advise consumers accordingly.
Conditional factors	Impact of the measure should be carefully considered. Introducing obligations on the installation of RHC systems in existing buildings can be an expensive measure. Therefore, the obligation could be made more conditional – e.g. RHC systems have to be installed provided they meet a reasonable payback time. There is some evidence that the 'good practice' in Baden-Württemberg (cf. *infra*) has slowed down the replacement of old heating installations as a negative side effect[4].
Good practice	The German state of Baden-Württemberg has implemented legislation which requires existing buildings to have 15% of their heat supplied from renewable sources when a heating system is replaced. This is a rare example where renewable heat is mandatory in existing (rather than new-build) buildings (IEA 2018a).

[4] https://arnejj.org/wp-content/uploads/Sticks-and-Carrots_FINAL.pdf

Recommendation T3	Include renovation roadmaps in EPC certificates
Description	The already existing system of Energy Performance Certificates (EPC) for buildings can be improved to stimulate the uptake of RHC solutions. EPCs should also have the obligation to highlight, on the front page, the environmental impact of the building, as well as the shares of the different energy sources and technologies used. This could also be accompanied by the obligation to include renovation roadmaps on EPC documents, with tailored advice to owners and investors on how to improve the energy performance of their buildings. Such roadmaps have to include estimations on the investment and operating/life-cycle costs, as well as a brief profitability analysis linked to the future measure(s). This would bring a positive competition among heating systems that should decrease the installation price. When the dwelling is sold, this could be coupled to an obligation for the new owner to renovate the house up to a certain standard foreseen in the renovation roadmap. The costs for the renovation will then be taken into account in the sales price of the dwelling.
Intermediaries	Governments to set requirements for EPC certificates; consultants, architects and planners to develop methods for including renovation roadmaps in EPCs.
Conditional factors	
Good practice	The German region of Baden-Württemberg has successfully implemented a system where EPCs include renovation roadmaps.

7.4.2 A timely RHC policy

A Timely RHC policy entails various aspects. The first one involves creating a sense of urgency for the heating and cooling transition, connecting long term goals to short term actions. This requires developing and communicating a long-term decarbonisation plan for the heating and cooling sector, including intermediate milestones (T4). Such a long-term vision sends a political message to homeowners that RHC solutions are needed to safeguard the future value of their property, something homeowners are typically concerned about.

A second aspect is finding the right timing to phase out fossil-fuel HC solutions through mandatory installation of RHC technology. A first recommended step is to make RHC technology in new buildings mandatory (T5), for example by setting in place energy performance criteria that only RHC solutions can meet. For most countries, this is a step that can already be taken. Such a policy sets the stage for a further, gradual phase out of fossil fuels from the existing building stock (T6). Denmark is the first country to have put in place a consistent policy and ban fossil-based installations, including since 2016 a ban on installing new oil-fired boilers in existing buildings in areas where district heating or natural gas is available.

A third aspect involves the timing of RHC support schemes. Experience shows that inappropriate timing can act as a barrier by creating an overheated market followed by market collapse. Therefore, it is important to adapt government incentive programs to the development of the RHC market (T7). Support policies and financial instruments should be adapted to the technologies' stage of maturity and technical characteristics, as well as the maturity of the market in which they are promoted.

Recommendation T4	Develop and communicate a long-term decarbonisation plan for the heating and cooling sector, including intermediate milestones
Description	The EU has set itself a long-term objective of reducing GHG by 80-95% when compared to 1990 levels by 2050. To achieve these goals, significant investments need to be made in renewable energy, energy efficiency and grid infrastructure. However, compared to the electricity sector where the need for a transition to a renewable electricity system is now commonly acknowledged, this is not yet the case for the heating and cooling sector (even though a sizeable part of GHG emissions originate from the built environment). Investments in heating and cooling infrastructures are made for a period ranging from 15 years for individual heating systems to 60 years for larger plants and infrastructure. For this reason, policies that create a stable business climate and promote investments in the decarbonisation of the H&C sector through energy efficiency and fuel switch to renewables must begin today and be finalised by 2050. A sense of urgency should be created: in 20 years from now the heating sector must be decarbonised to a large extent, and this means we must start to install low-carbon solutions right now. Installations being put into operation now need to be '2040-ready'. A clear political message regarding the need for a clean-energy transition in the heating and cooling sector was also perceived to be an important factor influencing the decisions of home owners. People are concerned about the future value of their property, therefore a 'future-proof' RHC solution could be seen as an added value. The perception is that in the current situation, property developers only look at immediate costs and therefore choose to install conventional technologies. It is therefore crucial to ensure consistency of current and upcoming legislation with long-term objectives. In countries where this is relevant (e.g. where coal or fuel oil is commonly used), local air quality can be used as an additional argument in favour of RHC solutions.
Intermediaries	Governments leading the development of long-term decarbonisation plans, supported by RHC industry associations.
Conditional factors	EU level needs to support national policies by • Proposing a strong governance system with ambitious mechanisms to incentivise Member States to develop a carbon-free heating and cooling sector; • Providing uniform and binding templates for national climate and energy plans, including the heating & cooling sector. (FRONT consortium b)

