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Sun coupled innovative Heat pumps

D7.1 – SunHorizon Technologies social and market acceptance

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Abbreviations

C&I Commercial and Industrial

EC European Commission

EED Energy Efficiency Directive

EPBD Energy Performance of Buildings directive

HP Heat pump

MAQ Market acceptance questions

NZEB Nearly Zero Energy buildings

PV Photovoltaic

RES Renewable energy sources

RPQ Respondent profile questions

SAQ Social acceptance questions

Executive Summary

Heat pumps and solar appliances are among the most installed residential energy systems. In SunHorizon, innovative heat pump technologies are combined with solar appliances in technology packages with the aim of unlocking the potential for a mass-customized, user-friendly and cost-effective solution for heating and cooling and will be demonstrated in four geographically spread locations in the EU (Germany, Spain, Belgium and Latvia). In this deliverable the needs and requirements of relevant stakeholders in terms of social and market acceptance are explored. Social acceptance is defined in this report as the *attitude* towards the technology. It evaluates the likelihood of accepting or opposing innovation. Market acceptance is defined as the willingness to adopt the innovation. It evaluates *barriers and motivators* to adopt the innovation in buildings and business models. The deliverable collected information by a three-step approach: a market analysis of heat pumps and solar appliances, a literature review (both scientific papers and EU projects) and a survey.

The heat pump market analysis showed an increasing trend in the EU and further growth is expected. The two main barriers identified for the heat pump market are 1) the initial investment cost, 2) the difference between electricity and natural gas. The solar market analysis identified solar as a growing market within the EU, both for electricity generation and thermal energy. The two main barriers identified are 1) the lack of access to finance, 2) that EU legislation on energy performance only covers new buildings which is a minority of the total building stock. The EU policies addressed at decarbonizing the heating and cooling sector, increase the share of renewable in the energy system and increase energy efficiency in building are the main opportunity for the SunHorizon technology. New buildings are estimated to account only for 25% of Europe's building stock in 2050 and implementing striker energy requirements on the existing building stock and increasing the renovation rates would provide a better market for the SunHorizon technology.

The EU literature review found that to enable the adoption of clean innovative technologies, the main barriers to overcome are lack of information and aspects of trust. The scientific literature review found three main aspects important for the adoption of renewables: the availability of information about technology, financial aspects and sociodemographic factors, such as income level and educational level.

The survey was completed by 153 respondents of which most were men (66 %), people with a university degree (88 %) and people with a high environmental index (78 %). For social acceptance, respondents that are involved with the SunHorizon project and thus more likely to have more information about the technology were found to be more positive towards the technology. All demo sites countries are largely positive about the environmental benefits of the SunHorizon technology and respondents were largely interested in the technology. Latvia and Belgium are mostly negative towards technology awareness aspects. Public building owners are the stakeholder group with the most positive attitude towards the technology and the only group that is very positive about the economic statements. All groups, but businesspersons, perceives that the technology negatively impacts on the visual landscape. For market acceptance, people with a high environmental index were more positive than other groups and again respondents involved with the SunHorizon project were more positive towards the technology. The respondents in the demo site countries all perceive that the investment cost is a barrier for adoption. In Latvia, Belgium and Spain legal and political aspects were also identified as barriers. In Spain, aspects related to the technology, organisational and trust are perceived as additional barriers. The economic aspects were perceived as the main barriers for all stakeholder groups, but especially among public building owners and the public. Businesspersons perceive the largest number of barriers including, economic aspects, lack of information, trust, business models and legal. Private building owners are the stakeholder groups that perceives the least number of barriers and all barriers are related to economic aspects.

1 Introduction

The SunHorizon project combines innovative heat pump technologies with solar appliances into technology packages with the aim of unlocking the potential for a mass-customized, user-friendly and cost-effective solution for heating and cooling. Heating and cooling accounts for just over 50% of the total EU energy consumption and today the demand is mostly met by fossil fuels. The technology packages are targeted towards providing heating and cooling in refurbished and new single/multi-family/tertiary buildings and will be demonstrated at eight demo sites (single family houses, multi-level buildings, municipality owned buildings, sport facilities) in four different EU countries (Germany, Spain, Belgium and Latvia).

The purpose of this deliverable is to evaluate the needs and requirements of relevant stakeholders in terms of social and market acceptance. The deliverable collects information by a three-step approach that includes an analysis of heat pumps and solar appliances markets, a literature review (of both scientific papers and EU projects) and a survey. Social acceptance is defined as the attitude of stakeholders towards the innovative SunHorizon technology. The attitude is assessed as positive or negative given a set of statements about the technology. The positive or negative attitude of the respondents gives an indication of whether someone will support or oppose the technology. Market acceptance, in this study, focuses on assessing the barriers and motivators for stakeholders to adopt the technology. This study of social and market acceptance of SunHorizon technologies is performed in M17 of the project. The technology packages have not yet been installed at the demo sites and thus the views of the stakeholders involved in the SunHorizon project, collected in this report, are prior to implementation.

The market analysis of heat pumps and solar appliances investigates the status quo of the technologies and identifies barriers facing the respective markets. The literature reviews look at how previous research projects have assessed social and market acceptance and what had fostered or hindered the adoption. The deliverable is based on the results of *D2.3 Macro-market analysis, value chains and conceptual business model*, together with scientific literature and reviews of previous EU projects, to develop a survey on social and market acceptance. D2.3 also yielded most of the stakeholder groups considered as potential respondents of the questionnaire. In D2.3 the PESTLE (Political, Economic, Social, Technological, Legal and Environmental) framework was applied to identify the barriers and opportunities for the SunHorizon technology in the demo site countries: Belgium, Germany, Latvia and Spain. Interviews with the demo site responsible partners resulted in value chains for each demo site as well as a generic value chain map for the SunHorizon technology. In the value chain, all stakeholders creating value along the supply chain of the technology packages were identified and the results are utilized in this deliverable to identify relevant stakeholder groups.

The report is structured into five main sections, namely a section introducing the deliverable to the reader, followed by a method section explaining the methodology for the various literature reviews and the methodology for developing, performing and analysing the survey performed in this deliverable. Section 3 presents the current market and policies for solar appliances and heat pumps. Section 4 presents the results of the literature review and survey respectively and in Section 5 the results are discussed from a market implications perspective and the limitations of the survey are discussed. Section 6 concludes the deliverable.

1.1 Background

The climate targets set by the European Commission for 2050 are feasible from both a technological and economical perspective. As a shift away from fossil fuels is imperative, the necessary technologies in the heating and cooling sector are available, but non-technological barriers still exist and need to be overcome to increase adoption in the market of technologies such as heat pumps and solar appliances. Social aspects of new technologies can have a great impact on the success of implementation, which is why social acceptance must be considered as much as technical and economic aspects. For instance, lack of information or awareness could give rise to social resistance that causes delays in the implementation of projects, resulting in negative impact of environmental or societal goals. Moreover, social acceptance becomes increasingly important when the technology needs to be implemented at building level, such as the SunHorizon

technology, as it requires not only passive acceptance (people not opposing the implementation) but also active acceptance by building owners to adopt and invest in the technology.

The role of the customer in the innovation process has moved from being an important but peripheral role to a key aspect for adoption of innovation. Most customers are still not involved, engaged or informed about energy and their usage thereof. Energy is seen as a commodity. Most people's relationship with energy exists only through the energy bill, as the cost of energy. Heating and cooling are part of society's everyday life as a comfort factor, but people generally don't consider energy unless it is missing. Therefore in order to account for the social acceptance of energy technologies, the engagement of customers is essential.

1.2 Aim and purpose

This deliverable aims at exploring the social and market acceptance of the innovative SunHorizon technology (solar energy coupled with heat pumps) with the purpose of identifying which aspects need more focus for the replicability of the solutions to a wider audience. The current market and policies surrounding the SunHorizon technologies is assessed to identify the status quo. Moreover, previous studies (scientific papers and EU projects) on social and market acceptance of similar technologies are assessed to learn more about what drives acceptance and adoption. Finally, a survey collects data about the social and market acceptance amongst different groups and the analysis aims at increasing the knowledge on how to better target specific groups. For social acceptance, the aim is to make respondents more positive towards the technology and thus less likely to oppose the technology. On the other hand, for market acceptance the focus is on barriers and motivators for different groups to adopt the technology and aims at increasing the knowledge for policy makers on how to create policies that result in higher adoption of the technology.

A co-benefit of conducting a survey with stakeholders in the supply chain, customers and consumers is that the survey increases awareness and knowledge about the SunHorizon technologies and thus supports social and market acceptance.

1.2.1 Research questions:

The aim and purpose of the deliverable resulted in the following four main research questions to be answered:

- What have research projects (scientific papers and EU-projects) previously looked at in relation to social acceptance, and what results have been found?
- How is market the acceptance of SunHorizon technologies (heat pumps and solar energy) in Europe today, and what barriers are facing further uptake of the respective technologies?
- How does social and market acceptance of the SunHorizon technologies vary among different groups and between the demo site countries? What stands out?
- What knowledge can be drawn about key barriers for market uptake of the SunHorizon technology that can contribute to the creation of policy to foster market acceptance?

1.3 SunHorizon value chain and stakeholders

In SunHorizon deliverable *D2.3 Macro-market analysis, value chain and conceptual business model definition* (1) the value chain for the SunHorizon technology packages was developed and the result is shown in Figure 1. The value chain describes the value-adding activities in each phase of the product (or service), from the design to the disposal from a customer perspective. Because the project is still at its early phases, the value chain is focused on inbound logistics and operations. Later in the project the value chain could be extended to include also outbound logistics, marketing & sales

and aftersales. From the value chain, the relevant stakeholders involved along the supply chain can be identified and included in the social and market acceptance survey to learn more about their respective needs and requirements.

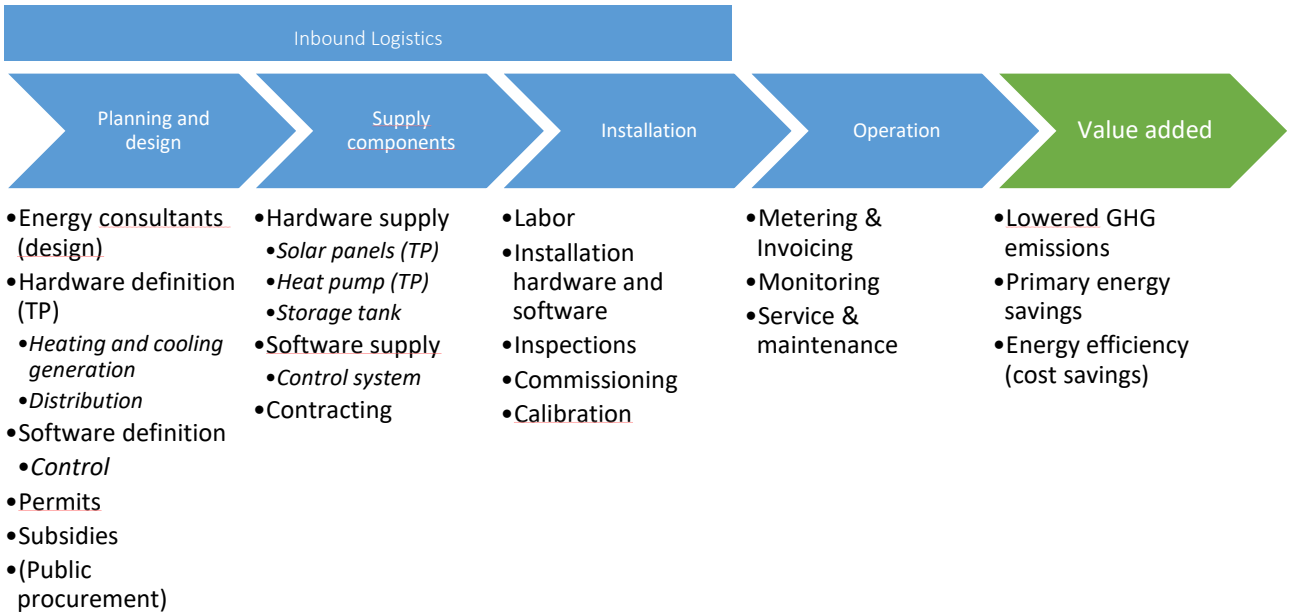

Figure 1: The generic value chain for all SunHorizon technology packages at all demonstration sites

From the generic value chain for the SunHorizon technology the stakeholders can be identified. The identified stakeholder groups are listed below in Table 1 and correspond well with the stakeholders and value chain identified by Curtis (2018) (2).

Table 1: List of stakeholders identified along the SunHorizon value chain.

Private building owner	Equipment manufacturers	Installers
Public building owner	Energy utilities	Service/maintenance
Residents	ESCOs	Real estate developers
End-users	Energy consultants	

1.4 Description of the demonstration sites

In the SunHorizon project innovative technology packages combining heat pumps with solar energy systems are demonstrated at eight different sites in four geographically dispersed EU countries. The SunHorizon project is developing five different technology packages, described in 1.4.1.

1.4.1 The SunHorizon technology packages

All technology packages combine a solar system with innovative heat pump technology integrated with a thermal energy storage. The five technology packages are summarised in Table 2 below. For a more detailed description about the technology packages see D2.3 (1).

Table 2: Summary of the technology packages being developed in SunHorizon

Technology package	Notation	Solar system	Heat pump technology	End user energy
TP1	Parallel solar-heat pump integration	Solar thermal panels (TVP)	Thermal compression HP (BH)	Space heating + DHW
TP2	Mixed solar-assisted/parallel solar-heat pump integration	Solar thermal+Solar PV (DS)	Thermal compression HP (BH)	Appliance electricity+ space heating + DHW
TP3	Solar driven heat pump for cooling	Solar thermal (TVP)	Hybrid sorption/ compression chiller (FAHR)	Space heating + DHW + Space cooling
TP4	Parallel solar-heat pump integration	Solar thermal+Solar PV (DS)	Reversible HP (BDR)	Appliance electricity + space heating + DHW + space cooling
TP5	Mixed solar-assisted/parallel solar-heat pump integration	Solar thermal panels (TVP)	Hybrid sorption/ compression chiller (FAHR) + Thermal compression HP (BH)	Space heating + DHW + Space cooling

1.4.2 Demonstration sites in Germany

The **Berlin** demonstration site is a small privately-owned residential building with two apartments. The space heating and DHW is currently being supplied by two natural gas fuelled boilers and a solar thermal panel coupled together with a thermal energy storage tank. TP1 will be installed and the solar thermal panel will be used to cover as much of the space heating and DHW demand as possible and the natural gas fuelled heat pump will cover the additional demand. Identified stakeholders involved in the demo site that were subjected to the survey performed in this study are private building owners, residents, energy consultants and installers.

The **Nürnberg** demo site is a residential, multi-family building with four apartments. The buildings space heating and DHW is supplied through a connection to the natural gas grid and the flats have additional individual heating solutions, two gas boilers, one wood stove and one oil boiler. TP2 will be installed and the electricity generated by the hybrid solar panels will be used to cover appliance electricity demand within the building and the heat generated will be used to cover space heating demand as large extent as possible. The remaining heat demand will be covered by the natural gas-fuelled heat pump. Identified stakeholders involved in the demo site that were subjected to the survey performed in this study are private building owners, residents, energy consultants and installers.

1.4.3 Demonstration sites in Spain

The demo site in **Sant Cugat del Vallés** is a tertiary civic centre owned by the municipality. Currently the heating and cooling needs in the building are met solely by electricity through a reversible heat pump and several variable refrigerant flow air condition units. TP3 will be installed at the civic centre and the solar thermal panels will supply as much of space heating and DHW demand as possible and the hybrid chiller will provide space cooling. Identified stakeholders involved in the demo site that were subjected to the survey performed in this study are public building owners, end users, equipment manufacturers, energy utilities, ESCOs, energy consultants, installers and service/maintenance.

The **Madrid** demo site is a multi-family residential building with nine apartments owned by the municipality. The current system consists of a gas boiler per apartment supplying DHW and space heating and air/air split for cooling. TP4 will be installed and the thermal output from the hybrid solar panels installed will cover some of the heating demand in the building,

the electricity produced will power the reversible heat pump or else supply electricity to appliances in the building. The reversible heat pump will supply additional demand of DHW, space heating and cooling. Identified stakeholders involved in the demo site that were subjected to the survey performed in this study are public building owners and residents.

The demo site in **San Lorenzo de Hortóns** is a small privately-owned residential building. The existing heating system of the building comprises a hybrid heat pump supplying DHW and space heating and an oil boiler as complementing energy supply for space heating. TP4 will be installed and the thermal output from the hybrid solar panel will supply DHW. The generated electricity will power the new reversible heat pump, which will generate heating, cooling and DHW. Identified stakeholders involved in the demo site that were subjected to the survey performed in this study are private building owners, residents, equipment manufacturers, energy utilities and service/maintenance.

1.4.4 Demonstration sites in Belgium

The demo site in **Verviers** is a tertiary sport centre owned by the municipality. The current heating demand for DHW is met by natural gas boilers. TP1 will be installed at the sport centre and the solar thermal panels installed will supply as much of the hot water demand as possible and the additional demand will be met by the heat pump. Identified stakeholders involved in the demo site that were subjected to the survey performed in this study are public building owners, end users and equipment manufacturers.

The other demo site in **Verviers** is a tertiary swimming pool owned by the municipality. The current heating demand for space heating and DHW is met by natural gas boilers. TP2 will be installed at the swimming pool and the thermal output of the hybrid solar panels installed will supply as much of the heating demand as possible and assist with evaporation of the heat pump, that will supply the additional heating demand. The electricity generated by the hybrid solar panel will cover part of appliance electricity. Identified stakeholders involved in the demo site that were subjected to the survey performed in this study are public building owners, end users and equipment manufacturers.

1.4.5 Demonstration site in Latvia

The demo site in **Riga** consists of two privately-owned single houses. The current heating system consists of natural gas boilers for DHW and space heating. TP2 will be installed and the thermal output from the solar hybrid panel in TP2 is planned to cover the heat demand and to assist with evaporation of the heat pump. The electricity production from the hybrid solar panel will be used in the building appliances. Identified stakeholders involved in the demo site that were subjected to the survey performed in this study are private building owners.

1.5 Contribution from partners

IVL has had the lead in structuring and developing the deliverable. IVL is the author of the introductory Section 1, performed the scientific literature in Section 4 and authored the discussion in Section 5 . IVL was the main partner responsible for developing the survey and analysing the results from the survey.

CARTIF's main responsibility has been to perform the literature review of EU-projects. CARTIF has also been active in developing the survey to ensure an EU-project perspective is included.

RINA-C has participated in developing the survey and was responsible for online implementation of the survey. RINA-C has been the reviewer of the deliverable.

VEOLIA has been responsible for the current market and policy section on solar energy markets.

EHPA has been responsible for the current market and policy section on the heat pump markets.

The Demo site partners (BH, AJSCV, EMVS, BDR, GRE, RTU), have been involved to ensure that the survey is answered by the stakeholders surrounding the demo sites.

All partners involved in the SunHorizon project have been engaged to share the survey in their available channels.

2 Method

The method section provides detailed information of the methodology used to perform the respective parts of the deliverable. Starting with the method for the literature reviews, divided into scientific literature review, literature review of EU-projects, literature review of the solar energy market and literature review of the heat pump market. The second part of the method section focuses on the development, distribution and analysis of the survey.

2.1 Literature review

2.1.1 Method for scientific literature review

The following methodology guidelines of the Collaboration for Environmental Evidence (CEE) (2018) (3) was followed in conducting systematic evidence mapping, and documented it following the ROSES reporting standards for systematic maps (Haddaway et al 2017) (4) as shown in Figure 2 and explained in the following sections. We have not excluded any study after the "screening" phase in a systematic way. Therefore, the "critical appraisal" phase has been omitted, as it is optional according to the methodology.

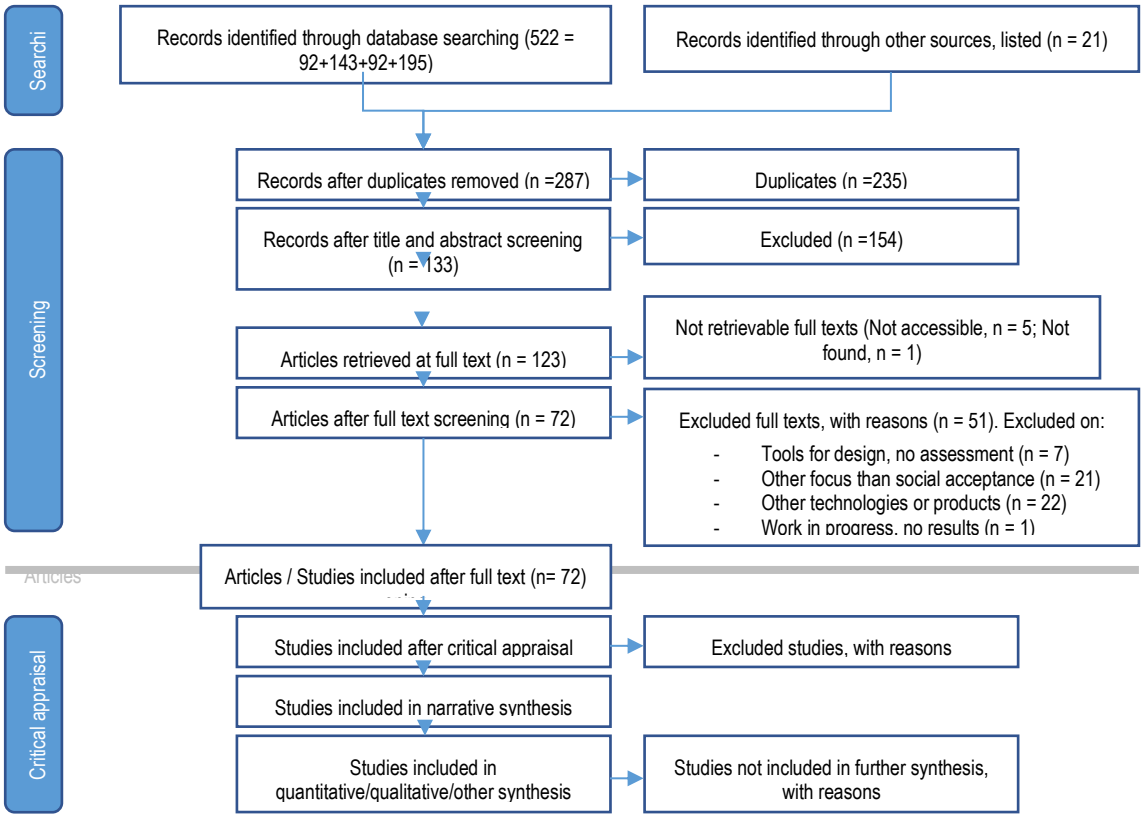

Figure 2: Adapted from ROSES diagram (4)

2.1.1.1 Search

The key elements of the research question were identified using a PICO approach. In environmental science, the most common question to answer is what type of impact an intervention or exposure has on the environment, and generally four key elements must be specified: what is the affected population (P), what is the intervention/exposure (I/E), what is the comparator (C), and what is the outcome (O)? (James et al. 2016) (5). Elements of the primary question are:

- Population, Buildings;
- Intervention: Social acceptance;
- Outcome: SunHorizon technologies.

Based on these elements, four searches were developed with slightly different focus, which are described below. An outline of the elements, searches and results obtained can be found in Table 3.

- Search 1 – General uses of the terms *social and market acceptance* for SunHorizon technologies
- Search 2 – Explicit reference to the building sector and to methodological approaches to address social and market acceptance
- Search 3 – Reduced number of synonyms to refer to the buildings, and increased number of synonyms to refer to social and market acceptance, and to Sun Horizon technologies
- Search 4 – Less restricted reference to buildings but disregarding key works by the Boolean AND NOT: *"drug*" OR "pharmacist*" OR "Satellite Power System*" OR "antenn*" OR "microwav*" OR photonics OR "vegetable oil*" OR "palm oil*" OR "infrastructure planning" OR "Power generation plant*" OR crystalline OR "cadmium telluride" OR ethylene OR "vinyl acetate" OR "large-scale manufactur*" OR "biomass waste residue*" OR "crop*" OR "fuel cell*" OR "desinfection*" OR "water treatment*" OR desalination OR "Personal Vaporizer" OR "smoking device*" OR "Site selection*"*

Table 3: Elements and number of results for each of the searches. P, Population; I, Intervention; O, Outcome.

Search #	*P: Buildings*	*I: Social and market acceptance*	*O: Sun Horizon technologies*	*Results*
1	*-*	"social accept*" OR "market accept*"	"photovoltaic" OR "PV" OR "solar panel" OR "heat pump*"	*92*
2	*("hous*" OR "building*" OR "resident*" OR tertiary OR commercial OR hotel OR "education*" OR "school*" OR "sport*" OR "service*" OR "religio*" OR demand OR "hospital*" OR healthcare) W/3 ("building*" OR facility OR "sector*"* ***OR stock OR side****)*	*("social accept*" OR "market accept*"* ***OR "stakeholder*" OR "value chain*") AND ("interview*" OR "survey*" OR "evaluation*" OR "method*" OR "assessment*")***	*"photovoltaic*" OR "PV" OR "solar panel*" OR "heat pump*"*	*143*
3	*("hous*" OR "building*" OR "resident*" OR tertiary OR commercial OR hotel OR "education*" OR "school*" OR "sport*" OR "service*" OR "religio*" OR demand OR "hospital*" OR healthcare)* ***W/3 ("building*" OR facility OR "sector*")***	*("social accept*" OR "market accept*" OR "stakeholder*" OR "value chain*"* ***OR "public attitud*" OR "public percept*" OR "public accept*" OR "aesthetic impact*" OR "aesthetic percept*" OR "user's percept*")*** *AND ("interview*" OR "survey*" OR "evaluation*" OR "method*" OR "assessment*")*	*"photovoltaic*" OR "PV" OR "solar panel*" OR "heat pump*"* ***OR "off-grid"***	*92*
4	*"hous*" OR "building*" OR "resident*" OR tertiary OR commercial OR hotel OR "education*" OR "school*" OR "sport*" OR "service*" OR "religio*" OR demand OR "hospital*" OR healthcare*	*("social accept*" OR "market accept*" OR "stakeholder*" OR "value chain*" OR "Public attitud*" OR "public percept*" OR "public accept*" OR "aesthetic impact*" OR "aesthetic percept*" OR "user's percept*") ("interview*" OR "survey*" OR "evaluation*" OR "method*" OR "assessment*")*	*"photovoltaic*" OR "PV" OR "solar panel*" OR "heat pump*" OR "off-grid"*	*195*

The searches have been conducted in Scopus database and result on 287 documents published in English.

2.1.1.2 Article screening

The searches were captured into the APSIS tool (MCC 2018) (6). After eliminating duplicates, 235 documents remained for screening at abstract and title level. Criteria for inclusion and exclusion were developed based on the PICO framework described previously. The inclusion criteria were relevant population (buildings), intervention (social acceptance), and outcome (SunHorizon technologies). The number of excluded articles and reasons for exclusion at each stage were documented (see Figure 2 and Supplementary Material). A total of 133 documents has been deemed relevant during this screening process, of which 123 full texts could be retrieved for analysis at full text levels (recording studies we cannot access).

2.1.1.3 Coding strategy

A data coding sheet was developed that includes elements of our mapping framework. By looking at the full text level, four key categories of data were extracted:

A. Scope of the work:
   - Sun Horizon solution studied: heat pump (Ground-source heat pumps, electric heat pumps), PV (e.g. building integrated PVs, pico PVs, solar PVs, solar space heating, etc) and technology-packages (Battery storage with PVs, microgeneration technologies, space heating, etc).
   - Geographical scope of the work, including country and World regions, following UN classification (Ref) on 5 regions and 17 subregions, and 195 countries.

B. Method:

   Methodological approach, distinguishing qualitative (interviews and surveys) or quantitative (simulation, decomposition, statistical methods, econometric models).

C. Background:
   - Stated technical potential for the solution investigated:
   - Interpretation of social and market acceptance: as economic feasibility, as barrier, as willingness to pay, as market share, as public acceptance or support, as user's perceptions, as attitudes).

D. Results:

- Qualitative results on social and market acceptance
   - Quantitative results on social and market acceptance
   - Policy recommendation

2.1.2 Method for literature review of EU projects

The purpose of the literature review of EU projects is to gather knowledge and main findings from similar projects to SunHorizon, in order to provide guidelines for the development of the survey to be performed in this deliverable. The review will focus on identifying approaches for data collection and evaluation of results applied in the identified projects. In order to limit the European projects to be reviewed, a set of criteria has been defined for the literature review of EU projects:

- The review is limited to those projects funded by European Commission (EC) in the last years in order to obtain recent information.
- The review is limited to those projects with the same research purpose as SunHorizon: projects where innovative renewable energy sources (RES) solutions are demonstrated at building scale.
- Only EU projects with specific activities on social and market acceptance and dealing with replicability in these issues are included.
- Number of EC projects to be analysed should be delimited to a number that obtains valuable insights from a perspective that results were confirmed by several reviewed projects.
- The selected projects should cover most of the European territory.

The information collected for each of the EU projects reviewed is summarized in Table 4. The following information has been extracted for each project:

- What is the technical solution evaluated, the place where is implemented and the involved citizens?
- Is the evaluation focused in social or market acceptance?
- What is the focus of the evaluation?
- Which are the main issues evaluated?
- What process is followed? (e.g. ex ante and ex post evaluation)
- What data sources have been used? (e.g. survey, individual interview or focus group interview according to the type of audience to be interviewed)
- What is the format of the tool used as data source? (e.g. online or paper form)
- The year of the result§

Table 4: Key information collected in the EU Project review

Focus of the review
Description of the sample: - Type of intervention evaluated - Location of the intervention - Type of building and end-user
Evaluation approach: - Type of evaluation - Objective of evaluation - Topics - Process - Data source - Target audience
Description of the data collection: - Format of the tool used as data source - Delivery of the tool - Response rate
Main results & year of result

2.1.3 Method for literature review of the heat pump market

In writing section 3.1.2 about the European heat pump (HP) market acceptance related to the SunHorizon technologies, the focus has been on the heat pumps application in the residential and commercial buildings, with particular attention to two segments: new and refurbished residential. Old buildings that have not been renovated have been disregarded since these are the possible applications of the SunHorizon technology packages.

Several free sources have been consulted and are cited when appropriate, but the main source of information and data is the EHPA "European Heat Pump Market and Statistics Report 2019" (7). The "European Heat Pump Market and Statistics Report 2019" has been evaluated as the most complete document available with a detailed analysis of the European heat pump market (in 21 countries), with segmentation and analysis of products and national markets. The data has been monitored yearly and gathered by national associations (members of EHPA) which have a direct access to local/national markets and can provide specific point of views on barriers and advantages on local level. The "European Heat Pump Market and Statistics Report 2019" has been written by the European Heat Pump Association (EHPA), gathering the information from all its national associations in Europe and providing market trends and policy references refereed to the

year 2018. The next report will be published in November 2020 with updated numbers for 2019. The "European Heat Pump Market and Statistics Report 2019" contains information about the HP market in three out of the four demo site countries where the SunHorizon technology will be demonstrated namely: Spain, Germany and Belgium. The report does not collect any data for the Latvian market as it is considered too small. No free reports or documents online could be obtained for Latvia displaying similar information. EHPA as the author of the section on the heat pump market offers to provide an updated analysis including Latvia and the other demo site countries in the framework of D7.6 in M42 of the project.

In reviewing the heat pump market acceptance some key aspects that have been analysed are:

- Market growth per EU country in different years
- Most sold units (analysis per category) and analysis of this consumer choice
- Policy framework

With the aim to understand and present the main barriers and opportunities in the market.

As it is explained in Section 3.1.4.2, the heat pump sales are influenced by the electricity price. The electricity price differs between countries and is difficult to predict. Apart from the electricity price, other market factors (strengths and threats) have been identified with the aim to determine what is influencing the market. Considering that both the market behaviour and the European heat pump market are influenced by EU/national regulations, an analysis of the EU policy has been performed. The EU policy analysis looks at how heat pumps can increase their market uptake given the new EU energy policies.

2.1.4 Method for literature review of the solar energy market

Section 3.1.3 about the solar market acceptance related to the SunHorizon technologies, focuses on PV and thermal technologies around Europe and its application in the residential and commercial buildings. Several sources have been analysed, but the main have been the EU Market Outlook (8) For Solar Power /2019 – 2023, published by Solar Power Europe and Solar Heat Markets in Europe. Trends and Market Statistics, summary November 2017 and published by Solar Heat Europe/ESTIF (9). These have been evaluated as the most complete documents available in the market with a detailed analysis of the European solar market (PV and thermal).

The aim of the SolarPower Europe Association is to ensure that more energy is generated by solar than any other energy source by 2030 and to lead its members to make solar energy the core of a smart, sustainable, secure and inclusive energy system in order to reach carbon neutrality before 2050. SolarPower Europe represents over 200 upstream and downstream organisations from the entire solar value chain. Solar Heat Europe strives for the growth of solar heat solutions in Europe through different actions, such as advocating for better regulation or encouraging the EU policy makers to shape a fair context for heating and cooling solutions. With around 40 members in Europe, Solar Heat Europe represents directly or indirectly over 90% of the industry across the value chain.

In reviewing the solar market acceptance different data have been analysed, starting from the global market and the European market, considering the top 3 EU markets. Both the challenges and opportunities facing of the solar energy sector are analyzed.

2.2 Survey

The following section describes how the survey was developed, implemented, distributed and the method for analysing the results.

2.2.1 Method for developing the survey

The survey was developed in five steps described in Figure 3. The first three steps set the structure of the survey; a definition of social and market acceptance had to be established, the research questions to be answered by the survey decided and the relevant stakeholder categories to survey had to be identified. The definitions were identified through the literature review and adapted to suit the objectives and conditions of this deliverable. Research questions were developed to suit the purpose of the deliverable and are presented in section 1.2.1. In EU projects, a common topic of research is the difficulty to implement innovative RES solutions in residential and tertiary buildings due to low social and market acceptance of citizens and stakeholders along the value chain.

The research questions in this deliverable reflects a similar approach. The potential target audience of the data collection tool must be identified and for EU projects these are typically citizens and residents, or end-user of the demo sites, that are affected by the technology as well as stakeholders involved with the technology. In EU projects the following stakeholder groups have often been included, citizens, residents, end-users, manufacturers and suppliers of technology, architects, contractors, financers, energy companies and building companies, research entities and municipalities. Stakeholder groups to target the survey at were identified from the value chain developed in *D2.3- Macro-market analysis, value chain and conceptual business model definition* (1) and described in section 1.3.

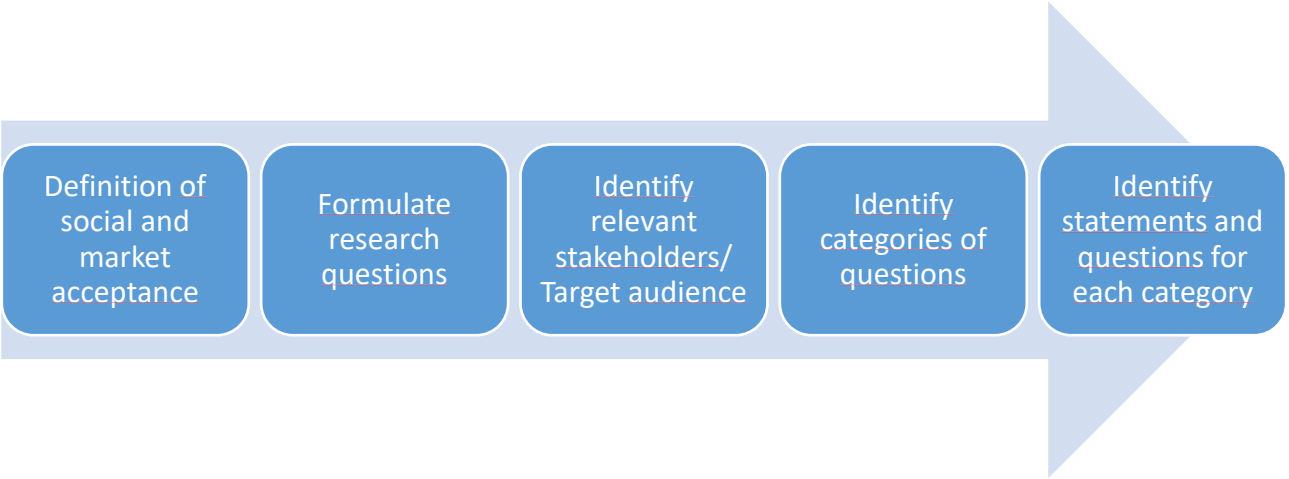

Figure 3: Method for developing the survey

Most of the reviewed scientific literature look at social and market acceptance from a household perspective (10) (11) (12) (13) (14) (15) (16), with the motivation that individual households are the stakeholder group adopting the technology (solar systems and heat pumps) by making the invest decision. In this study, a broader perspective is taken and stakeholder groups from the entire supply chain of the SunHorizon technologies have been included as well as building owners and private residents. Some additional literature was therefore reviewed where the installer perspective was analysed (17) (18) and studies including various stakeholder groups (2) (19), for example real estate owners, real estate developers, installers, energy utilities, institutional investors, and architects. In (2) the interview questions were altered to better suit the various stakeholder categories. In this study were the aim is to compare between stakeholder groups it was decided to ask the same questions regardless of stakeholder group and add the “not applicable” option for those statements were the respondent felt that the question was irrelevant or for other reasons did not want to respond.

The EU project review yielded several different data collection tools such as paper questionnaire, online questionnaire, individual interviews and focus group interviews. An interview or questionnaire can be structured into closed questions or open questions. In the EU projects closed ended questions with scale questions are the most usual way to capture respondent answer with the intention to identify the extent to which is in favor of a technology. Additionally, open questions were utilized to collect in open text format the respondent answer based on their complete knowledge, feeling, and understanding. By using open questions, the respondent is not limited to a set of options. Based on previous experience with conducting and analysing surveys all questions (except demographical variables) were answered using a 7-point Likert scale. The odd-numbered Likert-scale gave the respondents the option to select the middle option when the respondent had no opinion in either direction about the statement. For all statements there was a “Not applicable” option

available that allowed the respondent to avoid answering the statement. The questions were formulated as bi-polar descriptive pairs of statements with a negative statement (or barrier) to the left end of the scale and an equivalent version of the statement but as a positive statement (or motivator) to the right end of the scale. Some statements and questions identified in previous studies were used to build the descriptive pairs in the questionnaire and were appropriate examples could not be found in the literature, new statements were developed.

Factors that influence the social and market acceptance of stakeholders are identified in the literature and the survey is structured around these categories. The categories and topics identified in the scientific literature are listed below:

- Economic aspects are the most frequently appearing category with questions related to initial cost, payback time, availability of subsidies, maintenance cost, access to finance, property value (15) (2) (10) (11) (12) (19).
- Technological aspects related to level of complexity, reliability, performance and quality of the system (14) (2) (17).
- Social aspects are concerning the opinion towards the technology in the respondents surrounding (family, neighbours, media), a willingness to show off environmental concern and increase social status by adopting the clean technology (10) (12) (16).
- Comfort aspects including aesthetics, physical barriers of the property and general questions related to indoor climate are commonly included in studies (15) (11) (2) (10) (13) (14) (15).
- Environmental aspects related to improving the environment (2) (11), (12) (15) (16), and the importance of also looking at how aware and concerned the respondent is about the environment (19).
- Organisational and business related aspects are mainly regarding the availability of competent personnel (12) (18) and availability of suppliers (14). From D2.3 (1) it is also identified a need for developing new business models.
- The availability of information and questions related to trust are often occurring when dealing with innovative technology. Topics mostly look at the availability of information and awareness of technology from different angles as well as the perception of transparency and trustworthiness of the actors on the market (13) (2) (10) (12) (19) (16).
- Legal aspects where topics on permit and inspection procedures (13) (1), political commitment, favourable and predictive legal framework are asked (10) (19).

In the identification of statements and questions to be included in the survey, the EU project literature review found that it was important to understand the reasons behind low social and market acceptance among citizens and other stakeholders towards the technology. The EU project literature review identified the following factors as most influence for social acceptance:

- Aspects of trust: whether the local population trusts the intentions and information of the investors and other actors from outside the community
- Distributional justice: how are costs and benefits shared
- Procedural justice: if exists a fair decision-making process giving all stakeholders the possibility to participate
- Perceived usefulness: the degree to which a person believes that using a technology would suppose an improvement in the quality of life and in the environment.
- Perceived ease-of-use*:* the degree to which a person believes that using a technology would be free from effort.
- Affordable technology: how risky and expensive is a technology
- Personal attitude: according to the awareness in the technology and in environmental problems

On other hand, EU projects identified as key to know the most significant barriers (i.e. technical, economic, social) that restrain the social and market acceptance and the corresponding drivers that can contribute to increase the satisfaction with the new technologies.

One important factor when developing the questionnaire is that, apart from stakeholders involved in the SunHorizon project, the technology packages are *unknown technology* to the respondents of the questionnaire. Even to the stakeholders involved with the SunHorizon project, the technology is rather unknown since it has not been implemented yet at any of the sites and thus not tested. The innovation being tested for acceptance is *in the package* (solar energy coupled with heat pumps). It is not the focus of the study to examine social and market acceptance towards the components separately but rather as a package deal. Knowledge and acceptance of solar systems is not the same as knowledge and acceptance of the SunHorizon technology even though the technologies share some characteristics. However, several of the questions *did* ask about the respondent's opinion towards solar systems *or* heat pumps since the combination of the two was deemed unusual for many respondents to have an opinion about for the questions that were developed. Hence the respondent's opinion towards solar systems *and/or* heat pumps is used as an indicator for the opinion towards the SunHorizon technology.

The topics and identified categories were then split, and the questions rephrased, into the two sections; Social and market acceptance, to suit the definitions established for this study. The development and content of each section of the questionnaire is described in more detail in the three following sub-sections.

Table 5: An overview of the structure of the questionnaire

Part of the survey	Aim	Themes approached	Number of Questions
Respondent profile questions (RPQ)	Identify and characterize the stakeholder groups	Involvement in SunHorizon, Gender Stakeholder category Country of residence, Age, education level, Household (annual income, number of occupants, installed technologies)	10
Social acceptance questions (SAQ)	Identify personal perceptions about the technologies	Financial aspects Technological aspects Social aspects Comfort aspect Environmental aspects	16
Market acceptance questions (MAQ)	Identified willingness to adopt the technologies, including motivators and barriers	Economic aspects, Technological aspects, Organisational/business aspects, Availability of information & trust aspects and Legal aspects	18

2.2.1.1 Respondent profile

Demographic variables, or background variables, are often included in surveys about social and market acceptance in the scientific literature to create a profile of the respondent. Gender, age, income level, education level, employment status, number of occupants in household and some sort of environmental profile are frequently asked questions (10) (11) (12) (14) (15) (16) and have been included in the "Respondent section" of the survey developed in this study. In Eu projects, the most common questions related to respondent profile are age, level of education, level of income, nationality.

Since only stakeholders involved with the SunHorizon project have any real experience with the technology packages, it is necessary to know if the respondent is part of the SunHorizon project. Stakeholder group and nationality are necessary questions for the market acceptance analysis to be able to answer what needs and requirements different stakeholder groups in different countries have and thus suggest targeted actions necessary for market adoption. In accordance with the research questions.

Table 6: Respondent profile questions included in the survey

RPQ	Demographic variables	RPQ	Demographic variables
1.	**Involved in SunHorizon**	2.	**Age**
	Yes | No | Don't know		18-34 | 35-50 | 51-65 | >65
3.	**Gender**	4.	**Highest education level**
	Female | Male | Prefer not to say		University degree | Secondary school | Primary school | Other
5.	**Respondent category**	6.	**Occupants in household**
	Businessperson | Private building owner | Public building owner | The public/residents/end-users		1 | 2 | 3 | 4 | >4
7.	**Household annual income**	8.	**Employment status**
	<20 000 € | 20 000 – 40 000 € | 40 000 – 70 000 € | 70 000 – 90 000 € | >90 000 €		Employed in private sector | Employed in public sector | Self-employed | Unemployed | Student | Retired | Other
9.	**Country of residence**	10	**Already adopted similar technology in company or building**
	Germany | Spain | Belgium | Latvia | Other		0 | 1 | 2 | 3 | 4 | 5 | 6

2.2.1.2 Social acceptance

Social acceptance was defined in this report as the *attitude* towards the technology. It evaluates the likelihood for accepting or opposing innovation. For social acceptance the literature yielded five categories that were important in order to assess a respondent's likelihood to accept or reject a new technology. The categories were; Economic aspects, technology aspects, social aspects, comfort aspects and environmental aspects. The questions are researching the respondent's attitude towards the technology as positive or negative. The respondents were asked to "*Rate on the scale depending on your **personal perception** about the technology*" as the focus for social acceptance should be on a personal level.

Descriptive pairs were utilized in the questionnaire, where the pairs consisted of words or phrases that oppose each other. A semantic differential table was constructed using the developed descriptive pairs. Each pair was placed at each end of a 7-point Likert scale with the negative statement to the left and the positive statement to the right. The idea was for the respondent to place the marker closer to the statement that applied the most to the respondent's personal perception towards the innovative in relation to the statements. The closer to the statement would thus indicate a stronger feeling. The statements are meant to focus the respondent's attention on the innovation instead of on their own needs.

Table 7: Social acceptance questions in the survey

SAQ	Category	Negative statement	Positive statement
11.	Financial aspects	Does not generate economic savings	Generates economic savings

12.		Waste of money	Good value for money
13.	Technology aspects	I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood
14.		No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed
15.		The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking
16.		Unreliable technology for heating and electricity	Reliable technology for heating and electricity
17.	Social aspects	Decreases social status	Increases social status by displaying environmental commitment to others
18.		I am not interested in the technology	I am interested in the technology
19.	Comfort aspects	Does not improve quality of my everyday life	Improves quality of my everyday life
20.		Noisy	Silent
21.		Decreases thermal comfort	Increases thermal comfort
22.	Space requirements	The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology
23.		Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now
24.	Aesthetics of technology	The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape
25.	Environmental aspects	It is a dirty technology that increases pollution	It is a clean technology that reduces pollution
26.		I am little/not concerned about the environment	I am concerned about the environment
27.		Environmental and climate issues are not my responsibility	I take responsibility towards environmental and climate issues

2.2.1.3 Market acceptance

Market acceptance is defined in this deliverable as the willingness to adopt innovation. It evaluates *barriers and motivators* to implement the innovation in buildings and business models. The market acceptance section of the questionnaire aims to learn about how the different stakeholder groups perceive various statements to be a barrier or a motivator. The questions were set-up as bi-polar descriptive pairs with a barrier on the left end of the scale and the equivalent motivator on the right end of the scale. The statements are meant to focus the respondent's attention on their own/their companies needs and requirements. The identified categories in the literature were; Economic aspects, technology aspects, organisational/business aspects, availability of information & trust aspects and legal aspects.