Good practice	The Dutch draft climate agreement of 2018 includes a plan to make the building stock 'gas-free' by 2050. Intermediate steps are identified and clearly communicated to all relevant stakeholders.

Recommendation T5	**Start as soon as possible with the obligation to install RHC technology in new buildings**
Description	This requirement would have an important market impact. As it has been frequently stated in the interviews, one of the major barriers to RHC deployment is the lack of awareness and information on RHC technologies. By setting a RHC obligation in new buildings (which is a niche market, compared to the large market composed of the existing stock of buildings), awareness amongst professionals is indirectly triggered through the creation of a dedicated market for RHC. Professionals will have to adapt/train themselves if they want to have work in this new market. This will set the tone and kick-start larger deployment of RHC in existing building stock, where it is much more difficult to impose such a burden on building owners. (FRONT consortium b)
Intermediaries	Governments to set standards for new buildings; installers and other professionals to adapt to this new market.installers
Conditional factors	Dependent on the development of EU policy (Energy Performance of Buildings Directive)
Good practice	-

Recommendation T6	Gradually phase out fossil fuels in the built environment
Description	Legislation forcing a gradual phase out of fossil fuel heating installations can be put in place, sending out a clear political message that RHC solutions will become the default option in the near future, thus limiting the decision space of feasible options for consumers. It could start with new buildings where it is easier to integrate a RHC installation in the design phase of the house and where the cost of the installation is diluted in the whole construction cost (cf. Recommendation T5). Then it could be equally applied to existing buildings with a long-term renovation strategy.
Intermediaries	Governments to develop legislation forcing a gradual phase out of fossil fuel heating installations.
Conditional factors	Strong political support needed. (Economic) feasibility should be carefully checked in light of socio-economic characteristics of the country/region.
Good practice	Denmark is the first country to have put in place a consistent policy and ban fossil-based installations. Since 2013, the installation of oil-fired boilers and natural gas heating is banned in new buildings in Denmark. Since 2016, the Danes have also banned the installation of new oil-fired boilers in existing buildings in areas where district heating or natural gas is available (FRONT consortium b). In parallel, oil and gas are increasingly made expensive (cf. carbon tax – Recommendation A1).

Recommendation T7	Adapt government incentive programs to the development of the RHC market
Description	Timing of government support is important. In the past we have witnessed some cases of excessive government support, e.g. for solar heat or PV systems in many EU countries. Very generous subsidies were given, overheating the market with a very high demand. However, later on these subsidies were substantially decreased or removed altogether leading to a market crash. Such 'stop-and-go' policy should be avoided, it is better to let the market grow organically. Over-subsidy leads to loss of trust for innovative solutions. This needs to be considered in policy designs. A combination of different support policies and financial instruments should be promoted according to technologies' stage of maturity (risk) and technical characteristics as well as the maturity of the market in which they are promoted.
Intermediaries	Governments to adopt adequate timing of government support, consultants and other experts to provide insights on technology and market maturity.
Conditional factors	Strong administrative departments, backed by sound scientific expertise and advice
Good practice	-

7.5 Recommendations in the wider energy transition context

The policy recommendations elaborated based on the EAST principles should not be interpreted as a 'magical silver bullet' that will speed up the uptake of RHC solutions in no time at all. The list of 27 recommendations should also not be considered comprehensive. It rather constitutes a well populated list of concrete recommendations showing how the main policy messages emerging from this study, and clustered under the EAST principles can be operationalised. These recommendations should be carefully considered an applied in the context of national or regional energy transition plans or strategies, considering the current state of the heating and cooling sector.