Table 8: Market acceptance questions in the survey

MAQ	Category	Barrier	Motivator
28.	Economic	High investment cost	Low investment cost
29.		Availability of governmental support is unpredictable	Availability of governmental support is predictable
30.		Not enough subsidies available	Subsidies available
31.		Decreases value of a property	Increases the value of a property
32.		High maintenance costs	Low maintenance cost
33.		There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable
34.	Technological	Too complex technology	Easily understood technology
35.		Uncertain cost savings potential	Certain cost savings potential
36.		Uncertain performance of technology	Certain performance of technology
37.		New and innovative technology is risky	New and innovative technology is an opportunity
38.		Requires more maintenance than existing heating system	Easy maintenance
39.		Not enough solar irradiation	Good solar irradiation
40.	Organisational/Business	Lack of suitable business models	Suitable business models are available
41.		Not enough professional competence available	Enough professional competence available
42.	Availability of information	Not enough information is available about the technology	Sufficient information is available about the system
43.	Trust	Untrustworthy actors on the market	Trustworthy actors on the market
44.	Legal	Difficult permit procedure	Easy permit procedure
45.		Unsupportive legal framework	Supportive legal framework
46.		Unpredictable legal framework	Predictable legal framework

2.2.2 Methodology for on-line implementation

To reach a wide public for the social and market acceptance survey, the EU survey service from the European Commission was utilized. EUSurvey is an online survey management system for creating and publishing forms available to the public, e.g. user satisfaction surveys and public consultations. Launched in 2013, EUSurvey is the European Commission's official

survey management tool. Its main purpose is to create official surveys of public opinion and forms for internal communication and staff management, e.g. staff opinion surveys and forms for evaluation or registration.

EUSurvey provides a wide variety of elements used in forms, ranging from the simple (e.g. text questions and multiple-choice questions) to the advanced (e.g. editable spreadsheets and multimedia elements). The decision to utilize this service instead of other online services was mainly for the following reasons:

- Versatility of implementing different type of questions
- Possibility to translate the survey in different languages to increase the reachability of the survey among EU
- Security of personal data and online forms

The main features of EUSurvey are represented below:

- Customizable forms
    - In the easy-to-use editor you can choose from a variety of question types - from simple text and multiple-choice questions to spreadsheet questions or multimedia survey elements. Structure your survey using special structural elements.
- Dependent questions
    - EUSurvey can display additional questions and fields, depending on the answers given by the participant, making the survey interactive.
- Languages
    - The user interface is available in 23 of the official EU languages, and you can translate your form into any of the 136 languages covered by ISO 639-1, from Abkhaz to Zulu.
- Security
    - EUSurvey has the infrastructure needed to secure the online forms.
- Advanced privacy
    - The participant's privacy can be guarantee by creating an anonymous form. Connection details will then not be available.
- Customise the look and feel
    - With the built-in CSS style editor and embedded rich-text editors for all visible elements, you have full control over the form's layout. A large list of survey themes makes it easy to adapt the form to a project's identity. You can choose between single page and multi-page surveys.
- Analysing the results
    - EUSurvey offers basic result analysis capabilities and visualization of data in histograms and chart views. You can also export survey results to standard spreadsheet formats in order to import them into statistical applications.
- Publishing the results
    - Use the possibilities EUSurvey offers to publish a sub-set of all submitted answers on the internal pages of the application. Statistics and charts can be calculated and created automatically by the system.

Initially, the survey was implemented in the English version and shared the structure and graphic with the involved partners. Later, thanks to the online translation features and with the check of the other partners, the survey was translated in the languages of the demo countries (Latvian, German, Spanish and French). The results of the survey were downloaded as an Excel file and used for the statistical analysis as presented in Section 4.2

2.2.3 Method for distributing the survey

The demo site responsible partners have been responsible for distributing the questionnaire to the stakeholders involved in the SunHorizon project. Most of the demo sites (DS3 Sant Cugat, DS5 San Lorenzo, DS6 & DS7 in Verviers) distributed the questionnaire by sending out a digital link. One demo site (DS4 Madrid) opted for distribution via paper copies of the questionnaire and the remaining demo sites (DS1 Berlin, DS2 Nürnberg, DS8 Riga) used both digital and paper copies.

The questionnaire was further distributed to all partners in the SunHorizon project, who were encouraged to participate and to share the survey in their channels. The dissemination partner in the SunHorizon project, EHPA, shared the survey

on the SunHorizon project's official channels (twitter and LinkedIn). This enabled responses to be collected from stakeholders not involved in the SunHorizon project but who might have an interest in the technology.

2.2.4 Method for analyzing new evidence

Data analysis of the data collected through the survey was performed in R (20). R is a programming language and free software environment for statistical computing and graphics widely used among statisticians for performing data analysis. The analysis of the collected data in EU-projects in often presented as frequencies (CITyFiED and REMOURBAN) percentage of people that share an opinion. In the scientific literature typically more advanced statistical analysis methods have been used, such as various multivariate data analysis methods (12) (14). In this deliverable several approaches for analyzing the data have been used, multivariate data analysis using Principal Component Analysis (PCA) and a COST (consider one separate variable at a time) analysis, using the ANOVA test.

Multivariate data analysis using *Principal Component Analysis* (PCA) is used as the initial approach to see if the dataset reveals any grouping among the observations. PCA enables visualization of the variation present in a dataset that contains many variables by creating principal components that explain as much of the variance in the data as possible (normally 2-6 components are included in the analysis). Normally the first couple of components should explain at least above 50% of the variance in the data but preferably above 80%. The components are placed as x- and y-axis in a 2- or 3-dimensional coordination system to enable visual inspection. The idea is for the inspection to yield trends in the dataset and gives a sense of which variables are similar to one another, which are different and which points are deviating. The idea is to identify groups that are similar and identify which variables are related to that group. The visualization is achieved by graphically plotting the calculated values for *scores* and *loadings*. The scores plot is a summary of the relationship among the observations (the respondents) and the loadings plot is a similar summary of the variables (the questions in the survey). The two plots complement each other, the patterns seen in the scores plot should be interpreted by the patterns in the loadings plot. If the data contains information that can separate different group from each other the groups will cluster in the PCA plots. For more information about PCA analysis Multi- and Megavariate Data Analysis by MKS Umetrics AB is recommended reading (21).

Apart from multivariate analysis, single variate analysis was performed with ANOVA test in R. ANOVA, short for analysis of variance, looks for statistically significant differences between groups in the dataset by comparing the mean value. The method applied in this deliverable is to look at each of the respondent profile questions (x-variables), containing different groups, against each of the social acceptance questions (y-variables). Performing the ANOVA test by comparing different groups on a single variable is called a one-way ANOVA test. The null hypothesis in ANOVA is that all group means are equal and if the null hypothesis cannot be rejected then there is no statistically significant difference between the groups with regards to the tested statement. The null hypothesis can be rejected if the p-value, the probability of obtaining the results if the null hypothesis is correct, is below 0.05. All possible iterations were performed, and the cases were the p-value was less than 0.05, further analysis were performed as significant differences is identified between groups. The one-way ANOVA test indicates a significant difference between groups but does not say between *which* groups. Multiple pairwise comparison between the means between groups was therefore performed using Tukey HSD (Tukey honest significant differences) multiple pairwise comparisons. Tukey HSD yields p-values after adjusting for the multiple comparisons between groups. For the groups with p-value less than the significance level 0.05 the results are presented for social (section 4.2.2.2) and market acceptance (section Market acceptance4.2.3.2) respectively. For more information about the ANOVA test (22) and its applications in R (23).

ANOVA assumes that all data is normally distributed. A Kolmogorov-Smirnov test for normality was performed on all y-variables with the null hypothesis being that data was normally distributed. The Kolmogorov-Smirnov test can also be used to test if data follows other distributions than the normal distribution. The Kolmogorov-Smirnov test calculates the deviation of the observations from the normal curve and presents with a single number how much the data differs from the null hypothesis. A large deviation results in a low p-value, the probability of the null hypothesis being correct (24) (25).

In addition to the statistical analysis of the data the results are also presented to the reader in a summary of the demographical variables of the respondents (section 4.2.1). For the demo site countries some key findings are highlighted where many respondents had either answered very high (when 80% had answered between 5-8 for a statement) or when more than 50% of respondents had answered negatively to a statement (1-4). The key findings are presented for social (section 4.2.2.3) and market (4.2.3.3) acceptance respectively.

2.2.4.1 Pre-processing of data

Pre-processing of data was performed as follows for all analysis

- Adjust spelling mistakes where respondent could write freely in "Other" options
- Q4 PhD has been included as University degree. Other "Other" categories remain as other
- Q5 For businesspersons: type of business "Other" this category was kept and the new categories of stakeholders that were identified were added to the list of stakeholders clearly noting that they were identified as a result of the survey. The new categories were not included in the analysis, only as "Other". In the analysis only the main categories were used (not the type of business the company deals with- this is visible only in the summary table of demographical variables)
- Q6 Household members was changed into numerical values (>4 was set to 5,5)
- Q7 Household Income: was changed into numerical values (set as 1-5, were 1 was <20 000€ and 5 was >90 000€)
- Q7 Country of residents: All countries added under "Other" were included in the analysis in this first step
- Q10 Previously adopted similar technology- All selected choices were added up to a numerical value. I.e. if the respondent had selected that the building had already installed both solar thermal panels and a heat pump the numerical value for this variable was calculated at 2.
- Questions 26 and 27 of the social acceptance section of the questionnaire were used to establish an environmental attitude that was used as a part of the respondent profile (the background variables). The environmental index was produced by summarizing the result of Q16+Q17, a high index number is interpreted at the respondent being aware and willing to act against climate change. A similar approach was used in (12) were the ecological attitude was established by cluster analysis of the environmental variables.

Q26	Environmental aspect	I am little/not concerned about the environment	I am concerned about the environment
Q27	Environmental aspect	Environmental and climate issues are not my responsibility	I take responsibility towards environmental and climate issues

- "Not applicable" is managed as a data loss, as well as "Prefer not to say"
- All qualitative variables (the questions related to respondent profile) with less than 4 respondents per category were grouped together as "Other".

For PCA analysis the following steps were added to the points above:

- For all qualitative data (that has not already been processed to numerical data according to the descriptions above), namely; Q1, Q2, Q3, Q4, Q5, Q8, Q9, binary dummy variables were created.
- Mean-centering and auto-scaling of all variables
- In a second version of the PCA all statements with responses 1 to 7, the variables were truncated into binary variables (5-7 --> 1 and 1-4 --> 0) .

For Anova the following steps were added to all points above:

- The numerical respondent questions were changed to class character for Anova to treat them as groups.

3 Current markets and policies

The section on current markets and policies provides a description of the policy framework affecting the heat pumps and solar energy markets in the EU, followed by an overview of the market trends and uptake of heat pumps and solar technologies.

3.1.1 Policy framework

The HP and solar energy markets are influenced by the policy regulations and incentives adopted on national and European level. Focus in this section is towards EU policies related to the EU goals for 2030 and 2050 aimed at decarbonizing Europe. The effect of these regulations and goals can be considered an opportunity for the HP and solar energy market as HPs contribute to energy efficiency targets and solar energy contribute with renewable energy. The main EU regulations seen as positive influencers are described below.

- Energy Performance of Buildings directive (EPBD) is the main legislative instrument which is improving the buildings energy performances and stating that new buildings (and those undergoing major renovations) must be Nearly Zero Energy Buildings (NZEB) by the 31th December 2020. The directive aims to accelerate building renovation rates by reinforcing provisions on long-term building renovation strategies, with the vision of a decarbonised building stock by 2050 and the mobilisation of investments.
    - New buildings, however, will only represent between 10% to 25% of the European building stock by 2050 (8). As a result, energy renovation rates of existing buildings need to at least triple to meet energy and climate objectives.
    - Definitions of NZEBs still vary among member states, making direct comparisons problematic.
    - This directive is seen as an opportunity for the HP market since HPs contribute to the effort of reducing the energy consumption of buildings and reaching the NZEB goals, by providing energy savings and creating synergies with other technologies.

- Energy Efficiency Directive (EED) all EU countries are required to use energy more efficiently at all stages of the energy chain, from production to final consumption. Since the 2012, Member States must follow a set of binding measures to help the EU reach its 20% energy efficiency target by 2020.

- Clean energy package for all Europeans (containing notably the European Performance of Buildings Directive, the Energy Efficiency Directive, the Renewable Energy Directive, the Energy Union Governance Regulation and the Electricity Market Design). The new energy policies now require to be implemented by Member States. This shifts the focus of policy action on EU's 2030 climate and energy goals to the national level.

- The Renewable Energy Directive is the European legal instrument for the production and the promotion of renewable energy. A revised version of the directive entered into force on 24 December 2018 and sets a binding overall renewable energy target for the EU for 2030 of 32% final energy consumption from renewable sources, following on from the existing binding 20% target (including at national level) by 2020.

- EU strategy 2050, the European Commission's vision for a climate-neutral future covers nearly all EU policies and is in line with the Paris Agreement objective to keep the global temperature increase to well below 2°C and pursue efforts to keep it to 1.5°C (7).

3.1.2 Results of heat pump market analysis

The European heat pump market has grown constantly since 2012, and by comparing the data for HP sales in Figure 4 between 2012 and 2018 it is visible that the sales numbers have almost doubled (7).

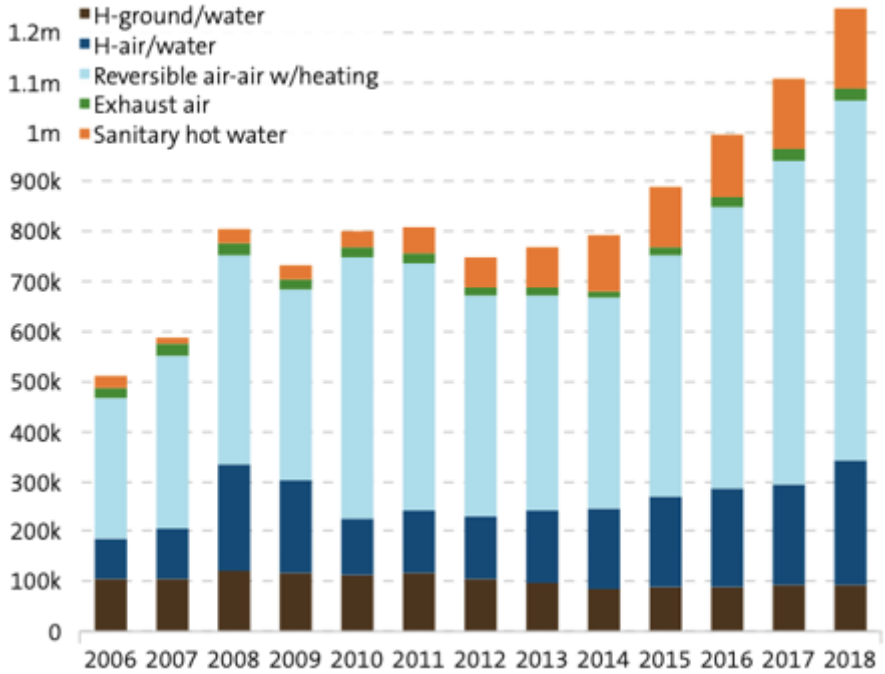

Figure 4: HP sales development by type in the EU-21 States (7)

The European sales growth with only 1.26 million HP units sold in 2018 in the 21 analysed countries, show that there is an increasing interest from the end-users in adopting HPs as technology for their heating and cooling system. In 2018, the 88% of the European market volume was sold in only ten of the targeted 21 countries, displayed in Figure 5. The five countries in which there was the highest number of units sold were France (275 114 units sold; 12,3% growth), Italy (200 433; 12,1%), Spain (119 928; 12,3%), Sweden (107 834; 3,4%), and Germany (99 100; 8,2%).

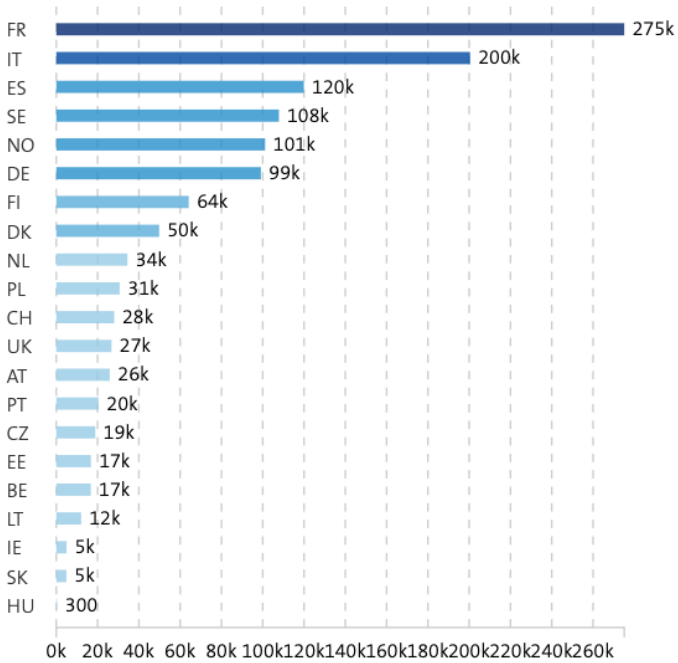

Figure 5 sales of HPs by country in 2018 (7)

In Figure 6 three of the four countries were the SunHorizon technologies is being demonstrated are highlighted by blue squares showing the HP market increase between 2010-2018. As described in section 2.1.3, no data could be obtained for Latvia.

	2010	2011	2012	2013	2014	2015	2016	2017	2018
UK	14%	-1%	-3%	-1%	6%	6%	-7%	20%	21%
SK	55%	-38%	33%	22%	15%	10%	109%	25%	70%
SE	9%	-16%	-11%	2%	-1%	8%	-2%	3%	3%
PT	58%	-23%	-39%	16%	-13%	30%	25%	33%	8%
PL		29%	18%	20%	25%	16%	4%	19%	14%
NO	12%	-11%	-19%	-7%	-8%	14%	12%	3%	34%
NL	-4%	10%	-3%	-15%	-8%	10%	97%	61%	40%
LT	-7%	15%	8%	12%	52%	29%	21%	456%	27%
IT	13%	0%	-7%	-1%	-12%	23%	46%	-1%	12%
IE	43%	-15%	13%	9%	54%	68%	27%	0%	0%
HU	18%	-9%	-19%	14%	-47%	44%	33%	0%	-63%
FR	-31%	18%	2%	8%	27%	8%	5%	12%	12%
FI	-4%	11%	-16%	0%	10%	-13%	2%	3%	3%
ES		6%	-32%	4%	5%	50%	7%	20%	12%
EE	2%	13%	14%	9%	8%	6%	0%	0%	0%
DK	-4%	6%	23%	3%	-26%	24%	-4%	60%	13%
DE	-6%	5%	7%	3%	-5%	2%	14%	15%	8%
CZ	78%	0%	3%	13%	4%	15%	40%	24%	21%
CH	-2%	-2%	6%	5%	1%	2%	2%	9%	9%
BE	101%	73%	22%	2%	-15%	58%	2%	21%	7%
AT	-6%	-2%	5%	6%	5%	19%	0%	15%	-2%

Figure 6 HP market increased in % per EU country. Marked by blue squares are three out of the four countries where the SunHorizon demo sites are located namely: Spain, Germany and Belgium (7).

In 2018 the HP market grew in Spain, Germany and Belgium, specifically (7):

- In Spain (third among the EU states in HP units sold) in 2018 there was an increase by 12% compared to the year before
- In Germany (sixth EU country with the highest number of HP units sold) had a growth of 8%
- In Belgium the HP market increased by 7% in 2018

3.1.2.1 Heat pump categories

Apart from looking at the numbers of units sold, the type of heat pumps sold is taken into consideration to learn what type of heat pump is preferred by customers (Figure 7 and more details in Figure 8).

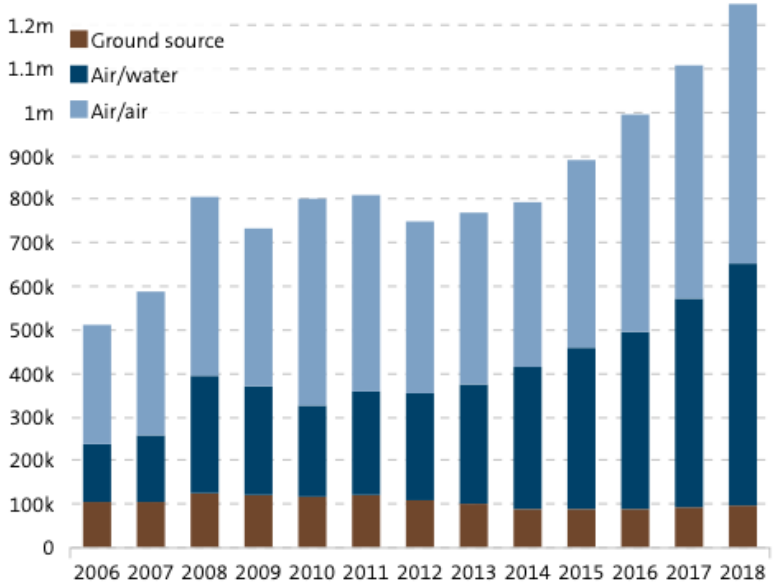

Figure 7 Development of sales by HP categories (7)

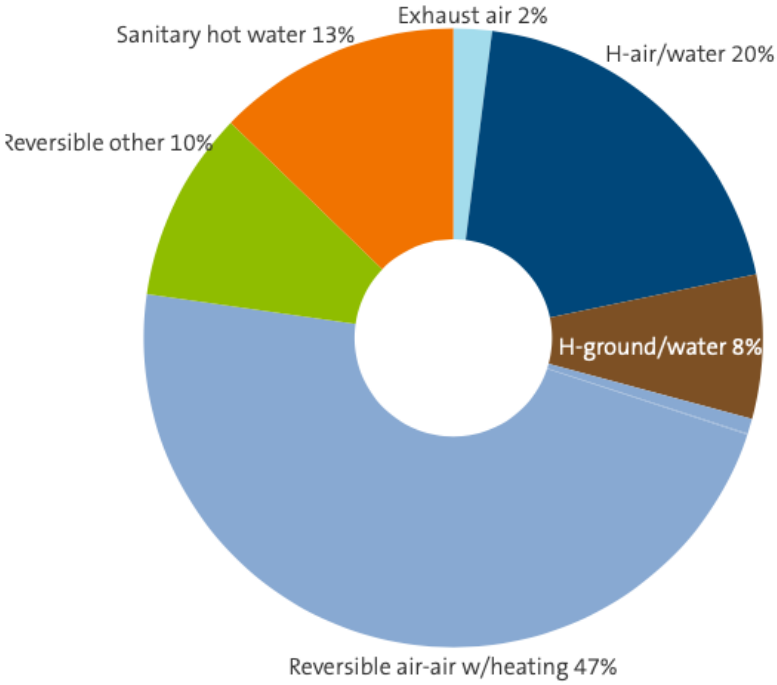

Figure 8 Split of sales by product category in EU-21, 2018 (Includes sales of reversible air/air heat pumps; "H-" indicates primary heating function) (7)

By looking at Figure 8, reversible air/air (47%) and air/water (20%) systems have the highest rates in sold units compared to the overall 2018 market. Altogether they account for 67% of total growth, this could hint at an increasing acceptance of air-distribution systems which may at least partly be caused by the overall reduction of the energy demand of buildings as

well as by an increased sales volume of higher capacity units in commercial buildings, where energy distribution by ducted air is the standard.

A more detailed look at the national market developed in the demo site countries Germany, Spain and Belgium. In Germany, in 2018, the major units sold were air/water units, followed by ground/water units and finally a minor share covered by sanitary water units sold, see Figure 9.