Based on our key messages and the findings from the two validation workshops, four key priorities stand out:

1. Given the fact that RHC technologies are still not able to compete at scale, a first priority would be improving its business case compared to fossil fuel based technologies, for example trough a carbon tax (see recommendations A1 to A4 in Table 8). However, it is crucial to move beyond monetary costs alone: RHC technologies provide a suite of non-monetary consumer benefits – for example their capacity to provide cooling in addition to heating - which should be better communicated to consumers (see recommendations A5 to A6 in Table 8).

2. Given the observation that installers are often not advising RHC to their customers, a second priority would be getting installers – notably installers – on board. For example, setting up dedicated trainings would ensure professionals have adequate knowledge and tools to convey RHC benefits to their customers (see recommendations E5 to E7 in Table 8). Furthermore, it is important to better understand the installers' perspective on RHC solutions and develop measures to make it more attractive for them to shift their portfolio towards RHC solutions.

3. Given the importance of the windows of opportunity for RHC investment, a third priority is to target those windows of opportunity more explicitly. Examples include system failure prevention (recommendation T1) to avoid rushed decision-making after system breakdown, promoting or mandating RHC technologies as part of energy retrofits (recommendation T2), and including roadmaps in EPC certificates (recommendation T3) to make transparent which investments are needed to bring the dwelling up to energy performance standards for people buying a new home.

4. A fourth priority is developing - and communicating to consumers - a clear political vision on RHC reflecting a sense of urgency. This calls for a timely RHC policy based on long-term decarbonisation plans with clear milestones for phasing out fossil-fuels in new buildings and ultimately from the existing building stock (see recommendations T4 to E7 in Table 8).

As stated in a recent report of the International Energy Agency (IEA) on transition policies for the heating and cooling sector, rapid progress in renewable heat deployment can be difficult to achieve: "*Slow renovation rates in the building stock and a slow turnover of heating appliances in both buildings and industry, coupled with multiple barriers, necessitate a long-term strategy for heat decarbonisation with a range of policy instruments. However, most countries will have some no-regrets options (e.g. producing biogas for heat from organic waste) which can be implemented more quickly and which bring multiple benefits. With the right strategy and policies, a transition to clean heat for buildings and industry can then be realised over time*" (IEA 2018a, p. 5).

In this regard, the IEA makes a useful first-order distinction between different groups of countries that need different strategic priorities in RHC transition plans:

Strategic priorities in RHC transition plans

Source: IEA (2018a)

The IEA (2018a) distinguishes different strategic priorities for different country groups as follows:

- **Countries with extensive district heating networks** and
    - **high shares of renewable heating** (>40%), where the focus should be put on integrating the heating and electricity sector and ensuring a cost-optimal alignment between energy efficiency and heating policies;
    - **medium to low shares of renewable heating** (<40%), where the focus should be put on targets and strategies for decarbonization of district heating, including developing the right supply chains (e.g. biomass).
- **Countries with relatively low shares of renewable heating** (10-20%) **and some district heating**, where the focus should be put on further developing district heating and introducing building regulations for renovations or new construction aimed to make the application of RHC solutions mandatory;
- **'Natural gas countries'**, where the focus should be put on carbon taxation, increasing district heating application, and developing building regulations and R&D to investigate 'green gas' options (e.g. biogas, hydrogen etc.);
- **Countries that currently do not have a renewable heat policy**, and therefore first need to develop a carefully thought-out transition plan from scratch.

In addition, it has to be underlined that most RHC solutions are still expensive compared to the fossil-fuel alternatives; therefore transition strategies should also carefully consider the impact on the least well-off in society to avoid problems of social inequalities (i.e. wealthy households able to afford comfortable dwellings powered by renewable energy vs. poor households having to rely on cheaper fossil fuel solutions).

In sum, the application of our recommendations should always be considered in the context of the state of the energy transition in a particular country or region, and consistency with existing (or to be developed) transition strategies or plans should be carefully checked.

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ANNEX 1- Overview of decision-factors

Annex 1 gives the detailed empirical results from the expert interviews on consumers' decision factors regarding RHC. It summarizes for each type of factor (economic factors, factors related to the easiness to install and operation etc.) and for each RHC technology considered the main pro's and con's brought up by the respondents. The respondents' information was kept as an acronym for further analysis. For example, SOL_AT means that it was mentioned by an interview partner from Austria who has expertise in solar thermal technology. Likewise, BIO_, GEO_, HP_, and DHC_ refer to biomass, geothermal, heat pump, and district heating and cooling respectively.