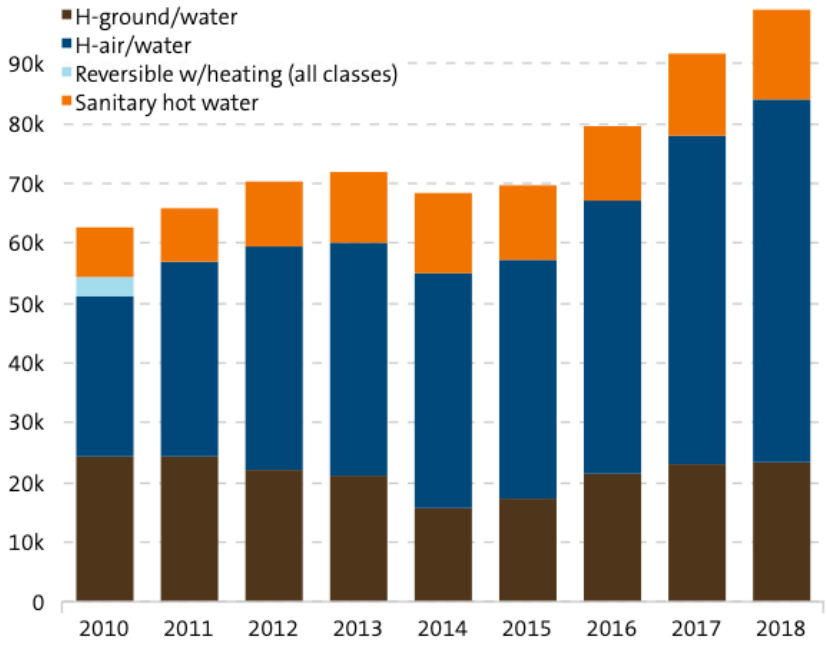

Figure 9 Heat pumps sales development per categories in Germany

In Spain in 2018, the situation is completely different. In Figure 10 is clear that the biggest market share in Spain is covered by reversible HP units, and a minor share by heat pumps used for sanitary hot water.

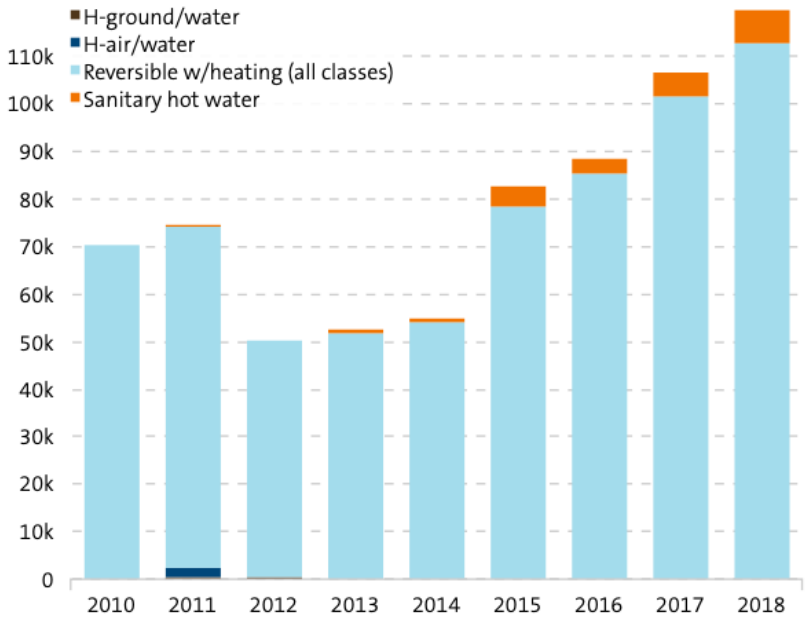

Figure 10 Heat pumps sales development per categories in Spain

In Figure 11 the segment of reversible HPs sold in Spain, is better analysed with a dedicated study.

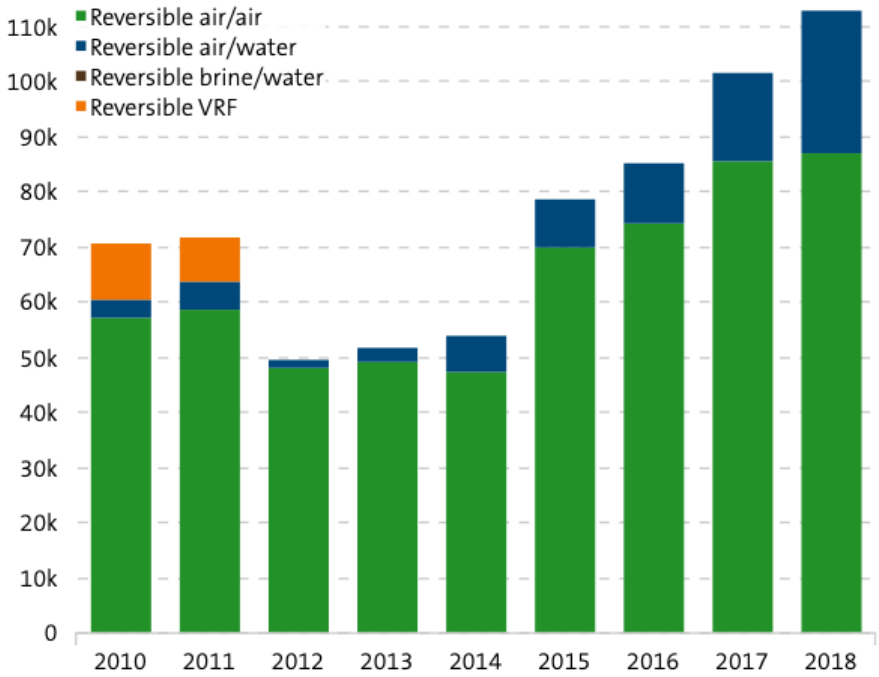

Figure 11 Reversible heat pumps sales, per sub-category, in Spain

Figure 11 shows that the majority of the market is direct to reversible air/air HPs (around 85.000 units sold in 2018) while a minor share is dedicated to reversible air/water heat pumps (with 25.000 units sold). In Spain, contrary to Germany, the HP market is focused on reversible units and no track of ground source HPs sold.

In Belgium, the market is different, compared to the previous ones, and is more varied (Figure 12). In Belgium the air/water HP units are covering a bigger share of the market sales in 2018, followed by sanitary hot water HPs, reversible HPs units and ground /water HPs. Belgium is representing a smaller (but growing) market (around 16.000 units sold in 2018) and more varied, compared to the two bigger markets in Spain (more than 110.000 units) and Germany (more than 90.000 units).

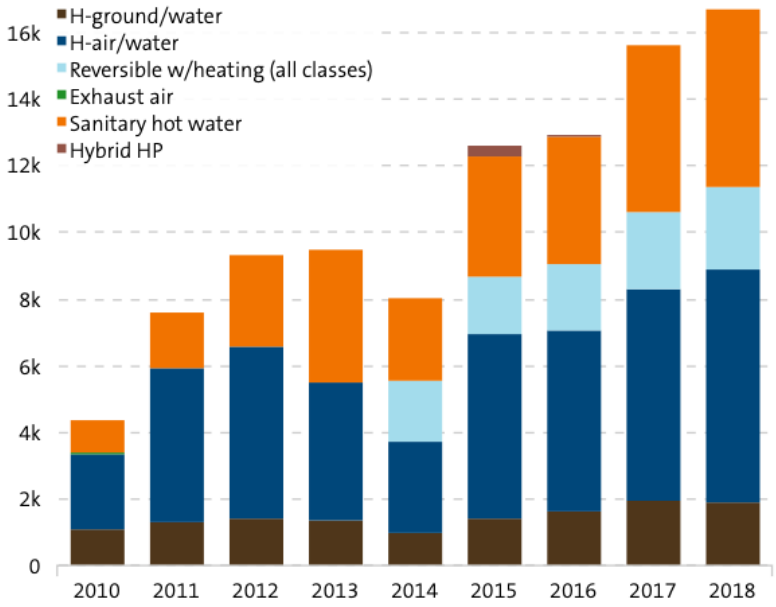

Figure 12 Heat pump sales development by type of heat pump – Belgium

3.1.2.2 Market forecast

Considering the shares occupied by the air/air and air/water units, the analysis focuses on the future development of these technologies in the European HP market. By looking at the forecast presented in Figure 13, it is visible that the prediction of a market growth of 6% regarding air/water HPs by 2024.

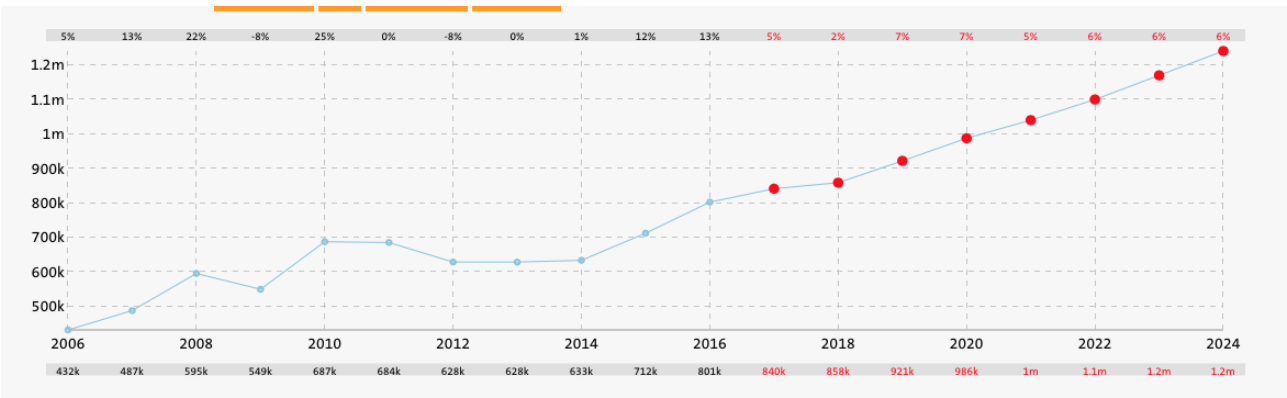

Figure 13 Forecast for air/water heat pumps in the EU market (26)

For reversible air- air HPs there is a prediction of 14% growth by 2024 in the EU market (Figure 14). Reversible air- air HPs larger growth can be determined by the lower investment costs and ease of installation, that is seen as an advantage.

Figure 14 Forecast or reversible air-air w/heating heat pumps in the EU market (26)

3.1.2.3 Segmentation of the EU Heat pump market

The European HP market can be segmented into new buildings and renovation, and then a further partition into residential and non-residential building categories (Figure 15). By looking at the data in Figure 15 in the residential sector, HPs have a solid market in new buildings, while in the renovation sector there is a growing market. In the commercial sector there is a solid market in the renovation sector with a growth in terms of investors, while in new commercial buildings this opportunity is not fully exploited yet.

	New building	**Renovation**
Residential: single/double family house	Mass market currently developing	Increasingly recognized market (France, Germany, Sweden, Switzerland), importance of domestic hot water units increasing
Residential: Multi family residency	Small; market developing	Small; market developing
Non-residential (commercial)	Minority share in currently sold heat pumps. Several demonstration projects available, potential for heating and cooling projects by far not exploited. Industrial heat pumps a small yet promising application.	Increasingly important with investors that value low operating cost. Special application in sewage systems, subways and tunnels.

Figure 15 Segmentation of the HP market (7)

For France, Slovakia and Sweden the market shares of HPs compared to the total heating market are shown in Figure 16, considering the categories: new buildings and renovation.

	New building	Renovation
France (space heating)	50%	20%
France (water heating)	70%	60%
Slovakia (Space heating)	80%	20%
Sweden (space heating; one-two family houses)	90-95%	70%

Figure 16 HP market shares of total heating market in France, Slovakia and Sweden (7)

3.1.2.4 Heat pump market factors

The main aspects that have contributed to the HP market growth are:

1. Today's HPs can cover a wider range of temperatures, operational from -25°C and providing 65°C hot water.
2. Hybrid systems enable HPs in the renovation segment, and they are more often chosen in building renovation
3. Building standards limit maximum heat demand per m^2, mandate the integration of renewable energy and favour smart buildings. This is often substantiated by institutional and financial subsidies that make market development easier.
4. Reduction of the HP investment cost.
5. HPs can contribute to reducing CO_2 emissions in heating and cooling systems if replacing other fossil fuels.
6. Governmental regulations have increased energy efficiency targets and incentives (27)

Opportunities for further development of the HP market are:

1. Development of digitalization and integration with IoT.
2. Increasing investment in commercial and residential sectors
3. Harmonization of the definition of the heat pump performances, giving the currently diverse testing procedures and definitions among different countries (28)

The three main challenges for the HP market in Europe are the relationship between the electricity price and the price of natural gas and oil, initial investment cost of buying a HP and energy systems related issues. The challenges are described in more detail below.

1. Electricity price versus natural gas price

In Eastern Europe in 2018, the price for 1 kWh of electricity increased more the price for 1 kWh of natural gas. In Poland and Slovakia, two years of raising the tax rates on electricity resulted higher taxation on electricity than fossil fuels. In Spain and Italy, cheaper gas lead to a higher electricity/gas price ratio. In Belgium, Czech Republic, Ireland, Germany, Poland, Portugal, Slovakia, UK and Spain the electricity price increased more than the price for oil and gas. In Austria, Denmark, Estonia and Sweden the price of electricity still increased more than for oil and gas but comparatively less. The resulting higher price ratio between electricity and natural gas for many European countries result in higher relative

operating costs for HPs, becoming a threat to sales. In Figure 17the relative price factor between electricity versus natural gas is visualized for some European countries. A high factor indicates a relatively high operational cost for HPs (7).

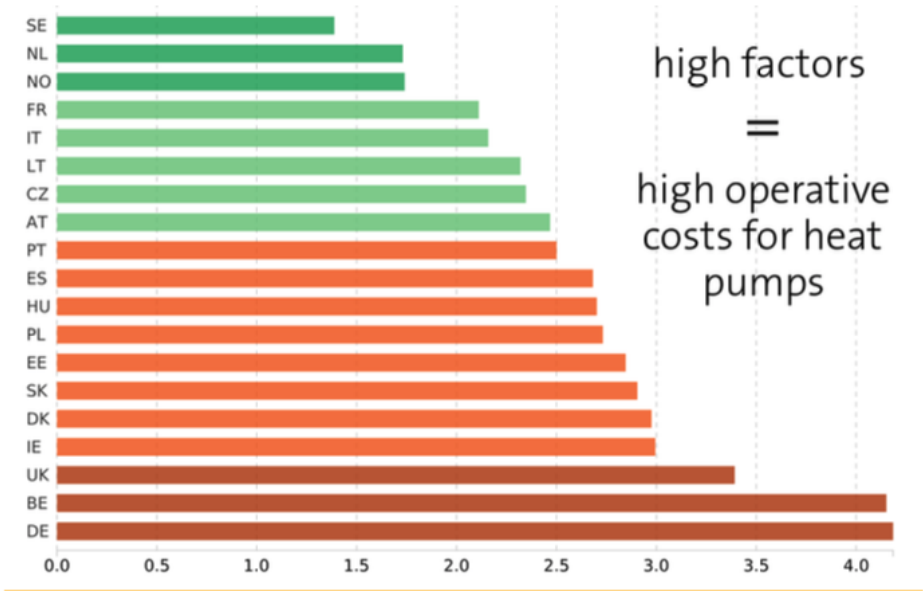

Figure 17 Relative prices: electricity versus gas for some European countries (7)

In 2017 the situation was slightly different. In 2017 for the first time since 2008 there was a decreased price in retail prices for electricity and a stop in raising network charges and taxes, see Figure 18. No forecasts on the electricity prices in Europe were found.

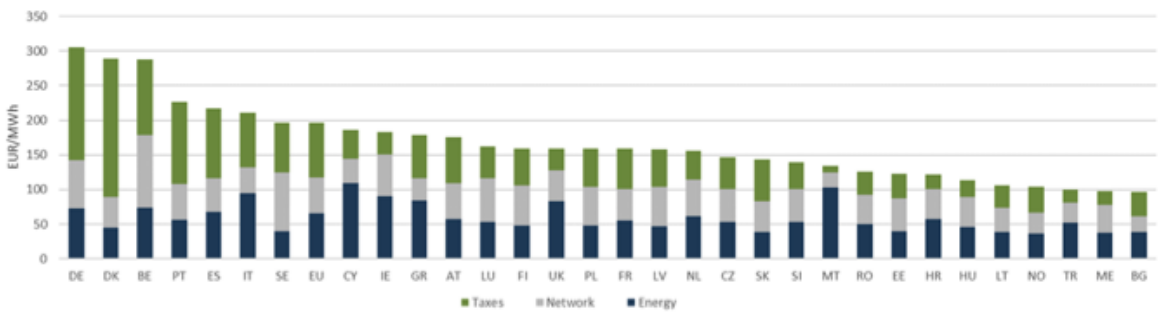

Figure 18 Household electricity prices in 2017 (29)

2. Initial investment cost of buying a HP

Due to a different energy prices, the potential customer considers the initial investment cost of a HP plus the current prices of electricity and the future expected price. This will result into a long-term analysis and consideration, evaluating also the operation costs. In reality, customers are more often guided by a short-term evaluation and are mostly driven by the cost of investment (7). Looking at operational costs, HPs are a more efficient solution than to gas boilers. The evaluation can be disadvantaged by the decreasing fuel prices and increasing energy prices and the initial cost per unit. This means that in many markets the installed costs for HPs relative to potential savings on energy spending (e.g. when switching from a gas boiler to an electric heat pump) often mean that heat pumps may be only marginally less expensive over 10-12 years, even with their higher energy performance (28).

3. Energy systems related issues

Energy system issues, such as need for expansion capacity if the demand for electricity increases, which may in turn increase the carbon intensity of electricity production (if the additional capacity is not provided by renewable energy sources), and risk for failures at peak hours.

3.1.3 Results of solar energy market analysis

3.1.3.1 Global Solar market

The current market for solar PV technologies is relatively small but growing quickly. In 2017, a total of 99.1 GW of grid-connected solar was installed. That's almost a 30% year-on-year growth over the 76.6 GW added in 2016. This is much lower than the 49% growth rate recorded in 2016, but much higher than the expectations of any solar analysts since the SolarPower Europe Association estimated a slight 5% growth rate to 80.5 GW was among the most optimistic forecasts for 2018. After the exceptionally strong growth in 2016, most solar analysts had initially forecasted no growth at all. The actual 99.1 GW installation figure turned out be close to the upper end of our GMO 2017 High Scenario estimate of 103.6 GW (30).

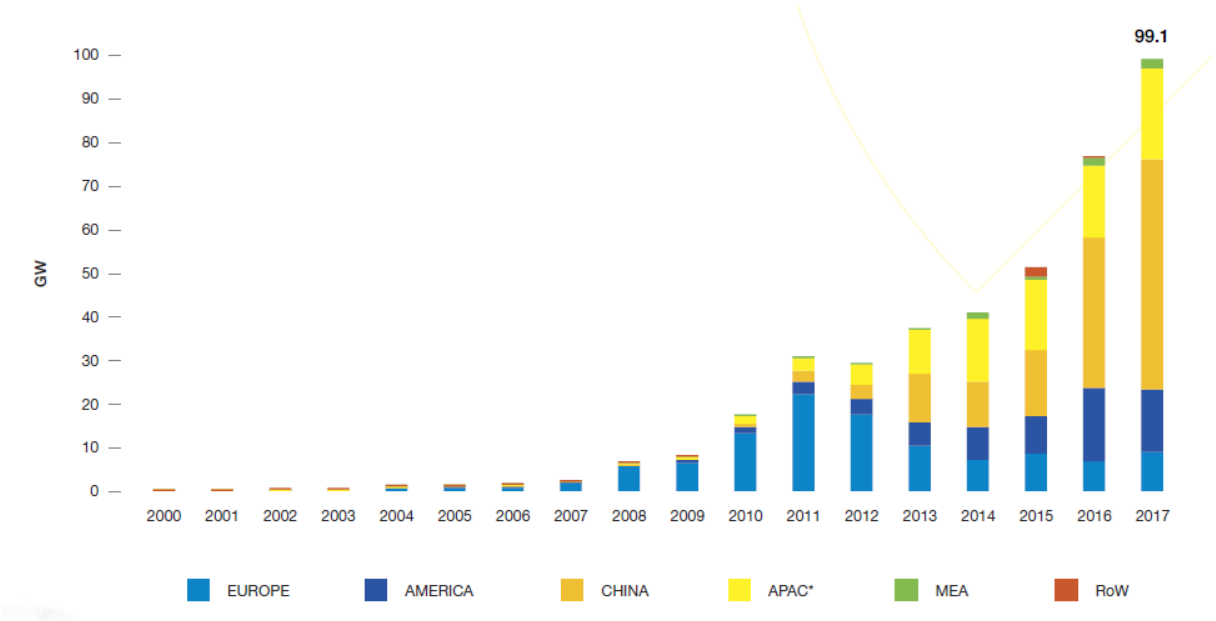

Figure 19. Evolution of global annual solar PV installed capacity 2000-2017 (30).

In the international landscape, global solar market demand in 2017 was dominated more than ever by China. For the first time, China installed more than half of the world's solar capacity in one year – to be exact, 53.3%. This 52.8 GW of newly added capacity means a 53% increase over the 34.5 GW installed in 2016, when the Chinese market grew by 128% compared to the 15.1 GW deployed in 2015. While the huge growth in 2017 stunned the solar sector, in hindsight, the explanation is very simple: China's feed in tariff program was basically un-capped, the tariff levels for solar power plants were higher than in most other places in the world, and companies wanted to beat upcoming scheduled subsidy cuts.

In terms of installed capacity, 2017, almost as much solar was installed in one year (99.1 GW) as the world had installed in total up to 2012 (100.9 GW). This led to a total global solar power capacity of over 400 GW in 2017, after solar exceeded the 300 GW mark in 2016 and the 200 GW level in 2015.

The cumulative installed solar PV power capacity grew by 32% to 404.5 GW by the end of 2017, up from 306.4 GW in 2016. In only 10 years, the world's total PV capacity increased by over 4,300% – from 9.2 GW in 2007. From the beginning

of the century, when the grid-connected solar era began with the start of Germany's feed-in tariff scheme, total solar power has grown by nearly 255 times.

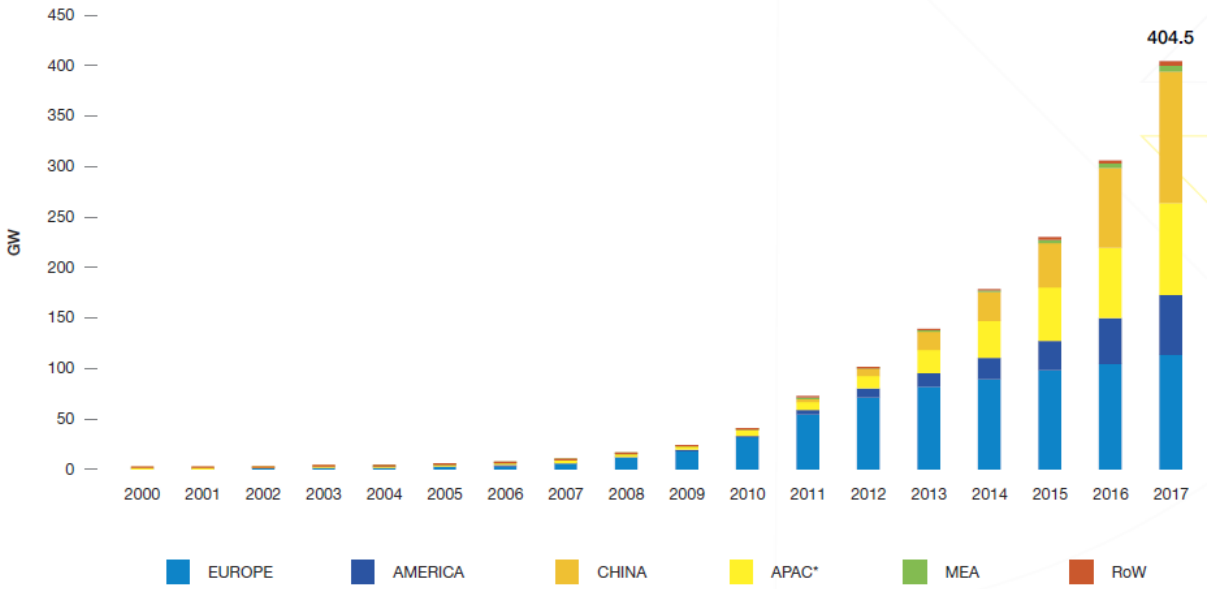

Figure 20. Evolution of global total solar PV installed capacity 2000-2017 (30).