		Economic factors **The main decision factor is the economic factor including both installation and running cost (GEO_SE, GEO_HU_2). Financial incentive for consumers will have an impact on the willingness to install the system (BIO_EE, BIO_UK, BIO_ES). If they think that the system can save money or the investment will be will paid back, they will make their choice (BIO_UK). Payback time is also an important factor (BIO_FI, GEO_SE, GEO_HU_2).**
Solar thermal	+	In countries where solar thermal system is perceived as cost-effective, saving money for long-term is the main reason for consumers to choose it (SOL_AT, SOL_GR, SOL_TR). Especially for solar thermal domestic hot water system, the affordable product and installation cost is the advantage (SOL_GR). In addition, if the residents do not have any burden for the investment cost, for instance in social housing sector which can utilize social funding for the installation, solar thermal is an attractive option as a low-consumption system (SOL_FR_2).
	–	Installation cost of solar thermal is more expensive than other systems, and this is the main issue (SOL_FR_2). If the work to run pipes in walls is needed, it won't be feasible for many consumers, because it is very expensive (SOL_DE_1). The competitiveness of solar thermal is not optimized due to the payback time (SOL_FR_2). In spite of financial supports and small decrease in the price of solar thermal product, it is still quite a long-term investment (SOL_FR_1, SOL_DE, SOL_ES). If the initial payment for the system is very high, it holds consumers back from the investment, even if they know that they will get the payback (SOL_ES). Besides, because solar thermal is often combined with other technologies and has an option whether to install storage system, it is hard to see clearly how much the solar thermal system contributes to the efficiency improvement. This makes more difficult for consumers to know if and by how many years the investment can be paid off (SOL_DE_1).
Biomass	+	Biomass use for heating system is fairly cheap, which is one of the main reasons why consumers choose the technology (BIO_EE, BIO_SE, BIO_ES), though the system itself is more expensive than gas or oil heating system (BIO_DE). However, the economic reasons to choose pellet as heating system is currently not the point anymore, because the oil price is low. A few years ago when oil was very expensive and the pellet was much cheaper than fossil fuels, the advantage in the cost was the main argument (BIO_DE).

	−	Consumers who are not using biomass have a perception that the use of bio energy is expensive, which is true regarding the installation cost, but not regarding the running cost (BIO_AT). They do not know that pellet is cheaper than oil (BIO_DE) or bio energy, and believe in the other way around (BIO_AT). They are sometimes not able to compare properly the prices (BIO_AT). There is concern among consumers for rising biomass fuel prices in the last years (BIO_EE).
Geothermal	+	One of the positive images of geothermal perceived by more and more consumers is the cost-efficiency in the longer-term (GEO_DE, GEO_UK) due to a reduction of the running cost (GEO_UK, GEO_HU_1). Consumers who invest in geothermal have long-term consideration and know that the investment will be paid back (GEO_UK). It would be more cost-efficient in combined use with PV for electricity to run the system (GEO_DE) or by using both heating and cooling (GEO_PO). Payback time would be short in some countries. For instance, in Sweden the short payback time of geothermal heat pump like 7 years is a big incentive. In addition to the low running cost, it is a key for investment in heat pump, especially expensive geothermal heat pump to install, that consumers know that the investment cost will be paid back. (HP_SE_2).
	−	The main barrier of geothermal is the initial cost (GEO_DE, GEO_HU_1, GEO_PO), which is much higher than fossil fuel-based boilers (GEO_HU_1), though the installation cost started to be more and more competitive (GEO_PO). Because the payback time would be long which is between 10-20 years in some countries, the economic driver for end-users to choose geothermal heat pumps is low (GEO_IT, GEO_HU_2). Even though electricity price is reduced for the operator of geothermal heat pump system, the low operation cost is not an attractive point, if the payback time is too long (GEO_HU_2). This hinders the investment decision, even if they want to have a modern and environmentally- friendly solution (GEO_HU_2). So the first question is if you have enough money to get the installation (GEO_SE, GEO_DE, GEO_HU_1, GEO_HU_2), or want to borrow money from bank (GEO_UK). Subsidy availability is often a key issue (GEO_HU_2). Consumers who consider geothermal heat pump expensive tend to invest rather in air-source heat pumps (GEO_SE). Regarding deep geothermal district heating, there are no big obstacles of cost for end-users, unless they need to pay it by themselves to connect to the main distribution system when the network is less developed. However, some local administrations and politicians who will be the investor still keep an old image that geothermal is expensive and not credible, which keep them from the investment (GEO_PO).