In 2017, almost as much solar was installed in one year (99.1 GW) as the world had installed in total in 2012 (100.9 GW). This led to a total global solar power capacity of over 400 GW in 2017, after solar exceeded the 300 GW mark in 2016 and the 200 GW level in 2015. The cumulative installed solar PV power capacity grew by 32% to 404.5 GW by the end of 2017, up from 306.4 GW in 2016 (see Figure 20). In only 10 years, the world's total PV capacity increased by over 4,300% – from 9.2 GW in 2007. From the beginning of the century, when the grid-connected solar era began with the start of Germany's feed-in tariff scheme, total solar power has grown by nearly 255 times.

3.1.3.2 EU Solar market

Europe has left its several-year long downward trend in 2017, adding 9.2 GW of solar PV, a 30% increase compared to the 7 GW installed the year before. The European growth is primarily a result of Turkey's gigantic growth, adding 2.6 GW, from less than 1 GW in 2016. When looking at the 28 members of the European Union, there was hardly any increase in growth at all: the EU-28 added only 5.91 GW in 2017, compared to 5.89 GW in 2016. This result still stems from the UK's 'solar exit' in 2016, (fall in solar power after the government announced a 65% cut to feed-in tariff),, which again halved new installations in 2017. Even though 21 of the 28 EU markets showed growth, this wasn't enough to compensate for the British losses.

Germany remains, by far, the largest European market, with installations totalling 521 MWth (744 000 m²) in 2016. This market faced a decrease of almost 8% (between 2000-2017), confirming some earlier expectations regarding the limited impact of the Market Incentive Programme (MAP) and other support schemes. The *Marktanreizprogramm*, MAP, is the main instrument of the German federal government to stimulate the uptake of renewable heating and cooling technologies. Still, the existing support schemes have helped to reduce the negative effect of other factors in the market, such as the competition coming from low fossil fuel costs, the competition from other RES, such as the use of solar PV for heating through production of hot water, the low modernisation rate for heating systems in general in the German market and also installation bottlenecks, as installers prefer other works considered more interesting and profitable than solar thermal systems (9).

The top three European solar PV markets in 2019 are Germany, Spain and Netherlands. Spain was Europe's largest solar market in 2019. In 2008, during a brief FiT-based solar rush, Spain installed 3.1 GW. Now, at around 3.9 GW, Spain is the

market leader in both the EU and Europe (8). The second largest European solar market in 2019 was Germany. At around 4 GW, solar PV demand in Germany increased by 35% in 2019, after the country installed 2.9 GW in 2018, which was already up 67% from 1.7 GW in 2017. Netherlands ranked third, added an estimated 2.5 GW; up 66% from 1.5 GW installed in 2018, when it exceeded the GW-level for the first time. The biggest market segment in the Netherlands in 2019 was rooftop solar market, with around 40% in the Commercial and Industrial (C&I) segment and an equal share in the residential segment.

Next to the four two-digit GW EU solar markets, 12 EU countries had solar capacities in the one-digit GW category, two of which are located in the medium range – the Netherlands with 6.7 GW and Belgium with 4.7 GW – while the bulk of EU countries fall in the 1-2 GW category (Austria, Bulgaria, Czech Republic, Denmark, Hungary, Greece, Poland, Portugal, Romania). It's noteworthy that three countries exceeded the cumulative installed GW level for the first time in 2019, Denmark, Hungary and Poland, turning the tide to the majority of EU member states having more than 1 GW of solar installed. In Latvia solar energy production is negligible.

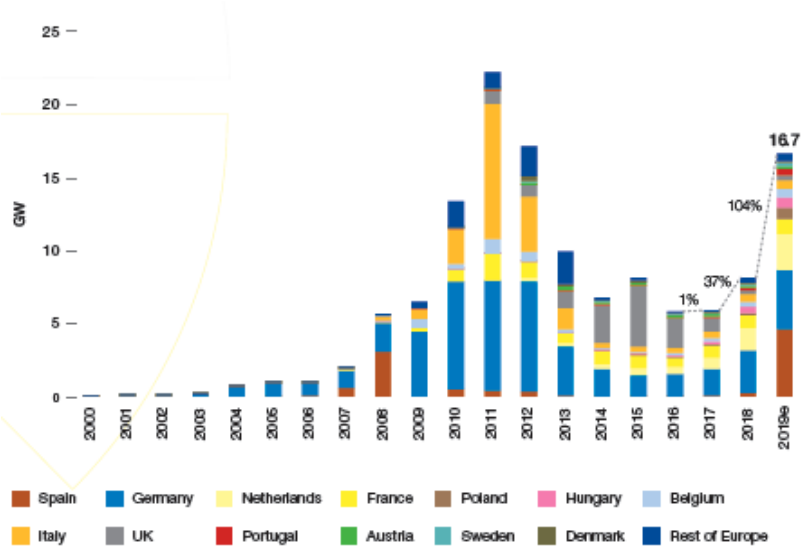

Figure 21 EU28 annual solar PV installed capacity 2000 – 2019 (30).

Solar heat is at diverse stages of market penetration in different markets. While in several markets the technology faced a strong growth pace in the first decade of the millennium to decay in this second decade, several other markets, namely in Eastern Europe have never reached relevant sales per capita.

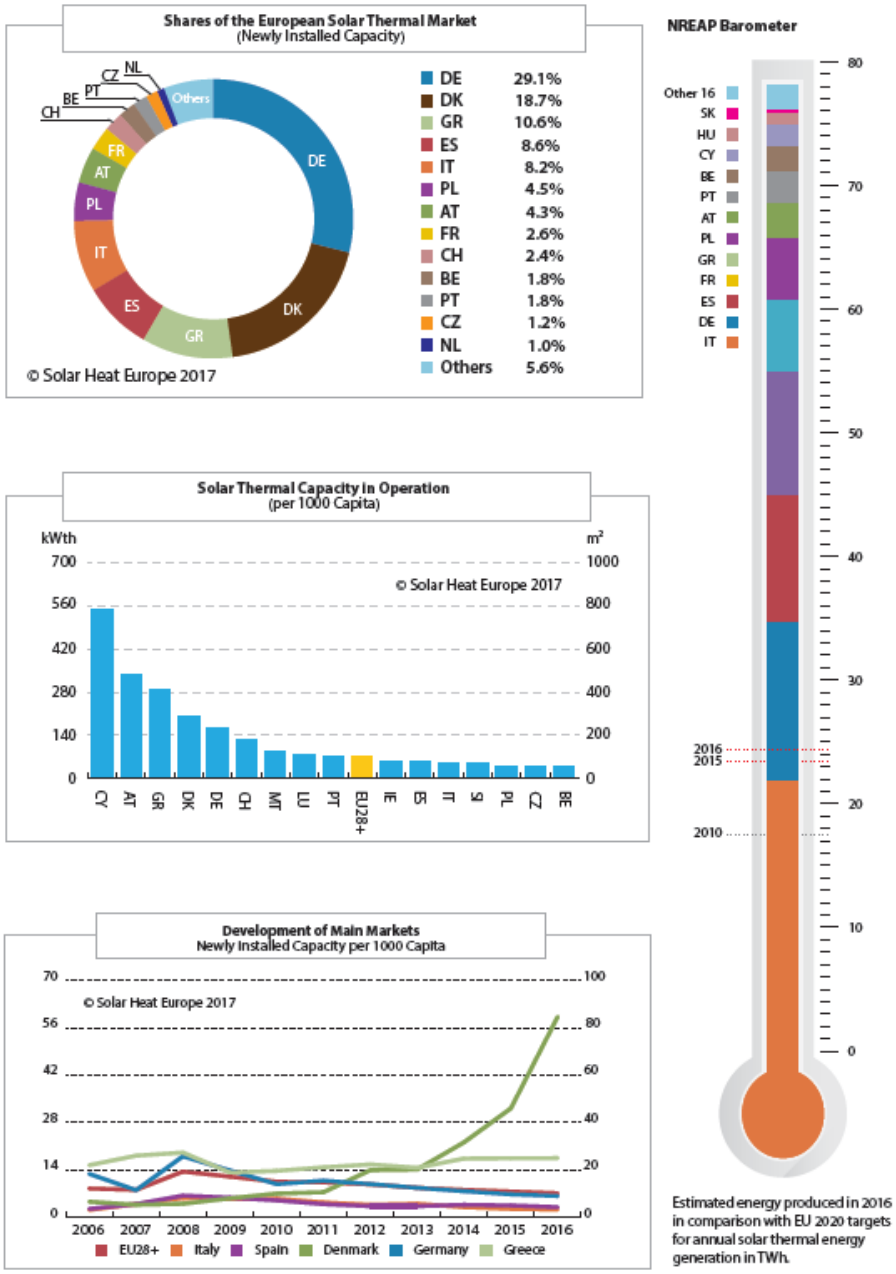

Figure 22. European figures on the solar thermal market (9).

In 2018, the European solar heat market has grown by 7.8%, reverting the trend of previous years. The annual sales surpassed 1.5 GW_{th}, bringing the total installed capacity in Europe above the 36 GWth mark. This represents an increase of 2.4% of the European solar thermal capacity, leading to an estimated heat generation of 25.6 TWh_{th}. Each solar thermal system incorporates a storage unit by default. As a result, the total solar thermal energy storage capacity available amounts to 180 GWh_{th}. Two years ahead of the 2020 milestone, with an estimated 10.1 million installed systems, solar thermal contributes to make millions of Europeans heat prosumers active in the energy transition.

3.1.3.3 Solar energy market factors

In the EU, only less than 10% of the available roof space is currently equipped with solar panels, reaching a total installed capacity of around 80 GW. However, the cost-effective rooftop potential of solar PV of existing buildings in the EU is estimated to be about 680 TWh, or 25% of current electricity consumption, according to the European Commission.

Challenges facing the solar energy market:

- Addressing the energy performance of existing buildings: EU legislation on energy performance of buildings only covers new buildings, which will account for 25% of Europe's building stock in 2050. As a result, energy renovation rates of existing buildings need to at least triple to meet energy and climate objectives.
- Slow uptake of solar rooftop installations despite its huge potential in Europe due to lacking access to finance, need to address re-skilling and upskilling of existing construction and electrical workers, and need to raise awareness among EU citizens.

Opportunities for the solar energy market:

- Large potential for solar rooftops in Europe: At least 600 GW of rooftop capacity remains across the EU.
- Stepping up energy renovations can play a crucial role to deliver a just and fair transition by securing more than 20 million jobs across the construction sector and unlocking new opportunities local and qualified jobs
- Security of supply: Deployment of on-site solar as part of energy renovations can support security of supply of EU regions, cities and citizens, guaranteeing direct renewable energy supply for electric vehicles
- The renewable-based electrification of EU buildings boosted with on-site solar installations can provide valuable services to the electricity system.
- An ambitious strategy to renovate the EU's building stock would contribute to EU global leadership in clean building technologies such as in building energy performance technology, complex on-site PV solutions and high-tech building-integrated solar systems (BIPV) products.

4 Results

The results section begins with conceptualising social acceptance based on the reviewed scientific literature. This is followed by presenting the result from the scientific literature review and the EU project review and presenting the new evidence found in the survey.

4.1 Results from the literature review

4.1.1 Conceptualization of social acceptance

The first attempt to conceptualize social acceptance of renewable energy was carried out by Wustenhagen *et al.* (2007) (31), proposing that it has three dimensions: socio-political, community and market acceptance. Later on, Sovacool and Ratan (2012) (32) added nine factors to explain social acceptance, factors that serve as criteria to assess it. The distinction between these is illustrated in Figure 23.

Figure 23: The triangle of social acceptance of renewable energy innovation (31)

Socio-political acceptance is the broadest, defined as the ability for regulators, policymakers and other key stakeholders to craft effective policies or frameworks that create and foster community and market acceptance. Community acceptance is the most specific dimension, and it is defined as the extent that projects are undertaken or invested in by local stakeholders and how costs and benefits are shared, and how policymaking is conducted. Finally, market acceptance is in the middle as a bridge between national politics and local communities, involving consumers and investors (32).

The socio-political dimension operates at a national level. Its main attribute is the existence of strong institutional capacity such as ministries or departments of energy with specific programmes, dedicated subsectors or finance for research. This requires political commitment in terms of clear positions promoting renewable energy and favourable regulatory frameworks to for example facilitate the entry into the solar market, easy access for small producers to the electricity grid, existence of interconnection standards exist and predictable changes in regulations. Due to the broad nature of this dimension, it cannot be assessed within this deliverable. Still, there is a policy making component in community acceptance, which deals with how much communities get involved in policy making, an attribute that can be explored in this study (32).

4.1.1.1 Social acceptance

Social acceptance features three main attributes according to Sovacool et al. (2012) (32):

- Prolific community and/or individual ownership and use.
- Participatory project siting, as communities being able to get involved in site selection. For example, allowing communities to say no/yes in my back yard.
- Recognition of positive or negative externalities. For example, awareness of environmental benefits in comparison with competing technologies.

Based on these findings, the assessment of social/community acceptance should be based on measuring how users feel about ownership, how involved were they in decision making for the installation or specifics of the project and how aware they are about externalities such as environmental benefits, comfort, etc.

4.1.1.2 Market acceptance

Market acceptance, as a middle between national or higher policies and local communities, has the following attributes:

- Involves the support from local stakeholders;
    - consumers who must adopt and
    - investors who must invest and foster the development of the technology
- The technology must be economically competitive in terms of;
    - costs of production and installation and
    - energy production rate as return of investment
- Is driven by policy incentives, large investments and/or a strong local manufacturing base.
- It depends on mechanisms for information and feedback and access to reliable information.
- There must be an easy access to financing (manufacturers and users) schemes.

Based on these findings, the assessment of market acceptance should be based on measuring the competitiveness of prices and investment costs in the eyes of consumers, how satisfied are the consumer with the technical performance and production rate of the technology, the awareness of existing incentives and legal aspects and how well-informed stakeholders are about technical aspects relevant to them.

4.1.2 Results of scientific literature review

The literature review resulted in a wide array of studies that somewhat tackle adoption issues using different methodological approaches. However, the focus of this section is to summarize the findings from studies that applied surveys or interviews including (but not exclusively to) end-users.

Starting in a European context, some interesting results for the main factors that influence adoption in European countries were found. Faiers and Neame (2006) (11) found that homeowner's attitudes in England depend largely on the perceived advantages of the technology and financial aspects. Another early study by Claudy et al. (2011) (33) discovered that in Ireland, adoption is largely based in homeowner's perceptions of product characteristics, social norms and sociodemographic factors. Still in England, the results obtained by Mbzibain et al. (2013) (34) show that policy and feed-in tariffs have increased the interest of farmers to adopt renewables. Meanwhile, the study by Li et al. (2018) (35) concluded that the most influential factors for UK homeowners to adopt HPs are existing technologies, income, number of bedrooms in household and awareness of eco-technologies. In the Netherlands, Jager (2006) (36) established that general problem awareness and financial support are critical for adoption of PVs; while information, word to mouth and existing infrastructure also have positive effects. Moving to Greece, Sardianou and Genoudi (2013) (37) found that income, education level and tax deductions have most effect on the adoption of renewable energy, while marital status and gender do not. Finally, in a Finnish context environmental awareness and the existence of tax reductions were the biggest factors to influence the willingness to adopt renewables (Jung et al., 2016) (38). On the other hand, the results obtained by Paatero et al (2019) (39) show that in Finland willingness to pay was higher for energy efficiency technology than for energy installations, and PVs and HPs were among the most well-known technologies.

A vast majority of the studies found correspond to studies in geographical contexts outside Europe, especially in Asian countries where studies using surveys have provided relevant contributions. According to D'Agostino et al. (2011) (40), the adoption of solar home systems in China would benefit of greater information about the system, and price influences adoption more than quality. Still in China, the main hinders for adoption appear to be the low level of application, lack of awareness, high capital cost, low performance, complicated auxiliary system and low storage capacity (Yuan et al., 2011) (41). Many studies have been carried out in Japan on the subject. For starters, Mukai et al. (2011) (42) found a strong causal relationship between Japanese users' expectations of financial return from the system and their level of satisfaction was confirmed empirically. The results from Reeves et al. (2017) (43) show that different types of Japanese adopters place value to information in different ways; the local market value more the information from contractors, while broader markets value more local utilities, advertising, home tours and word of mouth. Still in Japan, the study by Chapman and Itaoka (2018) (44) established that curiosity of consumers to adopt is stimulated by the attractiveness of the product and environmental benefits. Moving to Hong Kong, the main barriers to adoption of PVs are the high initial and repair costs, long payback period, inadequate installation space and service infrastructure, lack of stakeholders and community participation in energy choices and legal and regulation constraints (Zhang et al., 2012) (45). Interestingly as well, different stakeholder groups present similar opinions concerning drivers for adoption, but they have different opinions concerning barriers (Lu et al., 2019) (46).

In Bahrain, adoption defined as willingness to pay is most associated with income, gender and education or knowledge about the technology, while the small area available for PVs was raised by several respondents, an uncommon finding in similar studies (Alsabbagh et al., 2019) (47). Meanwhile, in Saudi Arabia the main hinders for adoption were the novelty of systems, lack of awareness, high investment cost, lack of information, capacity issues, aesthetics and uncertainty about adaptability to extreme weather (Alrashed and Asif, 2015) (48). Finally, researchers in Malaysia have also studied heavily the subject, starting with the work of Solangi et al (2013) (49) who found that significantly more public knowledge about PVs is important for adoption, as well as subsidies and incentives. The existence of financial support and incentives in Malaysia is necessary, but also public awareness of the existence of these programs (Al-Fatlawi et al., 2014) (50). Moreover, Solangi et al. (2015) (51) concluded that in Malaysia the main hinders for installing solar PVs at households are high investment cost, lack of information for decision-making and difficulty for obtaining best-possible price. Still, the most relevant barriers for BIPV implementation in Malaysia are the limited expertise available, lack of financial incentives, availability of cheap electricity due to government subsidies, reliability of technology (Goh et al., 2017) (52). On the other hand, the same study also concludes that among the drivers were policies and incentives, finances and free maintenance.

The subject has also been studied outside Asia and Europe. Hampton and Eckerman (2013) (53) concluded that perceptions of financial benefits were critical to adoption of renewables in Australia, even as most participants expressed favourable attitudes towards the technology. In California, the main hinders for adoption for consumers were the high investment costs and the troublesome installation process (Murphy, 2009) (54). The work by Bao et al. (2017) (55) suggests that in people in the US may be willing to pay a higher price for better-looking solar panels, meaning that improving the aesthetics of residential solar panels would help increase adoption. Rai et al. (2015) (56) found that in Texas perceived affordability, availability of information and knowledge about financial incentives are factors that influence adoption significantly, while the study by Abreu et al. (2019) (57) observed that factors that are commonly disadvantages for PVs such as upfront cost, maintenance and attractiveness; were less impactful for building-applied PVs.

Finally, some studies have used other methodological, more quantitative approaches, obtaining relevant results concerning adoption of PVs and HPs. For example, a group of researchers in Germany used aggregated panel data at the county level to develop a diffusion equation using a spatial autoregressive and a spatial error panel model (Dharshing, 2017) (58). They found that economic incentives and socioeconomic status have significant impacts on adoption, while environmental attitude and settlement structure have ambiguous influence. Still in Germany, spatial and non-spatial econometric methods were applied to study the adoption of small-scale PVs, concluding that other factors such as solar radiation, house density, home ownership, income and neighbourhood effects influence adoption (Schaffer and Brun, 2015) (59). On the other hand, spatial econometric methods were also applied to analyse determinants of PV deployment in the UK, observing that education level of households and housing types affect PV uptake at the regional level (Balta-Ozkan et al., 2015) (60).

The overall results of the literature review described in this section are summarized in Table 9, and some interesting observations may be drawn. The three aspects that were found to be important for adoption of renewables more consistently among the studies found were the availability of information about technology, financial aspects and sociodemographic factors (both in seven studies). Another interesting observation is that the appearance of the existence of policy incentives as factors fostering adoption in six of the studies found, as well as the investment costs and payback period as a hinder for adoption. Studies carried out in Asia dominate the findings in terms of geographical scope. Mean, while the adoption of solar PVs has been heavily studied, in contrast with heat pumps. It is worth noting that some aspects have been found to be potential hinders or facilitators of adoption; most importantly the availability of information (found as facilitator in seven studies and as hinder in three), financial aspects (found as facilitator in seven studies and as a hinder in three) and aesthetics (found as facilitator in three studies and as hinder in one). Interestingly, hinders of adoption have been identified almost only outside Europe, as European studies have studied mostly aspects that are important or foster adoption. Another interesting geographical difference is that environmental awareness appears as a very influential factor for adoption only in European studies.

Table 9 Summary of the findings from the literature review.

Study	Geographical scope	Technology	Important for adoption /foster adoption										Hinder adoption									
			Perceived advantages of technology	Financial aspects	Policy incentives	Sociodemographic factors	Social norms	Environmental awareness	Existing technologies	Information about technology	Curiosity about technology	Aesthetics and space available	Technical support during use	Applicability concerns	Lack of awareness and information	Investment costs and payback period	Performance issues	Complexity of equipment	Poor participation of stakeholders	Legal aspects	Aesthetics	Cheap electricity available
Faiers & Neame (2006) (11)	England	Solar PVs	X	X																		
Claudy et al. (2011) (33)	Ireland	Solar PVs	X			X	X															
Mbzibain et al. (2013) (34)	England	Renewables			X																	
Li et al. (2018) (35)	UK	Heat pumps				X		X	X													
Jager (2006) (36)	Netherlands	Solar PVs		X			X	X		X												
Sardianou and Genoudi (2013) (37)	Greece	Renewables			X	X																
Jung et al. (2016) (38)	Finland	Renewables			X			X														
D'Agostino et al. (2011) (40)	China	Solar PVs		X						X												
Yuan et al. (2011) (41)	China	Solar PVs												X	X	X	X	X				
Mukai et al. (2011) (42)	Japan	Solar PVs		X																		
Reeves et al. (2017) (43)	Japan	Solar PVs								X												
Chapman and Itaoka (2018) (44)	Japan	Solar PVs									X	X										

Study	Geographical scope	Technology	Important for adoption /foster adoption										Hinder adoption									
			Perceived advantages of technology	Financial aspects	Policy incentives	Sociodemographic factors	Social norms	Environmental awareness	Existing technologies	Information about technology	Curiosity about technology	Aesthetics and space available	Technical support during use	Applicability concerns	Lack of awareness and information	Investment costs and payback period	Performance issues	Complexity of equipment	Poor participation of stakeholders	Legal aspects	Aesthetics	Cheap electricity available
Zhang et al. (2012) (45)	Hong Kong	Solar PVs														X	X			X		
Alsabbagh et al., (2019) (47)	Bahrain	Solar PVs				X				X		X										
Alrashed and Asif (2015) (48)	Saudi Arabia	Solar PVs												X	X	X					X	
Solangi et al (2013) (49)	Malaysia	Solar PVs			X					X												
Al-Fatlawi et al. (2014) (50)	Malaysia	Solar PVs			X					X												
Solangi et al (2015) (51)	Malaysia	Solar PVs													X	X	X					
Goh et al. (2017) (52)	Malaysia	BIPV		X	X								X			X	X					X
Hampton and Eckerman (2013) (53)	Australia	Renewables		X																		
Murphy (2009) (54)	California	Solar PVs												X		X						
Bao et al (2017) (55)	US	Solar PVs										X										
Rai et al. (2015) (56)	Texas	Solar PVs		X						X												
Dharshing (2017) (58)	Germany	Solar PVs				X																
Schaffer and Brun (2015) (58)	Germany	Solar PVs	X			X	X															
Balta-Ozkan (2015) (60)	UK	Solar PVs				X																

4.1.3 Results of EU-projects literature review

The results from the review of EU projects show that there is lack of social and market acceptance of innovative solutions in the field of the clean technologies that restrain the implementation of these solutions in buildings. Thus, demonstrative projects funded by EC not only intend to test the performance of the energy efficiency and RES production solutions but also to address the non-technical barriers such as the social barriers.