Heat pumps	+	The main and most crucial factor to decide for a heat pump installation is the economic reason (HP_EE, HP_FI, HP_SE_1, HP_DE, HP_PO, HP_CZ). Because of the lower energy consumption, heat pumps have normally cheaper operation cost than other alternatives such as fossil fuel based boilers, direct electric heating, and even district heating in some areas (HP_EE, HP_FI, HP_SE_1, HP_SE_2, HP_DE, HP_PO, HP_CZ, HP_ES). If consumers have a PV system and they can use own generated electricity to run their heat pumps, it will be much cheaper (HP_DE).
	−	The positive image of cheap operation cost can be discredited because of the high price of electricity and low price of fossil fuels (HP_DE). If the difference of price in gas and electricity is quite high, it will not be easy to get decision from end-users, if they are only looking for the cost (HP_DE). The installation cost of heat pumps is higher than the one of fossil fuel-based boilers, which is still a barrier for consumers (HP_ES) in spite of the relatively well coverage of subsidies (HP_DE). Although the price of installation of the system started to be much more competitive with respect to other traditional energy sources (GEO_PO), many consumers especially who have less income think that the technology is still too expensive to invest (HP_PO, HP_CZ). If they think it is too expensive, it will be very hard to convince them to choose the heat pumps, because the main reason to choose a system is the price of the device and the installation cost (HP_PO). For new built houses, installation of heat pumps will be cheaper in line with regulations for new buildings (HP_DE). In addition, if the area does not have gas connection and consumers need to pay for the extra gas connection, the heat pump installation will be cheaper or at least equal to gas installation (HP_DE).
DHC	+	Depending on the energy source availability in the country, district heating will be very affordable. For instance, in Estonia, the use of biomass for district heating and cooling enables the solution to be very affordable, which contributes to the good image of district heating and cooling (DHC_EE). The investment cost for district heating or gas heating is quite low, though it depends on the size of the installation (DHC_EE). A positive point for customers to choose district heating is the price. Usually district heating has a better price, if they consider the long-term cost, which is the most important factor for them as well as the network availability. But this is not so easy to explain to customers, because the pricing system in comparison with other systems is difficult to be transparent for them (DHC_DE).
	−	Sometimes customers see the risk in the investment, because they do not understand how it works and they have to pay more at the beginning for the investment than for new gas boiler or oil heating system (DHC_DE)

		Easiness to install and operation One of the main important decision factors for consumers to choose a heating system is a limited maintenance requirement, which means easiness or simplicity (SOL_IT)
Solar thermal	+	One of the good reputations of solar thermal domestic hot water system such as thermosiphon system is that the installation takes very short time without many complications, and the operation is easy (SOL_GR).
	−	A reason why consumers do not switch to solar thermal system is the complicated installation process (SOL_ES). In order to take complete advantage of what solar thermal and the heat storage can do, the installation work can be significant (SOL_DE_1). Consumers don't want to have the work of pipe installation in the walls, while they live there (SOL_DE_1). The need of regular maintenance of solar thermal is a negative attribute for consumers also in terms of the maintenance cost (SOL_ES)
Biomass	−	It would be less convenient for those who use oil heating, because with biomass they need to remove ash and have to occasionally clean the fuel storage. That is part of the problems also for those who have not used the biomass yet (BIO_AT).
Geothermal	+	Geothermal heat pump is considered easy to operate and to maintain (GEO_SE, GEO_UK).
	−	Since the planning and installation process takes a few months, the installation is impossible in urgent cases (GEO_DE, GEO_UK). Some negative rumours on the significant installation work can affect people's decision quite a lot, when something happens. For example, in Germany, news reporting a big accident during the drilling of a borehole for a ground-water heat pump creates a negative image of heat pump in peoples' mind (GEO_DE, HP_DE).
Heat pumps	+	Time required for the installation of heat pumps depends on how deep consumers want to get the system. If it is only to change heat generator in case of air-to-water heat pump, it is quite simple (HP_DE).
DHC	+	If the house has already water piping system, it enables to connect to district heating without further construction. If they have only electric heating, it will be more difficult to connect to district heating (BIO_SE). If consumers connect to district heating, they do not need to have their own boilers anymore and do not have a certain bother or risk accordingly (BIO_SE).
	−	Customers are often sceptical because of the big construction to introduce the network in the area for the first time. Hence, the first context for the district heating is sometimes negative (DHC_DE).