Social Barriers are dealt under three focuses in EU projects reviewed:

1) Evaluation of the social acceptance on the intervention by the affected citizens (i.e. residents) with the objective of measuring the satisfaction on demonstrative solutions tested in their buildings and the factors that influence in how they perceive the innovative technology.
2) Identification of social barriers for the scale-up and the replication of the technologies in energy retrofitting of buildings with the purpose to study the replication potential as well as to find possible solutions that could overcome such barriers.
3) Measure of the difficulties found by stakeholders involved with clean innovative technologies for the deployment of a proper market.

The EU projects reviewed are outlined in detail in Annex A. The final sample consisted of 8 demonstrative projects funded by *7th Framework programme* (FP7) and Horizon 2020 Programs in the last 7 years and include:

- Complete retrofit of residential and tertiary buildings based on façade improvements, ICT and renewable energy systems: R2CITIES (61), CITyFiED (62) (63) (64) (65) (66), REMOURBAN (67), SmartEnCity (68), mySMARTLife (69) and MAtchUP (70).
- Refurbish of existing buildings with innovative circular solutions: HOUSEFUL (71).
- Demostrate systems based on recovery and reuse of waste heat available at the urban level: ReuseHeat (72).

4.1.3.1 Results of EU-projects literature review based on the evaluation of social acceptance

To evaluate the satisfaction with the technology, questionnaires and focus group interviews were performed to ask affected citizens about the satisfaction with the solution, the potential barriers affecting the successful demonstration of the proposed solutions and the factors that can influence their perceptions of the technology.

All these projects evaluated the social acceptance through questionnaires and in CITyFiED, focus group interviews were also applied to extend the information collected. Additionally, the consortium of each project decided if the social acceptance was evaluated in one or two stages according to the ambitious of the evaluation and possibilities in each demosite. Thus, R2CITIES, CITyFiED, REMOURBAN, MAtchUP and HOUSEFUL performed the search in two stages, whereas the evaluation was decided in one stage for SmartEnCity and mySMARTLife projects and some demos from REMOURBAN. This scheme of evaluation is key in the definition of the focus of the evaluation.

Thus, owners and tenants living in buildings of the demo sites of R2CITIES, CITyFiED, REMOURBAN were asked for the conditions of the dwellings and buildings, the satisfaction with the energy solution and the level of satisfaction with the project at the beginning and at the end of the project to compare and observe the change in the perception of the citizens. Whereas in SmartEnCity and mySMARTLife projects, these questions were only launched after the implementation of the solutions to collect the final perception. Respondent profile was also evaluated in terms of socio-economic profile and awareness on environment in all the cases.

Another difference found is that MAtchUP and HOUSEFUL analysed in more detail which factors can influence behaviour of the citizens on the technology and performed an evaluation of the success of the engagement strategy implemented to increase social awareness and engagement of services co-created. Also, in these projects the social acceptance evolution is analysed in three moments: initial situation, during the construction stage and after the interventions are concluded.

Below are compiled the main conclusions related to social acceptance on clean and innovative technologies from the interviewed people in these projects that cover demo sites located in all the European territory:

- A new solution is generally well accepted by citizens or citizens have a positive attitude towards new solutions if they are perceived as useful, adequate, is affordable and generates trust and fair. Thus, the final attitude towards the solution in all the cases analyzed is similar.
- The level of satisfaction of residents interviewed with the technical solutions was high because they found new technical solutions useful. In general, they consider that after the implementation of the solutions, the apartments have been revalorized, buildings have a better aesthetic and the indoor conditions are better and in most of cases they state that have disappeared the initial thermal discomfort. Additionally, residents have understood that a reduction in the energy consumption conducts to an economic savings and are aware of the improvements in the environment and consider that the district is now more sustainable.
- The level of satisfaction of residents with the renovation process was good because they found new technical solutions suitable. Thus, residents consider that the implementation of energy measures has been executed properly and annoyances have been assumable because have not affected much the living conditions.
- The level of satisfaction with the financing scheme is good since residents accepted the financing scheme promoted by the companies and perceived that the technical solution was affordable. In fact, most of the interviewed people displayed willingness to investing in improved energy efficiency.
- However, some citizens did not feel comfortable with the involvement achieved during the project but in general it was understood that is not possible to take part of each decision. Lack of information was also found in most of the cases analysed. Thus, the process of renovation had in most cases an initial opposition from a share of the residents despite the needs that the selected buildings have to do a deep retrofit. Most of people interviewed were not satisfied with the initial conditions (most of the residents complained of the thermal discomfort in winter and summer, of the bad conditions of windows and façades and high energy bill) and the financing scheme to pay for the retrofitting of the buildings was perceived as affordable (even in some cases without cost for residents), even if the social opposition found by residents made difficult the renovation process and in some cases the residents blocked the implementation of some action (e.g. district heating in Valladolid in R2CITIES project).

Other interesting results collected from the EU review is how in all the cases in which the evaluation of the social acceptance was made in two stages, the satisfaction with the new solution increased once people started to be familiar and in all the cases when they were implemented in buildings. Reasons found for this initial opposition from residents to implement innovative solutions in their buildings:

- Solutions to be implemented were not considered as adequate:
    - Residents claimed to improve the accessibility to their homes by installing lifts or a change in windows and these solutions were not included.
    - Concern of the annoyances during the renovation process (noise, scaffolding blocking entrances to buildings, etc)
- Solutions to be implemented were not considered affordable:
    - For most of the residents, the key to facilitate the renovation was not to assume any economic risk and cover all costs through public funds. Innovative business models such as ESCO were not welcome at the beginning. Additionally, the profile of people living in the buildings were age-advanced people with low incomes, so they were concerned about how to upfront costs and the long payback period was observed as inconvenient.
- Solutions to be implemented were not considered as useful.
    - Lack of information about how the solution can improve the indoor conditions.
    - Lack of environmental awareness and the benefits in the air quality due to the technology.
- Solutions to be implemented did not produced confidence
    - Lack of knowledge in new financing scheme to afford upfront costs.
    - Lack of trust in companies working in the renovation.

4.1.3.2 Results of EU-projects literature review based on the identification of barriers that restrain market acceptance

The main technical barriers found in EU-projects were identified in two cases; a set of focus interviews in 11 cities (city cluster in CITyFiED) and a questionnaire sent to European stakeholders along the energy supply chain and retrofitting sector (also in CITyFiED). In both cases, the same conclusion was reached; technology generates trust if citizens are familiar with it, if there is trust in market stakeholders, if there is a constant supportive framework for the technology and if there are proper financing schemes supported by a proper business model.

Regarding the social barriers found to replicate renovation of residential buildings with energy efficient and RES solutions, the representative from the cities that were interviewed stated that:

- The main non-technical barriers are the social opposition due to high costs to be assumed by residents if there is not a grant or a proper business model, the opposition to invest in the long term, the resistance to change from the residents that usually live in potential buildings to be renovated (elder and people with low education and low income) and the difficulty for residents and companies to have access to financial resources. Also, a lack of knowledge in new energy solutions was detected. Citizens are unaware of the energy and cost savings and consider the energy efficiency solutions are more expensive than traditional solutions. Finally, the discomfort related to construction works has low importance when the possibility to perform renovation of façade or implementation of RES in buildings is being analysed.

Related to barriers to deploy innovative energy solutions according to the impressions collected from different stakeholders around Europe, that the following conclusions were found:

- Most of the stakeholders interviewed considered that non-technical barriers were the main type of barrier that hinders energy efficiency retrofit projects in the building sector. In fact, this statement was supported mainly for the stakeholders related to technical developments (research organisations, designers and energy companies). Concerning the main non-technical barriers, economic barriers are seen as the most influenced (72%) followed by political barriers (12%) and social barriers (11%).
- Economic barriers identified:
    - Main economic barriers: high upfront costs and long payback periods.
    - Less influenced economic barrier: Difficult Access to Capital and Low incomes of the Owners
- Social barriers identified:
    - Main social barriers: Lack of Knowledge in Economics Savings with Energy Conservation Measures, Low Environmental Consciousness of the Residents or Owners
    - Less influenced social barrier: Lack of Knowledge in Financial Options, Lack of Confident in Innovative Energy Solutions
- Political barriers identified:
    - Main political barriers: Unclear Legal framework, Restrictions for technological Implementation
    - Less influenced political barrier: Uncertainties in front of Changes in Funding Policies, Lack of Support from Local Public Administration
- Technical barriers identified:
    - Main technical barriers: High costs differential between new and existing technologies and Lack of knowledge and professional competence
    - Less influenced technical barrier: Technology integration limitations and lack of demonstration projects

Factors that can influence for early market replication and more effective long term market deployment:

- Finantial factors: perception of the benefits and risk
    - Difficult to have access to financing (e.g. loans, subsidies)
    - Definition of the cost-structure (all costs incurred to operate a business model) and revenue model (the way the incomes are generated and the period of payback)

- Organizational factors:
    - Existence of a well development market
- Legal factors:
    - No restrictions in the normative to the implementation of the solution
    - Existence of a constant supportive legal framework towards the solution

4.2 New evidence

The survey conducted as a part of data collection in this deliverable collected responses between 2020-02-17 and 2020-03-03 and 153 respondents completed the survey.

The planned initial approach for analyzing the data using PCA was found to not be a useful method on the collected data set. As was explained in the method section the first couple of components in a PCA should be able to explain at least 50% of the variance experienced in the data set. The first couple of components for the collected data set was less than 20%. This means that when performing visual inspection of the resulting plots (an example of a score plot from the social acceptance analysis with stakeholder categories color-coded in Figure 24), only less than 20% of the data is actually explained and therefore no results can be identified with significance. No further results are therefore presented from the PCA analysis.

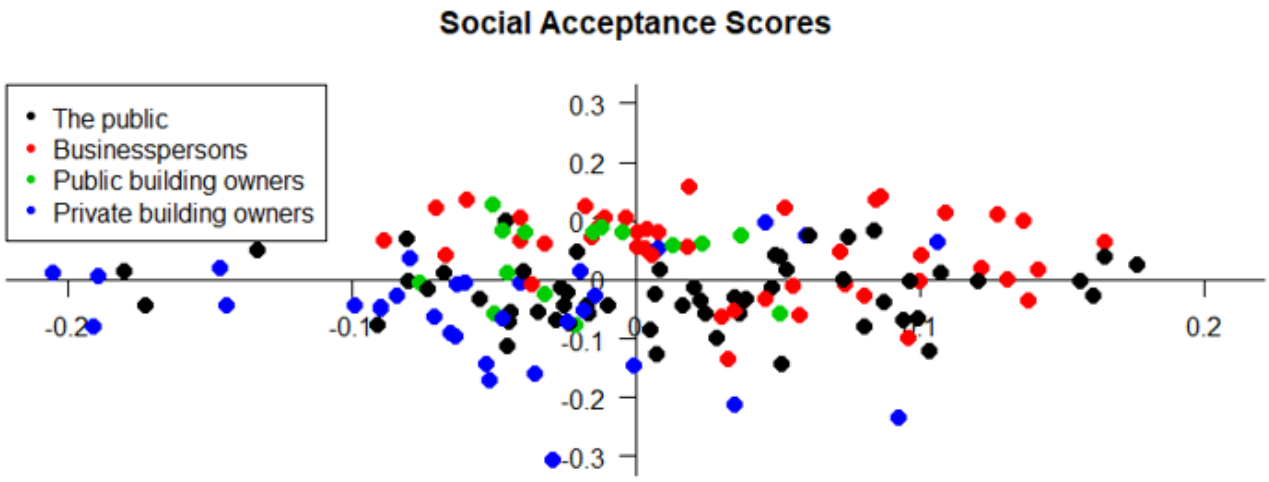

Figure 24: Social acceptance analysis using PCA and color coding by stakeholder category. Some tendencies to group clustering can be seen through visual inspection, however less than 20% of the data is explained by the first couple of principal components and hence there is no significance in the result.

Instead the section focuses on the results from the ANOVA test, as well as a summary of the demographical variables, the correlation matrix of the data sets, a summary table indicating on which statements the demo site countries answered particularly high or particularly low and a summary table focusing on stakeholder category.

4.2.1 Summary of demography of respondents

In Table 10 the demographical variables of the respondents have been summarized and are displayed as percentage of respondents and in absolute numbers. Some noticeable results from the demographical variables are that the survey was mostly answered by men (66%), people with a university degree (87,6%), people not involved with the SunHorizon project (68,6%) and people with a high environmental index (78,4%). As a reminder to the reader the environmental index was developed by merged the respondents answer in two of the questions related to environmental aspects in the survey, explained in more detail in the method section. The high representation of some respondent categories should of course be considered when viewing the results.

Table 10: Summary of demography of respondents

Demographic variable	Percent of participants [#]	Demographic variable	Percent of participants
Part of SunHorizon project		**Household annual income**	
Yes	25,5% [39]	<20 000	5,9% [9]
No	68,6% [105]	20 000 – 40 000	19,6% [30]
I don't know	5,9% [9]	40 000 – 70 000	24,8% [38]
Age		70 000 – 90 000	15,7% [24]
18-34	30,7% [47]	>90 000	8,5% [13]
35-50	39,2% [60]	Prefer not to say	25,5% [39]
51-65	21,6% [33]	**Employment status**	
>65	8,5% [13]	Employed in private sector	47,7% [73]
Gender		Employed in public sector	29,4% [45]
Female	33,3% [51]	Self-employed	9,1% [14]
Male	66% [101]	Unemployed	3,3% [5]
Prefer not to say	0,7% [1]	Student	0,7% [1]
Highest education level		Retired	7,8% [12]
University degree	87,6% [134]	Other	2% [3]
Secondary school	7,2% [11]	**Country of residence**	
Primary school	0,7% [1]	Germany	13,1% [20]
Other	4,6% [7]	Spain	21,6% [33]
Respondent category		Belgium	18,3% [28]
Businessperson	31,4% [48]	Latvia	12,4% [19]
• Equipment manufacturer	29,2% of businesspersons [14]	Canada	0,7% [1]
• Energy utility	0% of businesspersons [0]	France	4,6% [7]
• ESCO	0% of businesspersons [0]	Greece	0,7% [1]
• Energy consultant	35,4% of businesspersons [17]	India	0,7% [1]
• Installer	16,7% of businesspersons [8]	Ireland	2% [3]
• Service/Maintenance	4,2% of businesspersons [2]	Italy	13,7% [21]
• Real estate developer	0% of businesspersons [0]	Sweden	9,8% [15]
• Other	14,6% of businesspersons [7]	UK	2% [3]
Private building owner	20,9% [32]	**No of included technologies**	
Public building owner	9,8% [15]	0	35,9% [55]
The public/residents/end-users	37,9% [58]	1	32% [49]
Occupants in household		2	15% [23]
1	12,4% [19]	3	7,8% [12]

2	35,3% [54]	4	5,2% [8]
3	7,8% [12]	5	3,3% [5]
4	25,5% [39]	6	0,7% [1]
>4	19% [29]	**Environmental Index**	
		Low (Index 0-8)	5,9% [9]
		Medium (Index 9-11)	15,7% [24]
		High (12-14)	78,4% [120]

Table 11: Summary of respondents who answered yes to being involved with SunHorizon divided by each of the demo site countries and stakeholder category. Possibly the low numbers indicate that stakeholders connected to the demo sites are not aware that they are indeed involved with the SunHorizon project.

	Germany (DS1 Berlin DS2 Nürnberg)	**Spain (DS3 Sant Cugat, DS4 Madrid, DS5 San Lorenzo)**	**Belgium (DS6 Verviers 1, DS7 Verviers 2)**	**Latvia (DS8 Riga)**
Businesspersons	3	1	1	-
Private building owner	-	1	1	1
Public building owner	-	1	1	-
The public/residents/end-users	-	6	2	1
TOTALS	3	9	5	2

4.2.2 Social acceptance

The social acceptance dataset had 5.5% of missing data. This is a result of the respondents' option to choose *Not applicable* to the statements.

4.2.2.1 Correlation matrix

The correlation matrix for the social acceptance dataset was calculated in R using pairwise cancellation were N/A was included in the data. As can be seen in Figure 25 data in general has very low correlation indicating that the variables in the data set have a weak relationship. A strong correlation, positive or negative, indicates a strong relationship, whether causal or not, between the variables. A positive correlation means that when the value of the first variable increases, the value of the positively correlated variable increases as well and a negative correlation means that when the value of the first variable increases, the value of the negatively correlated variable decreases. Some exceptions were correlation is stronger are questions that are similar, such as SAQ11 ("Generates economic savings") and SAQ12 ("Good value for money") that are both considering financial aspects of the technology, and respondent profile questions, such as RPQ1_Yes and RPQ1_No that ask whether the respondent is involved in the SunHorizon project, Yes or No.

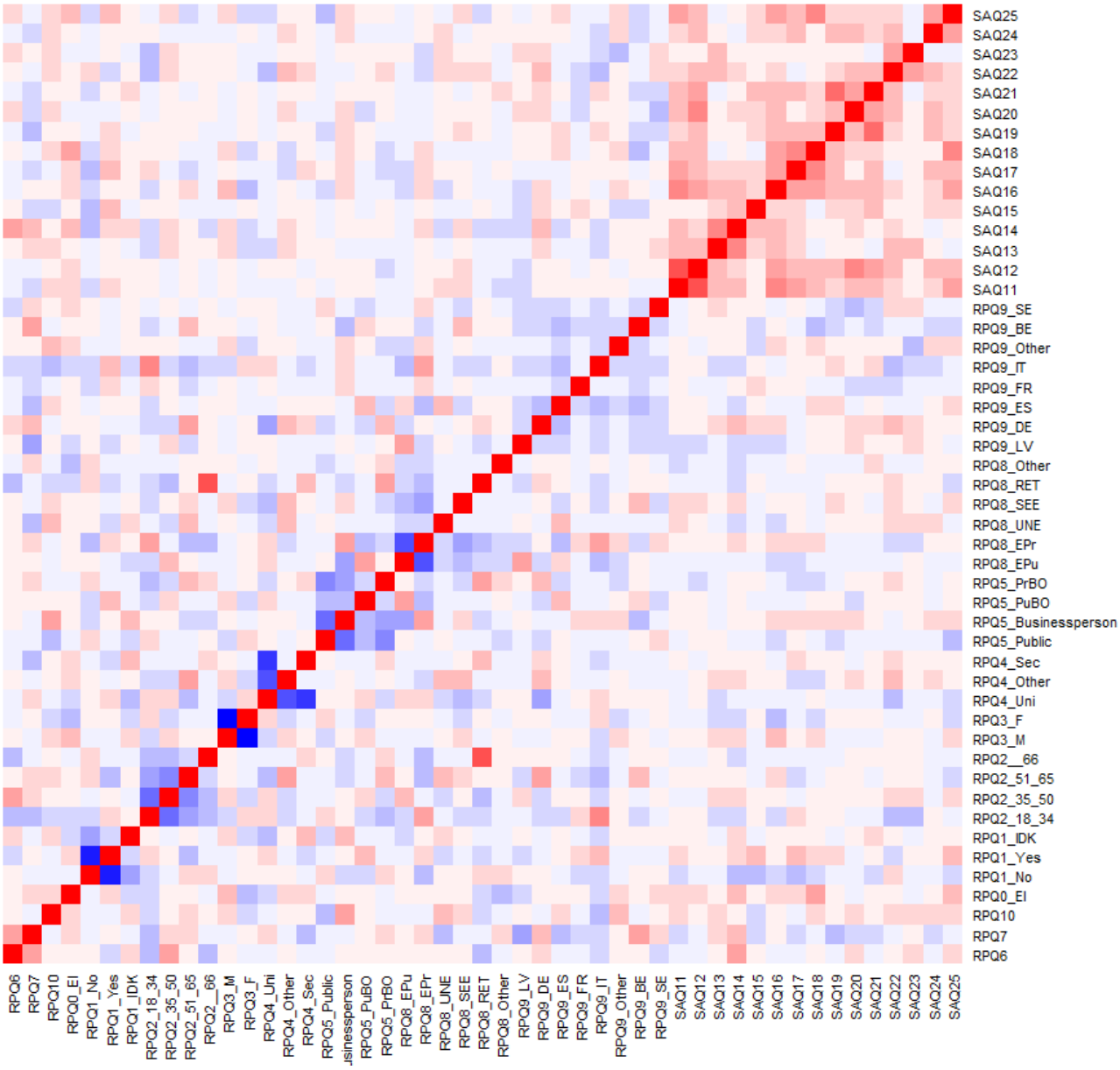

Figure 25: Heat map of the correlation in the Social Acceptance dataset. Red indicates a positive correlation (when the value of the variable increases, the value of the positively correlated variable increases) and blue indicates a negative correlation (when the value of the variable increases, the value of the negatively correlated variable decreases). White indicates that there is no relationship between the variables. A key to the variable names is available in the Annex C.

4.2.2.2 Anova

The single variate analysis approach using ANOVA in R yielded some statistically significant differences between groups in the dataset. The model looked at each of the respondent profile questions (x-variables) against each of the social acceptance questions (y-variables). For social acceptance this resulted in 165 iterations (11 questions from respondent profile and 15 questions on social acceptance) and in 21 cases was statistically significant identified. Statistical significance in ANOVA is defined as a p-value <0.05. Further analysis of the 21 cases showed that seven were not applicable for further analysis as the confidence interval between each of the groups as identified using TukeyHSD function encloses zero or because the connection included the category 'Other' which includes all categories with less than four respondents per category (as defined in the data pre-processing section). 13 cases of statistically significant results remained and are presented in this section.

Environmental awareness was found in the scientific literature review to be a very influential factor for adoption in European studies. Low environmental awareness was found to be one of the main barriers for innovative energy solutions amongst different stakeholders in the EU literature review. For the social acceptance analysis however, a significant difference can only be identified for one statement. People who have a very high environmental index (>12) thinks that the technology has a positive effect on the visual landscape (SAQ25) to a larger extent than those with index 11 (1.6-1.7 in mean value difference). The median response for environmental index 13 was 6.5 and for index 14 the median was 7, very positive numbers.

People involved with the SunHorizon project thinks that the media (newspapers, tv, websites) present these technologies as innovative and forward looking, median response was 5, (SAQ15) to a larger extent than those not involved with the SunHorizon project, median value 4 (0.9 in mean difference). People involved in the SunHorizon project also believes that the technology increases social status by displaying environmental commitment to others, median response was 6, (SAQ17) (0.6 in mean difference) and are more inclined to think that it is a clean technology that reduces pollution, median response was 7 (SAQ25) (0.5 in mean difference). People involved with the SunHorizon project are likely to be more informed about the technology and that this group is more positive towards the technology in many statements could be due to having more information. This is backed by the literature, the EU project review identified that lack of information is a key factor of low social acceptance and the scientific literature review found that the availability of information was one of three main aspects for adoption.

People aged 35-50 are more content with their home as it is now compared to people aged 18-34 (SAQ23) (0.9 in mean difference). Men, more than women, tend to know many people who have solar systems or heat pumps installed (SAQ14) (0.6 in mean difference). Men and women median value is both at 4, but in mean value men are slightly more positive. Men also believe that the technology is more reliable as a source of heating and electricity than women (SAQ16) (0.5 in mean difference). Median value of men is 6 and for women 5.