		Physical space consumption
Solar thermal	−	A room for heat storage is needed, which is usually water storage that takes a lot of space (SOL_DE_1). For the equipment on the roof, sky sight and light as well as PV installation can be a competitor, since the roof space is limited (SOL_DE_1).
Biomass	−	Some consumers feel that it is hassle and complicated to have a storage room (BIO_DE).

		Well-known and trust worthy technology **It is certainly a positive message for consumers that the technology is safe (HP_ES). This trust worthiness depends a lot on the market diffusion of the technology. Whether it is a well-known technology does not matter so much for a group of early adopters, though it is important for them that the technology is not a prototype and it is proven to work well (SOL_AT).**
Solar thermal	+	In the countries where solar thermal is already very common, consumers have confidence and trust to use the system (SOL_AT, SOL_TR).
	–	Some negative image comes from the malfunctioning of solar thermal system in the past, due to no maintenance or some wrong installation by untrained and unskilled installers, which can happen with the mandatory installation in new buildings (SOL_ES), and during the initial start-up phase of the solar technology market (SOL_AT, SOL_FR_1, SOL_FR_2). The actual problem is not the quality, but rather the negative image in reliability and durability of the installation (SOL_FR_1, SOL_FR_2). In countries where solar thermal is not common, consumers will not choose the option because installers are unfamiliar with the technology (SOL_ES).
Biomass	+	In countries where biomass is abundant, the main reason to choose a biomass solution is that consumers are culturally and historically used to using biomass as energy source (BIO_EE, BIO_FI, BIO_SE). This contributes to developing the positive image and makes them staying with the familiar solution (BIO_EE).
	–	Some consumers are afraid to install biomass, as it is something still new for them (BIO_DE, BIO_ES). They would think the system might not work as much comfortably as old fossil fuel system does (BIO_DE), or would think that the fuel would run out quickly, if everybody uses it (BIO_ES).
Geothermal	+	End-users do not think it as risky to connect to geothermal district heating, because geological researches must have been already done for the deep geothermal and they just need to connect to the grids (GEO_PO).
	–	There is a perception among people who have not experienced the technology directly that this is new technology and therefore risky (GEO_UK). It is all about how much knowledge people have. The more knowledge they have, the more positively they see the technology, and less risky they perceive it (GEO_UK).

Heat pumps	+	It was perceived as a risky investment in the past. By now, however, because of many references on the internet and social surroundings, consumers have positive images about heat pumps (HP_FI, HP_SE_1, HP_ES, HP_CZ). Consumers are well convinced to use the technology in countries where heat pumps are a mainstream and trustworthy technology (HP_FI, HP_SE_1).
	−	In countries where heat pump is still new in the market, many consumers would think the technology of heat pumps is still risky. Some of them think that installers do not know about the technology and do not propose the option. Those consumers want to keep going with the traditional familiar technology for heating and cooling system, not trying unknown technology (HP_PO).

		New technology **Whether the person is curious about technology in general and is open for new technology or not would influence on his or her consideration (HP_SE_1).**
Solar thermal	+	For innovators and early adopters who install solar thermal by their initiative when the market is still in the initial phase, factors driving them to do so are that they know the technology and they want something new (SOL_AT, SOL_ES).
	−	In the countries where solar thermal is known to a large extent, the system is not perceived as a high and very modern technology any more (SOL_DE_1, SOL_AT). While other new renewable technologies develop, it makes solar thermal especially for small installations less attractive that there is little development in the solar fraction and the design, and it has been the same technology used and the same price (SOL_AT).

		Ecological reasons **The ecological reason would be the motivation of those who installed in early days (BIO_DE). However, for most people, the environmental aspect is not the most decisive decision factor, this reason becomes increasingly more important for consumers to choose a heating system (SOL_IT, GEO_IT), especially in younger generations (HP_EE).**
Solar thermal	+	One of the main reasons for consumers who invest in solar thermal is the environmental factor (SOL_AT). However, for many consumers, the good image that solar thermal is green and can contribute to social benefits cannot be decisive to invest in it (SOL_AT, SOL_IT, SOL_GR), and they tend to prefer less investment cost rather than the CO_2 reduction (SOL_ES). Besides, even if they have enough environmental awareness, they do not invest in solar thermal unless they have enough budgets (SOL_FR_1, SOL_ES). In addition, this ecological image of CO_2 reduction is not specific for solar thermal, since other renewable systems can do the same things and can be cheaper (SOL_FR_2).
Biomass	+	Consumers, who are willing to install biomass, consider the option from the environmental perspective (BIO_FI, BIO_SE, BIO_UK, BIO_DE). They see the solution as environmentally- friendly and renewable alternative (SE). Since the oil price is low, which in turn makes biomass solution relatively expensive, the ecological reason is the main motivation for people who decide to install biomass (BIO_DE).
	−	Some people concern that it is not sustainable, if the heating system burns the wood (BIO_UK). Some have a negative attitude about the emissions from fire woods and for air pollution, though modern boilers have small emissions (BIO_SE, BIO_DE). Some have concerns that biomass might be imported and not s domestic product, even if it is not true (BIO_DE). The use of wood as a primary source of energy is under debate due to the climate reasons, and some believe that there are more sustainable options for heating purposes (BIO_EE).
Geothermal	+	Geothermal is considered as a low-carbon solution (GEO_SE, GEO_DE, GEO_UK), especially if the electricity is produced based on renewables as well. However, this carbon reduction will be the second level consideration for most consumers only, but it would amplify consumers' desireto get some money from bank to spend on reduction of carbon and fuel cost (GEO_UK).
	−	It depends on the fuels for electricity to power the system. If power plants use fossil fuels, it is not considered entirely ecological in terms of CO_2 emissions (GEO_PO, GEO_HU_2). This negative image would be, however, only by politicians, and most consumers consider geothermal to be clean and modern (GEO_HU_2).
Heat pump	+	The motivation to install heat pump from environmental perspective is only for a small group of consumers, which can be an additional argument for the installation but not the main reason for many people, which would be the

		financial reason (HP_FI, HP_SE_2, HP_DE, HP_CZ). This is clearer in comparison with, for instance, solar energy, which is considered “greener” (HP_SE_2). On the other hand, considering some growth of the market of heat pumps in spite of the long payback period, the installation of the system must be partly environmental mind-driven (HP_EE).
	−	If the electricity production is based on fossil fuels, the sustainable argument is discredited (HP_EE).
DHC	+	Some people, especially in older generations, have a positive image from the environmental perspective. Since district heating does not need to have chimneys anymore, the air quality has improved tremendously in cities compared to 30-40 years ago (BIO_SE).
	−	Some consumers associate the district heating in combination with coal (DHC_DE).

		Independence from heating supply / Energy security **Consumers are concerned about the movement in price of imported fossil fuels (GEO_HU_2). Especially when oil is expensive, debate about security of energy supply starts, which pushes forward the switch from fossil fuel to renewable (BIO_SE). Partly with this energy security reason, consumers prefer domestic or even regional energy source (GEO_HU_2).**
Solar thermal	+	A reason why more and more people choose solar thermal system is that it is a solution with high degree of autonomy (SOL_FR_2, SOL_DE_2), which is especially a good argument for consumers in areas where the solar fraction is high enough. Independence from increasing energy price of fossil fuels is a good image of solar thermal (SOL_FR_2, SOL_DE_2). For those who expect the increase of energy cost in the future, the investment in solar thermal is an investment for energy security, which is like insurance (SOL_FR_2, SOL_DE_2). In order for this decision factor to play a role, consumers have to be convinced that the system has a good quality to guarantee to work well for the next few decades (SOL_FR_2). Solar thermal has a better image than PV, as the image of PV includes a lack of solidarity that PV as it has affected the electricity price for all consumers (SOL_DE_1).
Biomass	+	Independence from grid or fossil fuel and having local fuel are coming to more important reason to choose biomass (BIO_DE). Especially for single family houses, the fuel comes from the nearby forest, so it is local. This is positively perceived compared to some other imported fuels (BIO_FI).
Geothermal	+	It is an advantage that geothermal is a domestic energy source (GEO_HU_2), and consumers can get more energy independent from the government who has a very big influence on the energy market (GEO_HU_1).
Heat pumps	+	Some consumers expect an increasing electricity price in the future, which makes those who have only electricity heating consider installing a heat pump (GEO_SE).
DHC	+	A positive point for customers to choose district heating is not depending on gas or oil price (DHC_DE).