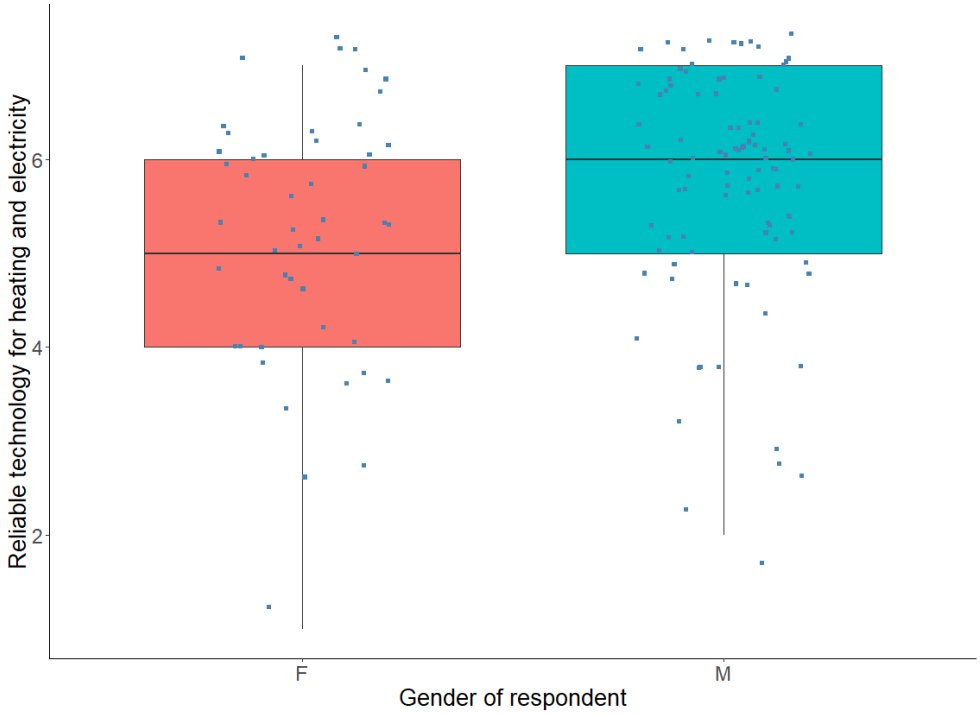

Figure 26: Men are more positive than women towards the reliability of the technology for heating and electricity. The midline through the boxplot indicates the median, the hinges corresponds to the first and third quartiles (the 25th and 75th percentile) and the whiskers extend from the hinge to the highest and lowest value respectively that is within 1.5 times the inter-quartile range (distance between whiskers).

With more people in the household (>3) it is more likely that the respondent perceives to know many people who have the technology installed (SAQ14) than households with only two persons (1.1 and 1.2 in mean difference). People in the household income group 70-90 k€ see the technologies more frequently in their surroundings than people with incomes between 20-40k€ and 40-70k€ (SAQ13) (1.6 and 1.2 in mean difference respectively). People with a household income

less than 20k€ are more content with their home as it is compared to those earning 20-40k€ (SAQ23) (2 in mean difference).

Germans know more persons who have the technology installed than people living in Spain (SAQ14) (1.4 in mean difference). Germans, however, thinks that the design and size of their homes are not sufficient for the technology to a larger extent than those from Italy (SAQ22) (2.2 in mean difference).

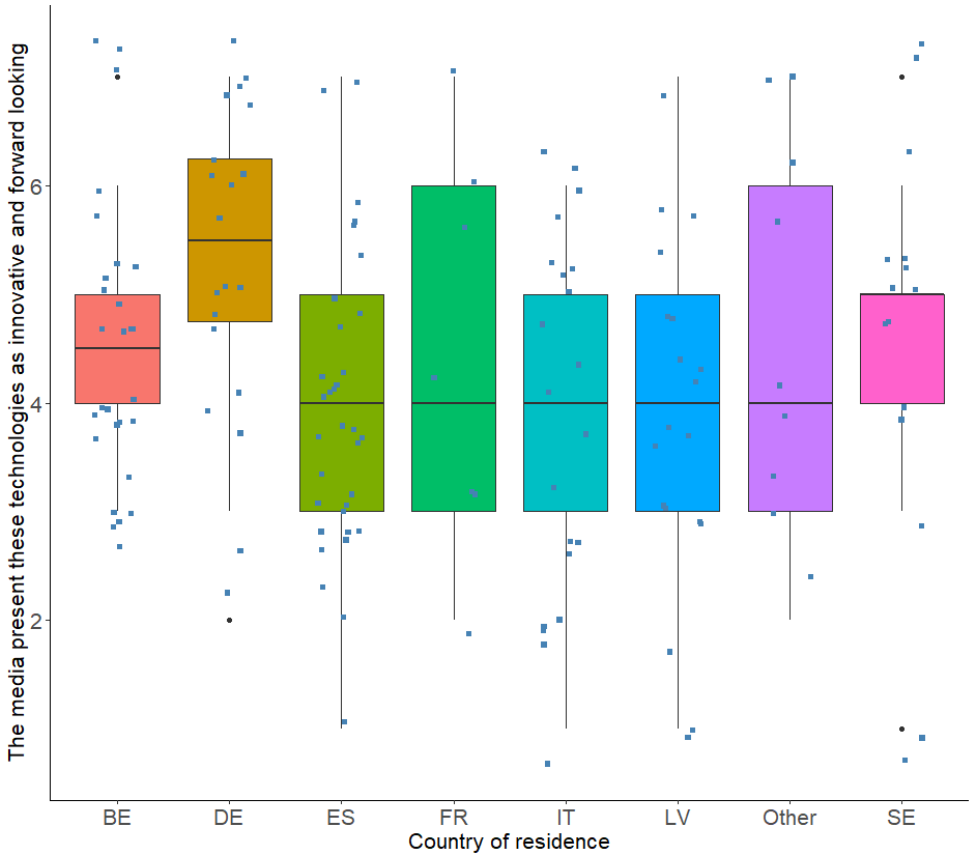

Figure 27: Germans know more people who have solar systems or heat pumps installed than people living in Spain.

4.2.2.3 Key findings from the demo site countries

When categorizing the respondents as negative (answered between 1-4 to the questions) or positive (answered between 5-7 to a question) towards the technology some statements stand out as especially negative (more than 50% of respondents answered negatively to a statement) or especially positive (more than 80% answered positively to a statement). The uneven selection criteria between positive and negative is because the survey is more interested in learning about what factors could possibly cause opposition towards the technology. The full data tables can be seen, analysed and understood further in Annex B.

Table 12: Results of the social acceptance section of the survey displayed by country. A '+' in the table means that more than 80% of respondents answered positively (>4) to the statement and a '-' in the table means that more than 50% of respondents answered negatively (<5) to the statement.

Negative statement	**Positive statement**	Latvia	Germany	Spain	Belgium
Does not generate economic savings	Generates economic savings			+	+
Waste of money	Good value for money			+	+
I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood	-			-

No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed	-		-	-
The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking	-			-
Unreliable technology for heating and electricity	Reliable technology for heating and electricity		+	+	+
Decreases social status	Increases social status by displaying environmental commitment to others	+	+		+
I am not interested in the technology	I am interested in the technology	+	+	+	+
Does not improve quality of my everyday life	Improves quality of my everyday life	+			
Noisy	Silent	+	+		
Decreases thermal comfort	Increases thermal comfort	+	+		
The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology		+		
Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now				
The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape				-
It is a dirty technology that increases pollution	It is a clean technology that reduces pollution	+	+	+	+

Common for all countries with regards to social acceptance are that people are very positively interested in the technology and consider it to be a clean technology that reduces pollution to a very large extent. Curiosity towards a new technology was found to be important for adoption in (44) and given that environmental awareness was found to be a very influential factor for adopting it is very positive that the demo site countries are so positive about the environmental performance of the technology. None of the statements received a majority of negative responses from all countries. For none of the statements was there an inconsistency were some countries where negative and other countries were largely positive.

Latvia has answered negatively to statements related to technology awareness aspects, in Latvia the technology seems to be uncommon and not well represented in the media. The same is true for Belgium. Lack of awareness and information was found to hinder adoption in (41), (48), (51) and the availability of information about the technology was important for adoption in seven of the reviewed study (Table 9).

The respondents in Belgium are also more negative to the visual effect on the landscape. The aesthetics could be a hinder adoption according to (48). Germany had no statement for which more than 50% of respondents answered negatively (<5). In Spain the only statement to which people responded mainly negative was that the respondents do not know people who have the technology installed. This could be viewed as a social norm and was found to be important for adoption in (33), (36) and (59) .

Spain and Belgium are very positive to economic aspects of the technology, that the system would generate income and is good value for money. Financial aspects are widely found in the scientific literature to be importance for adoption (Table 9). The EU project literature review found that lack of knowledge in economic savings with energy improvement measures was a key barrier to technology similar to SunHorizon, but the results of the survey are more positive towards that the technology would generate economic savings. Latvia and Germany were very positive to the technology being silent and increases thermal comfort. All countries but Latvia to a large extent considered the technology to be reliable for heating and electricity. Performance issues was found to hinder adoption in (41), (45), (51) and (52) but at least for the demo site countries this is not perceived to be an issue. All countries but Spain are very positive about that the technology would increase their social status, which again could be an important social norm.

4.2.2.4 Key findings based on stakeholder category

Processing the data for all 153 respondents split into the stakeholder category groups (Businesspersons, public building owners, private building owners and the public) in the same way as described in the section above resulted in the summary table below. Given that the demo site countries responses make up approximately 65% of the total responses similar trends can be observed also in this section. For example, very positive attitudes about the reliability and environmental aspects of the technology as well as a large interest in the technology. Public building owners are the category with the most positive attitude towards the technology (seven) and the only group that is very positive about the economic statements. All groups, but businesspersons, believes that the technology negatively impacts on the visual landscape.

Table 13: Results of the social acceptance section of the survey displayed by stakeholder category. A '+' in the table means that more than 80% of respondents answered positively (>4) to the statement and a '-' in the table means that more than 50% of respondents answered negatively.

Negative statement	**Positive statement**	Business-persons	Public building owner	Private building owner	Public
Does not generate economic savings	Generates economic savings		+		
Waste of money	Good value for money		+		
I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood	-		-	
No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed	-			-
The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking		-		
Unreliable technology for heating and electricity	Reliable technology for heating and electricity	+	+	+	+
Decreases social status	Increases social status by displaying environmental commitment to others	+			+
I am not interested in the technology	I am interested in the technology	+	+	+	+
Does not improve quality of my everyday life	Improves quality of my everyday life		+		
Noisy	Silent				
Decreases thermal comfort	Increases thermal comfort		+	+	
The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology				
Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now				-
The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape		-	-	-
It is a dirty technology that increases pollution	It is a clean technology that reduces pollution	+	+	+	+

4.2.3 Market acceptance

The market acceptance dataset had 6.6% of missing data. The number is somewhat higher than in the social acceptance dataset which could be due to some stakeholder categories feeling less informed or interested in the market acceptance questions.

4.2.3.1 Correlation matrix

The correlation matrix for the social acceptance dataset was calculated in R using pairwise cancellation were N/A was included in the data. As can be seen in Figure 28 data in general has very low correlation, however somewhat higher than the social acceptance dataset. The low correlation indicates that the variables in the data set have a weak relationship

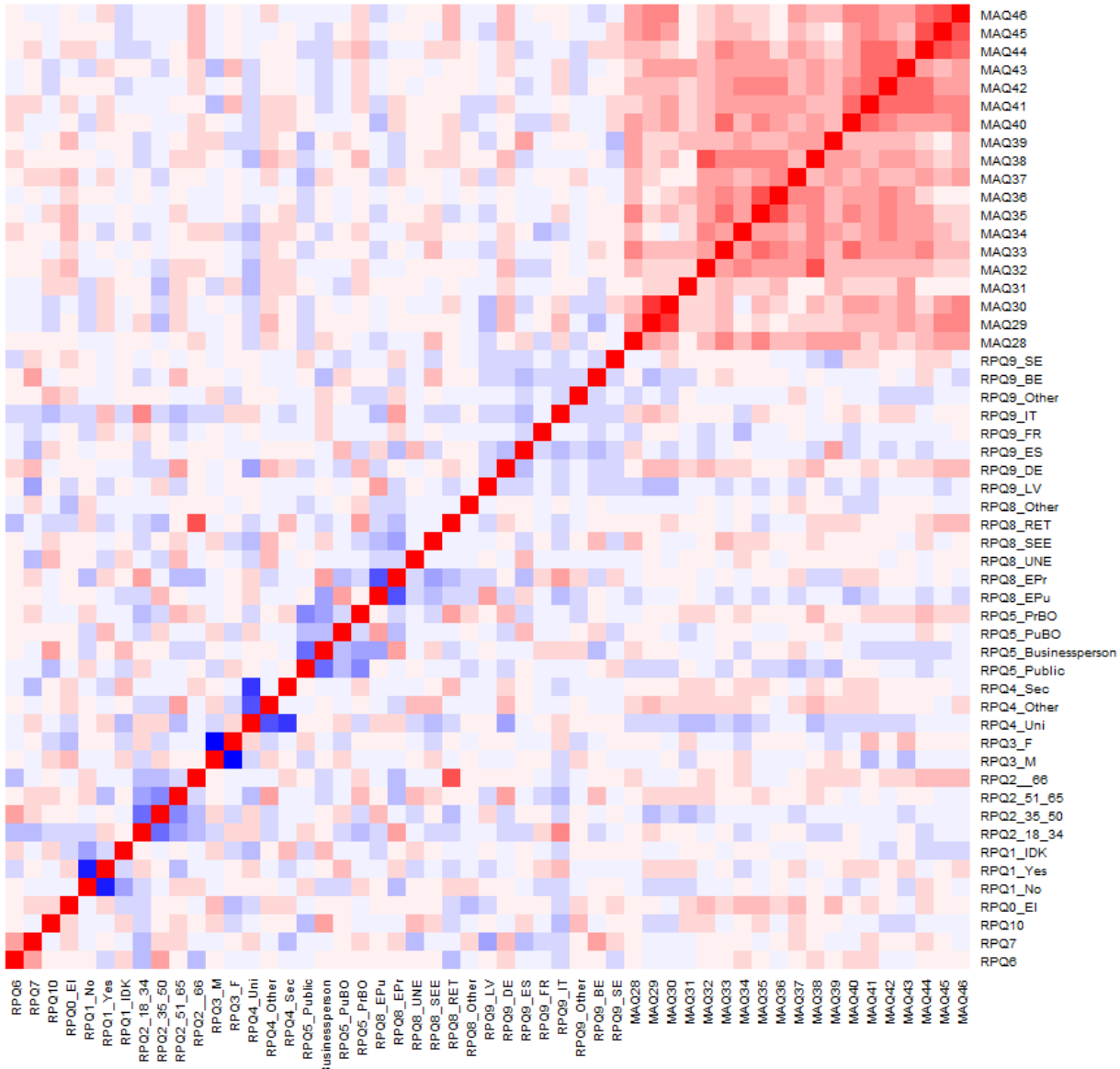

Figure 28: Heat map of the correlation in the Market Acceptance dataset. Red indicates a positive correlation (when the value of the variable increases, the value of the positively correlated variable increases) and blue indicates a negative correlation (when the value of the variable increases, the value of the negatively correlated variable decreases). White indicates that there is no relationship between the variables. A key to the variable names is available in the Annex C..

4.2.3.2 Anova

The single variate analysis approach using ANOVA in R yielded some statistically significant differences between groups in the dataset. For market acceptance 209 iterations (11 questions from respondent profile and 19 questions on market acceptance) and in 24 cases statistically significant was identified. After the TukeyHSD test for differences in the groups 13 cases remained for further analysis.

In the market acceptance section the findings in the both the EU projects literature review and the scientific literature about environmental awareness being a very influential factor is confirmed further. In four of the statements a significant difference could be found between people with a very high environmental index and people with lower index. People high environmental index (14 and 9) thinks the system will increase the value of their property to a larger extend than those with index 8 (MAQ31) (1.7 and 2.1 in mean difference respectively). People with environmental index 14 has 6 as median value, index 9 has 6.5 in median and index 8 has 4 in median value. At the same time people with index 14 believes that cost savings potential is more certain (MAQ35), median value of 5, and that new and innovative technology is more of an opportunity (MAQ37), median value of 6, than those with index 9 (1.9 and 1.7 in mean difference respectively). People with the highest index (14) are more certain of the performance of the technology, median value of 6, than those with index 13 (MAQ36) (0.9 in mean difference).

As was found in the social acceptance Anova analysis, people involved in the SunHorizon project and thus more informed about the technology can be distinguish from people not involved with the project. The availability of information is again confirmed as a means to reduce perceived barriers. People involved with SunHorizon thinks that the legal framework is more predictable than those who do not know if they are involved with SunHorizon (if they don't know they are probably not involved with the project) (MAQ46) (1.5 in mean difference). People involved in SunHorizon had 4 in median value, which is still a low number.

People over the age of 66 thinks that the permit procedure is easier, 6 in median value, than those in younger age categories (18-34 and 35-50) (MAQ44) (2.0 and 1.7 in mean difference respectively).

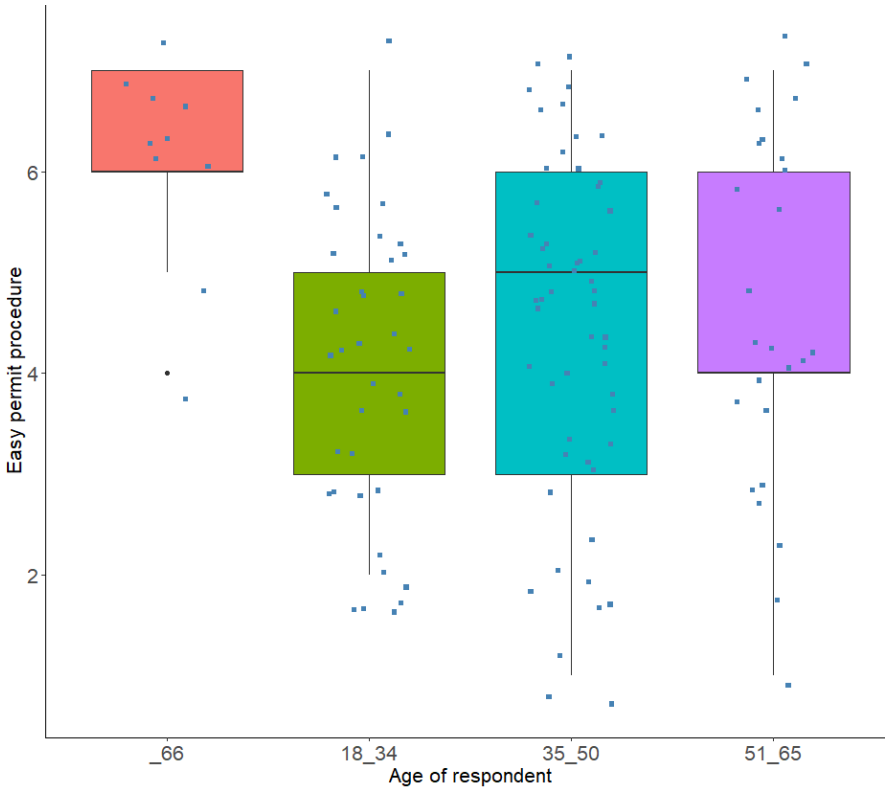

Figure 29: People aged over 66 thinks that the permit procedure is easier to a larger extent than people in other age groups.

Women think, to a larger extent than men, that there is enough professional competence available (MAQ41)(0.7 in mean difference). Women also think that the actors on the market are more trustworthy (MAQ43) (0.7 in mean difference). Women answered 5 in median to both those questions.

Private building owners thinks that the maintenance of the system is easier, median value of 6, than the public's perception (MAQ38) (1.0 in mean difference). Private building owners further think that the permit procedure is easier, median value of 5.5, than both businesspersons and the general public (MAQ44) (1.1 and 1.1 in mean difference respectively).

Looking by country both Germany, 5.5 in median value, and Italy, 5.5 in median value, think that the predictability of governmental support is higher than Belgium and Latvia (MAQ29) (2.1 in mean difference between both Belgium-Germany and Belgium-Italy, 2.4 in mean difference between both Latvia-Germany and Latvia-Italy). Germany, 5 in median value, and Italy, median value of 4, further think that the availability of subsidies is higher than people in Latvia (MAQ30) (2.3 and 2.1 in mean difference respectively). People in Germany thinks that the technology has easier maintenance, median value of 6.5, than people in Spain and Sweden (MAQ38) (1.6 and 1.8 in mean difference respectively). People in Spain thinks that the solar irradiation is higher, median value of 7, than what people in the more northern countries, Belgium, Sweden and Latvia thinks (MAQ39) (1.2, 1.8 and 1.6 in mean difference respectively).

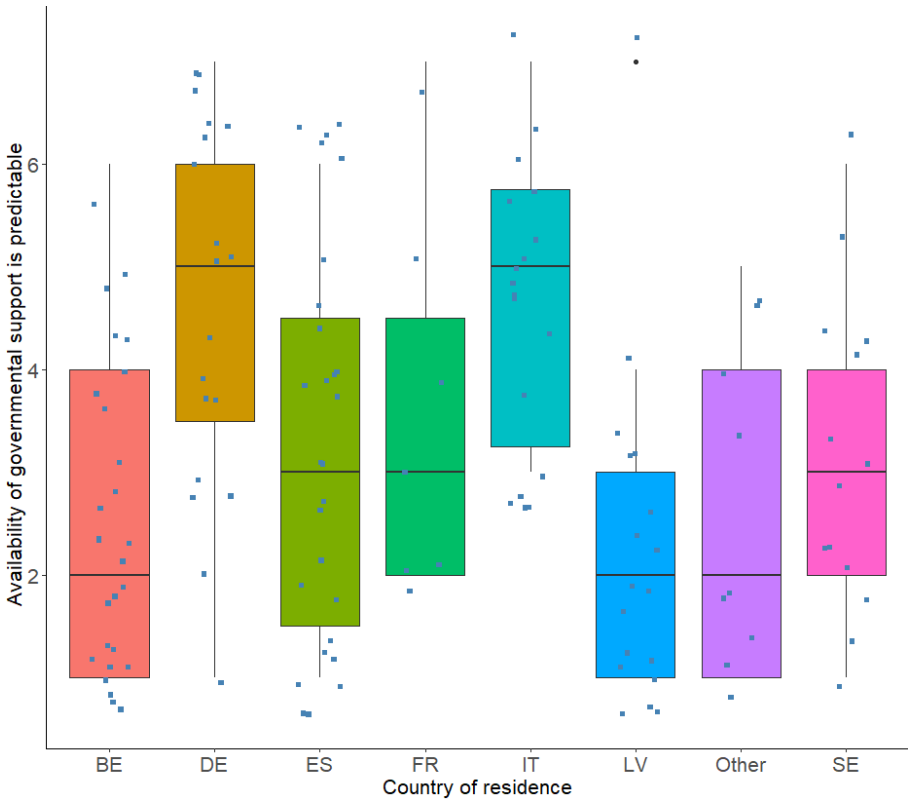

Figure 30: Germany and Italy think that the predictability of governmental support is higher than Belgium and Latvia.

4.2.3.3 Key findings from the demo site countries

When categorizing the respondents as negative (answered between 1-4 to the questions) or positive (answered between 5-7 to a question) towards the technology some statements stand out as especially negative (more than 50% of respondents answered negatively to a statement) or especially positive (more than 80% answered positively to a statement). The uneven selection criteria between positive and negative is because the survey is more interested in learning about the barriers to market adoption. The full data tables can be seen, analysed and understood further in Annex B.