		Function of the system / Quality of system Consumers put a weight on the quality of the product, when they choose a heating and cooling system (HP_PO).
Solar thermal	+	One of the positive images of the system by consumers is the function of the system in areas with high solar fraction, because in practice they can almost fully depend on the system throughout the year (SOL_GR).
	−	Consumers might be concerned of the quality of some equipment of solar thermal domestic hot water system, but they do not care so much, because it is cheap anyway (SOL_TR). There is still large myth that solar energy is not available in winter, and the system might get frozen (SOL_DE_1).
Geothermal	+	Geothermal heat pump can offer both heating and cooling (GEO_PO). Cooling is started to be considered to be important, as temperature rises (GEO_PO). Consumers are aware that geothermal heat pump is more efficient than air-source heat pump (GEO_SE). Besides, geothermal heat pump is quiet (GEO_SE).
	−	Some end-users worry that shallow geothermal systems might influence each other thermally, if the systems are installed denser in a certain area and the heat recovery is considered not so fast (GEO_SE, GEO_PO). If consumers choose a cheap model, which might not have good performance, or if a geothermal heat pump is not installed properly according to the particular geological condition, it can create some bad images discouraging other consumers to install the system (GEO_PO, GEO_HU_1). Some consumers have an uncomfortable feeling with the use of a geothermal heat pump, because there were lots of problems in previous installations (GEO_IT).
Heat pumps	+	One advantage of heat pumps is the double benefits offering both heating and cooling (HP_FI, HP_ES), which will be a stronger argument in the areas where both heating and cooling are necessary (HP_ES). This multi-function would be a main reason to choose, in particular when building a new house under mandatory regulation to use a certain renewable (HP_ES). This multi-function might not be understood by consumers due to companies' sales strategy to sell more systems, in which two different types of heat pumps are installed in a building for the heating and cooling separately (HP_TR).
	−	There are some rumours that heat pumps are not working correctly, and the back-up electrical heater is doing the big part of the work, if the heat pump is not working (HP_DE). Even in countries where heat pumps are well diffused already, there were bad reputations for heat pumps due to some malfunctions in the past (HP_SE_2). Regarding air-to-water heat pump, a most serious problem is the noise, even though it is improved in new products. If neighbours hear the noise by cheaper

		heat pumps, and think that heat pump is too loud, this creates a negative image of the system (HP_DE).

		Appearance **Consumers take the design of system, how it looks like, into their consideration, when they choose a heating and cooling system (HP_PO).**
Solar thermal	–	Some people might think that the appearance of a house with solar thermal is odd, because it looks quite different from typical family houses. It might look futuristic like UFO for some people. Whether the appearance has influence on their decision depends on the person, but there must be some who prioritize the appearance of their house (SOL_DE_1).

		Social status
Geothermal	+	Consumers are proud of having a geothermal heat pump (GEO_SE).
Heat pumps	+	Consumers who have installed heat pumps are so proud of having the system, which is environmentally- friendly and can save money, that they will talk about the technology with neighbours and friends (HP_SE_1). However, consumers might not install a heat pump for prestige reasons, but for economic reasons (HP_EE), though, as a result, having a heat pump might give a certain sense of social status.

		Added value to the building
Geothermal	+	Geothermal heat pump installation adds value on the building (GEO_SE, GEO_HU_1).
Heat pumps	+	Heat pump installation makes the house more popular by the added value in terms of a modern and cost-efficient system (HP_FI, HP_SE_2).

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This report is the analysis of the heating and cooling consumers carried out in the framework of the Study "Support to key activities of the European Technology Platform on Renewable Heating and Cooling" (PP-2041/2014). The analysis develops a qualitative understanding of the barriers and opportunities associated with consumers' adoption of renewable heating and cooling technologies and derives policy recommendations.

For more information on the Study, please consult catalogue number KI-02-19-085-EN-N on EU Bookshop.

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