Table 14: Results of the social acceptance section of the survey displayed by country. A '+' in the table means that more than 80% of respondents answered positively (>4) to the statement and a '-' in the table means that more than 50% of respondents answered negatively (<5) to the statement

Barrier	**Motivator**	Latvia	Germany	Spain	Belgium
High investment cost	Low investment cost	-	-	-	-
Availability of governmental support is unpredictable	Availability of governmental support is predictable	-		-	-
Not enough subsidies available	Subsidies available	-		-	-
Decreases value of a property	Increases the value of a property	+	+	+	+
High maintenance costs	Low maintenance cost			-	
There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable	-		-	-
Too complex technology	Easily understood technology				
Uncertain cost savings potential	Certain cost savings potential				
Uncertain performance of technology	Certain performance of technology	+			+
New and innovative technology is risky	New and innovative technology is an opportunity				
Requires more maintenance than existing heating system	Easy maintenance		+	-	
Not enough solar irradiation	Good solar irradiation			+	
Lack of suitable business models	Suitable business models are available			-	-
Not enough professional competence available	Enough professional competence available			-	
Not enough information is available about the technology	Sufficient information is available about the system			-	
Untrustworthy actors on the market	Trustworthy actors on the market				-
Difficult permit procedure	Easy permit procedure	-		-	
Unsupportive legal framework	Supportive legal framework	-		-	-
Unpredictable legal framework	Predictable legal framework	-		-	-

Some common features between the countries are that many people are very positive to the fact that the technology increases the value of the property. For all countries more than 50% of respondents consider the high investment cost to be a barrier. The investment cost and payback period are a particularly specified economic barrier identified in several of the reviewed scientific papers (Table 9) and it is also identified as the main economic barrier in the EU literature review.

Only in one case is there inconsistency between people who are very positive and people who are in majority negative. In Germany people to a large extent consider the maintenance of the technology to be easy whereas in Spain people think it is a barrier that the technology would require more maintenance than the existing technology.

In Latvia the barriers are mainly driven by the economic aspects and the legal aspects. Legal aspects was found to be a barrier in one of the reviewed scientific papers (45) and legal factors was found to be influential for early market replication and effective long-term market deployment in the EU project literature review. The legal framework in Latvia is considered unsupportive and unpredictable, the permit procedure is considered difficult and the availability of governmental support is perceived as unpredictable with not enough subsidies available and there is a lot of uncertainty of recouping the investment. The PESTLE analysis (1) confirms a poor macro environment in Latvia for the SunHorizon technology with a low target of increasing renewable energy, very little political and financial support for the technologies and low levels or

irradiation. Policy incentives was found to be important in several of the reviewed scientific papers (Table 9). In Belgium the barriers are mainly economical and legal, but also connected to trust in the actors on the market and lack of suitable business models. In Belgium the availability of governmental support is considered uncertain and not enough subsidies are available. The scarce availability of financial support for Belgium is confirmed by the PESTLE analysis in D2.3 (1) and only some political support exists for the technologies. Belgium also identifies the legal framework as a barrier.

The only identified barrier in Germany is the high investment costs, a barrier that is shared between all demo site countries. Germany's macro environment for the SunHorizon technologies is overall positive with positive government support, good levels of irradiation and a high demand for heating, domestic hot water and cooling (1) and is seems the respondents from Germany experience less barriers than other countries. Spain has the highest number of identified barriers, 12 barriers are identified, categories as economical, organisational, availability of information, trust and legal. In the PESTLE analysis Spain was however, found to have an overall positive macro environment for the SunHorizon technologies with a high target to increase renewable energy (22% by 2030), positive governmental support, good levels of irradiation and a demand for cooling, domestic hot water and heating (1). Spain is the only country that is very positive to the level of solar irradiation. The EU literature review yielded that the lack of professional competence is an important barrier and the existence of a well-developed market is an important factor for long-term market deployment.

4.2.3.4 Key findings based on stakeholder category

Processing the data for all 153 respondents split into the stakeholder category groups (Businesspersons, public building owners, private building owners and the public) in the same way as described in the section above resulted in the summary table below. Given that the demo site countries responses make up approximately 65% of the total responses similar trends can be observed also in this section. For example, the economic aspects are perceived as the main barriers, especially among public building owners and the public. Businesspersons perceive the largest number of barriers (nine) and except for economic aspects, lack of information, trust, business models and legal barriers are identified. Private building owners are the stakeholder groups that perceives the least barriers (three).

Table 15: Results of the market acceptance section of the survey displayed by stakeholder category. A '+' in the table means that more than 80% of respondents answered positively (>4) to the statement and a '-' in the table means that more than 50% of respondent

Barrier	**Motivator**	Business-persons	Public building owner	Private building owner	Public
High investment cost	Low investment cost	-	-	-	-
Availability of governmental support is unpredictable	Availability of governmental support is predictable	-	-	-	-
Not enough subsidies available	Subsidies available	-	-		-
Decreases value of a property	Increases the value of a property	+	+	+	+
High maintenance costs	Low maintenance cost		-		-
There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable		-	-	-
Too complex technology	Easily understood technology				
Uncertain cost savings potential	Certain cost savings potential				
Uncertain performance of technology	Certain performance of technology			+	
New and innovative technology is risky	New and innovative technology is an opportunity	+		+	
Requires more maintenance than existing heating system	Easy maintenance				-

Not enough solar irradiation	Good solar irradiation		+		
Lack of suitable business models	Suitable business models are available	-	-		-
Not enough professional competence available	Enough professional competence available	-			
Not enough information is available about the technology	Sufficient information is available about the system	-	-		
Untrustworthy actors on the market	Trustworthy actors on the market	-	-		
Difficult permit procedure	Easy permit procedure	-			-
Unsupportive legal framework	Supportive legal framework	-			-

5 Discussion

The section discusses some potential implications of the results of the deliverable, to be considered to increase the dissemination and market adoption of Sun Horizon technologies. It also discusses some identified limitations of the survey.

5.1 Market implications

5.1.1 Social acceptance

Since environmental awareness was found in both the scientific literature review and the EU project literature review to be a very influential factor for adoption of clean energy in Europe, attention should be given to raising the awareness among citizens on this topic. The results from the social acceptance part of the survey identifies only one aspect where a distinction can be made between groups with very high environmental index being more positive towards the technology than other groups. Namely that the technology has a positive effect on the landscape. Since environmental awareness was found to be a very influential factor for adopting, it is very positive that the respondents from the demo site countries (Belgium, Germany, Latvia and Spain) are so positive about the environmental performance of the technology. The environmental benefits of the SunHorizon technology should therefore be communicated clearly in information campaigns. The respondents from the demo site countries are also to a large extend very interested in the technology and curiosity has been found to be an important driver in previous literature. Availability of information was found in both the scientific literature review and the EU project literature review to be important to foster adoption, and the lack thereof was identified as an important barrier. The survey confirms these findings as groups that are involved with the SunHorizon project, and thus have more information about the technology, are found to be more positive towards how the media presents the technology, that the technology increases social status, about the availability of information and the environmental aspects of the technology. Information campaigns could be an option to increase awareness among stakeholders.

Respondents from Spain and Belgium are very positive to the economic aspects in the social acceptance section, such as that the technology generates money and is good value for money. These financial aspects are widely found in literature to be important to foster adoption. The respondents in Latvia and Belgium are only negative towards the technology awareness aspects, the technology is not frequently seen in the neighbourhood, they don't know people who have the technology installed and the media does not present the technology as innovative and forward-looking. This should be addressed to foster adoption in Latvia and Belgium. The only negative aspect perceived by respondents in Spain is that they do not know people who have the technology installed. Respondents from Germany do not perceive any statement in the social acceptance section as negative.

Public building owners were found to be the stakeholder category with the most positive attitude towards the SunHorizon technologies and the only stakeholder group that had a very positive attitude about the economic aspects of the technologies. All analysed stakeholder groups (businesspersons, public building owners, private building owners and the public) are very positive towards the reliability and environmental aspects of the technologies and show a large interest; these are aspects that should therefore be communicated. There needs to be an improvement with regards to the perception that the technology impacts the visual landscape negatively in all stakeholder groups, except for businesspersons.

5.1.2 Market Acceptance

The availability of information about the technologies is found to be a distinguishing factor between groups also in the market acceptance section. People involved with the SunHorizon project perceives the legal framework to be more predictable. The market acceptance analysis confirms that a distinction can be made between respondents with a high environmental index and other groups. Respondents with a high environmental index are more positive that the technologies increase the value of the property, more certain about the technical performance and the cost savings potential and consider new and innovative technology to be more of an opportunity. The survey indicates that the

environmental index must however be very high (13 or 14 where 14 is maximum) for a significant distinction to be made. The same recommendations presented in the previous section can be applied also to increase market acceptance.

Respondents from all the demo site countries are very positive to the fact that the technology increases the value of a property and this aspect should be promoted in communication in all countries. In Latvia and Belgium, the performance of the technology is seen as very positive and can be pushed further. The advantages of easy maintenance are mostly found in Germany. In Spain solar irradiation is perceived as very good and the SunHorizon technologies should be framed from this perspective.

However, for wide adoption to take place it is important to not only highlight the features that groups already are positive about but to also work to remove the identified barriers. In the market acceptance section, the respondents were generally more negative than in the social acceptance section. The reviewed literature found that the key financial barrier was the investment cost and payback time. This is true also for the respondents in the demo site countries, all of which considered the investment cost to be a barrier. Information about recouping the investment cost of the SunHorizon technologies must be clearer in information campaigns. This is true regardless of stakeholder category, as all stakeholders identify economic aspects as the main barrier, especially public building owners and the public. Respondents from Latvia and Belgium would need more predictable governmental support and predictable legal framework for adoption to occur. The legal framework must be more supportive, and subsidies are not perceived as available enough. Respondents in Spain identify the highest number of barriers in relation to the technologies. The Spanish market would therefore need to see improvement with regards to legal, economic aspects as well as organisational and trust aspects. Businesspersons are the stakeholder category that perceives the largest number of barriers, including lack of information, trust, business models and legal barriers. Private building owners are the stakeholder group that perceives the least barriers, and all relate to financial aspects. More predictable financial support and information about recouping the perceived high investment cost is necessary to remove barriers among private building owners.

5.2 Limitations with the survey

Given the selected distribution method of sharing the survey on various digital platforms it is not possible to tell how many people were reached by the survey and therefore the response rate cannot be calculated. Distributing a survey in this manner could also result in distorted data collection as people voluntarily responding to a survey could be people who are already interested about technologies such as the SunHorizon technology packages. Visible in the summary table of demographical variables is that the survey was mostly answered by men (66 %), people with a university degree (88 %) and people with a high environmental index (78 %).

The survey was not tested before distribution due to time constraints and it is possible that respondents have interpreted the questions in a different matter than intended. This could also occur because the survey was translated into four other languages than English by different persons.

The survey was structured by placing two opposite statements on each end of a Likert scale. The interpretation when analysing the collected data has been that all statement to the left of the Likert scale are negative (or barriers) and all the statements located to the right of the Likert scale are positive (or motivators). There is a possibility that some of the identified barrier and equivalent motivator does not hold the same meaning for all stakeholder groups. A barrier for a houseowner could be an opportunity for a businessperson.

6 Conclusions

Social aspects of new technologies such as the SunHorizon technology packages can have great impact on the success of implementation and market adoption. Social acceptance must therefore be analysed, just as the technical and economic aspects, to understand the needs and requirements of relevant stakeholders and to ensure negative attitudes and barriers can be managed. The aim of this deliverable has been to explore social and market acceptance with the purpose of identifying key aspects to increase the replicability of the solutions to a wider audience. First, a market analysis has been performed, looking at heat pumps and solar appliances separately to understand the market status quo today and the existing barriers. Second, a literature review has been performed, looking at both scientific literature and deliverables in previous EU projects. Finally, a survey has been conducted to explore how social and market acceptance vary amongst groups and between the demo sites countries for the SunHorizon technologies. The results are summarized in the sections below.

6.1 Markets and policies

The European HP market data shows increasing sales in the last 7 years, and HPs are establishing their position in the market for heating, cooling and sanitary water. The main HP technologies are air/water and air/air units. HPs are confirmed to have a strong market in the residential market for single/double family houses mainly for new buildings but also in renovations. In residential buildings for multifamily residency the market is still small but developing, both for new and renovated buildings. For commercial buildings there is an established market for renovated buildings while in new buildings the market is still limited. For the four EU countries in which the SunHorizon technology is being demonstrated, the HP market is at different stages. In Germany and Spain there is a confirmed and strong market for the technology, while in Belgium the market is still under development. A market analysis of the Latvian HP market could not be included in this deliverable, as explained in section 2.1.3. The main challenges of the European HP market are the initial investment cost, the price ratio between electricity and natural gas and energy systems issues, such as expansion capacity in the power grid.

In 2019 solar energy in the EU added more capacity than any other generation technology. The region installed 16.7 GW, more than doubling the 8.2 GW added the year before. Further, 2019 also showed the strongest solar growth since 2010, when the EU PV market increased by 104% during the first European solar boom reaching 13.4 GW of added capacity. The estimated total thermal energy generation of solar heating and cooling systems in Europe corresponds to 25.6 TWh_{th}, with a 7.8% increase of year-on-year sales, taking as reference the solar collector area or the equivalent nominal power of the installed systems. There is a large potential for solar Europe with at least 600 GW of rooftop capacity remaining to be used across the region. The main challenges of the solar market uptake in the EU are lack of finance, need to address re-skilling and upskilling of existing construction and electrical workers.

The EU policies addressed at decarbonizing the heating and cooling sector, increasing the share of renewable in the energy system and increasing energy efficiency in buildings are the main opportunity for the SunHorizon technologies which can fulfill these goals. As new buildings are estimated to account only for 25% of Europe's building stock in 2050, to achieve the above-mentioned goals, it is necessary to implement stricter energy requirements on the existing building stock and increase the renovation rates. There is therefore a potential for SunHorizon technologies to grow in the market of building renovations.

6.2 Literature review

The aim of the scientific literature review was to map the existing knowledge concerning social acceptance of renewables and the specific barriers that HPs and solar appliances are facing towards adoption. The review was a systematic evidence mapping, searching and screening of scientific literature. The search was carried out using a PICO approach (population, intervention, comparator, outcome). A total of 287 scientific publications were identified and screened with a global scope using the APSIS tool, and 72 of these were included in the review. Out of the reviewed studies 30 had their scope in Europe, 21 in Asia, 8 in the US and the remaining studies in other parts of the world. The results of the scientific literature

review show that the aspects most commonly identified as important for social acceptance of renewables are the availability of information, the financial aspects and sociodemographic factors; while the existence of policy incentives, the investment costs and the payback period were also commonly found as important factors. Moreover, the studies carried out in Europe and North America have focused mostly on identifying aspects that foster social acceptance, while studies in the rest of the world have focused on identifying hinders to social acceptance.

The scientific literature review identified three main aspects for adoption of renewables; the availability of information about technology, financial aspects and sociodemographic factors (e.g. income level and educational level). The availability of information refers mostly to how the technology works, the proper way to operate it, the investment and operational costs, the government incentives available and the installation process. Financial aspects on the other hand can be positive or negative. For instance, economic incentives such as tax deductions or easy access to loans could foster adoption, whereas the investment costs and payback period appear as main barriers for adoption. These observations from the literature review have been confirmed by the results of the survey. More informed respondents were more positive towards the technologies, financial aspects stimulated positive and negative attitudes in respondents, and gender was a relevant demographical variable. Environmental awareness appears as a very influential factor for adoption only in European studies, which was also confirmed by the results of the survey. As for non-EU countries, financial aspects, availability incentives and information appear to be more influential.

Eight demonstrative projects funded by *7th Framework programme* and Horizon 2020 Programs in the last 7 years have been reviewed. Clean technology, such as solar appliances in buildings and integration of renewables in district heating networks, is generally well accepted by stakeholders if it is perceived as useful, adequate, is affordable and generates trust and fair. Stakeholders targeted in the reviewed EU projects are mainly building owners and end-users, but also the public and other stakeholders in the supply chain of the technology. Regarding barriers against adoption of innovative clean technologies in the building sector, all stakeholders identified non-technical barriers, such as economic, social, political and technological issues, as most important. The key to unlocking further market uptake of new clean technology in the building sector is to overcome the lack of information and trust issues among stakeholders that are not familiar with the technology.

6.3 Results from the survey

The survey has gathered new evidence on the social and market acceptance of the SunHorizon technologies. The survey was developed by identifying categories and key questions in previous studies on social acceptance and formulating statements around the categories that were suitable to the target audience for the survey. The survey was mainly distributed online (a minority of paper copies were distributed to the demo sites), using the EUSurvey tool, both to participants involved in SunHorizon and to the general public by sharing the survey in social media. The survey consisted of three parts: respondent profile, social acceptance and market acceptance. 153 respondents have answered the survey, of which most were men (66 %), people with a university degree (88 %) and people with a high environmental index (78 %).

Social acceptance refers to the respondent's attitude towards the technology. A total of 16 questions aimed to gather the respondent's perception about the technology from a financial, technological, social, comfort and environmental point of view was included in the survey. Respondents who answered 6 or higher (on a 1-7 Likert scale) to the two environmental awareness questions in the survey are categorised to have a high environmental index. Respondents with a high environmental index are found to be more positive towards the visual effect that the technology has on the landscape than other groups. Respondents that are involved with the SunHorizon project, and thus likely to have more information about the technology, are found to be more positive towards the technology with regards to how the media present the technology, that the technology increases social status and that it is a clean technology. Men are slightly more positive than women towards the technology being a reliable source of heating and men perceives they know more people who have the technology installed. Key findings from the demo site countries show that all demo sites countries are largely positive about the environmental benefits of the SunHorizon technology and respondents are largely interested in the technology. Latvia and Belgium are mostly negative towards technology awareness aspects. They do not see the technology around the neighbourhood, do not know people who have the technology installed and do not perceive that

media is presenting the technology as innovative and forward-looking. Studied stakeholder categories were businesspersons, public building owners, private building owners and the public. Public building owners are the category with the most positive attitude towards the technology and the only group that is very positive about the economic statements. All groups, but businesspersons, believes that the technology negatively impacts on the visual landscape.

Market acceptance refers to the respondent's willingness to adopt the technology and evaluates barriers and motivators. A total of 18 questions aimed to gather the respondent's perception about the technology from an economic, technological, organisational/business, legal, availability of information and trust point of view were included in the survey. Respondents with a high environmental index are found to be more positive than other groups towards several of the statements, such as the cost savings and performance are more certain, the system will increase the value of their property and new and innovative technology is seen more as an opportunity. Respondents involved in the SunHorizon project are found to be more positive than other groups towards the availability of information and the predictability of the legal framework. Gender is again found to be a relevant demographical variable. Women perceive, to a larger extent than men, that there is enough professional competence available and that the actors on the market are more trustworthy. The key findings from the demo sites countries show that all countries perceive the investment cost of the technology to be a barrier for adoption. Respondents in Spain perceive the largest number of barriers related to the technological, economic, legal, organisational issues and trust. The respondents from Germany only perceived the investment cost as a barrier. In Latvia economic and legal barriers were identified. Respondents in Belgium have identified mainly economic (the availability of governmental support is considered uncertain and not enough subsidies are available) and legal barriers, but also connected to trust in the actors on the market and lack of suitable business models. The availability of financial support is scarce in Belgium and only some political support exists for the technologies. The key findings by studying stakeholder group yields similar results, for example, the economic aspects are perceived as the main barriers, especially among public building owners and the general public. Businesspersons perceive the largest number of barriers including economic aspects, lack of information, trust, business models and legal. Private building owners are the stakeholder group that perceives the least barriers, only related to economic aspects.

6.4 Sample reached in EU project review

Taking into account criteria introduced in section 2.1.2 to delimit the analysis of EC projects, the review of projects has been restricted to those projects funded through 7th *Framework programme* (FP7) and Horizon 2020 Programs on which CARTIF has participated in the last 7 years

As a result, 10 projects have been selected in order to analyse the workplan and deliverables developed and collect the main inputs for the analysis to be performed in this current deliverable. The list of projects selected for the review are shown in table below:

Table 16: List of EU projects reviewed

Project name	Demostration	Duration	Website	Funded under
BRICKER: Total Renovation Strategies for Energy Reduction in Public Building Stock	Refurbish of existing public non-residential buildings based on facade improvements and renewable energy systems	2013-2018	http://www.bricker-project.com/	FP7
COMMON ENERGY: Converting EU shopping centres into beacons of energy efficiency	Refurbish of existing shopping centers based on facade improvements and renewable energy systems	2013-2018	http://www.commonenergyproject.eu/	FP7
R2CITIES: Renovation of Residential urban spaces: Towards nearly zero energy CITIES	Complete retrofit of residential buildings based on facade improvements, ICT and renewable energy systems	2013- 2018	http://r2cities.eu/	FP7
CITyFiED: Replicable and Innovative Future Efficient Districts and cities	Complete retrofit of residential buildings based on facade improvements, ICT and renewable energy systems	2014-2019	http://www.cityfied.eu	FP7
REMOURBAN: REgeneration MOdel for accelerating the smart URBAN transformation	Complete retrofit of residential buildings based on facade improvements, ICT and renewable energy systems	2015-2020	http://www.remourban.eu	H2020
SmartEnCity: Towards Smart Zero CO2 Cities across Europe	Complete retrofit of residential buildings based on facade improvements, ICT and renewable energy systems	2016-2021	https://smartencity.eu/	H2020
mySMARTLife: Smart Transition of EU cities towards a new concept of smart Life and Economy	Complete retrofit of residential and public buildings based on facade improvements, ICT and renewable energy systems	2016-2021	https://www.mysmartlife.eu/mysmartlife/	H2020
MAtchUP: MAximizing the UPscaling and replication potential of high level urban transformation strategies	Complete retrofit of residential and tertiary buildings based on facade improvements, ICT and renewable energy systems	2017-2022	https://www.matchup-project.eu/	H2020
HOUSEFUL: Innovative circular solutions and services for new business opportunities in the EU housing sector	Refurbish of existing buildings with innovative circular solutions	2018-2022	https://houseful.eu/	H2020
ReUseHeat: Recovery of Urban Excess Heat	Demonstrate systems based on recovery and reuse of waste heat available at the urban level	2017-2021	https://www.reuseheat.eu/	H2020

The table below describes the demo sites where social acceptance was evaluated in the project identified in EU project review as well as the RES technologies implemented.

Table 17: Main features of the demo sites of EU projects reviewed

Project name	Type of building	RES technologies	End-user of building	Demo sites
BRICKER	Public non-residential buildings (administrative, education, hospital)	Solar parabolic collectors / chillers / biomass boiler / ORC cogeneration unit	Workers, students, patients	Cáceres (Spain), Liége (Belgium), Aydin (Turkey)
COMMON ENERGY	Shopping centers	Geothermal, BIPV	Clients and workers	Valladolid (Spain), Trondheim (Norway), Modena (Italy)
R2CITIES	Residential buildings	Solar thermal collectors	Owner and tenants	Valladolid (Spain), Genoa (Italy), Kartal (Istanbul)
CITyFiED	Residential buildings	District heating network (*biomass*) with support of a microcogeneration system / Photovoltaic panels / Solar thermal collectors	Owner and tenants	Laguna (Spain), Lund (Sweden), Soma (Turkey)
REMOURBAN	Residential buildings	RES in buildings (*solar thermal*) / Connection with city scale district heating (90% renewable and waste heat)	Owner and tenants	Valladolid (Spain), Nottingham (UK) Tepebasi (Turkey)
SmartEnCity	Residential buildings	RES in buildings (*solar thermal, photovoltaic and hybrid panels*) connected to storage solutions / RES city infrastructure connected to buildings (*solar plants and district heating*)	Owner and tenants	Vitoria (Spain), Sonderborg (Denmark), Tartu (Estonia)
mySMARTLife	Residential buildings and public building (social restaurant, which host municipal showers)	RES in buildings *(solar thermal, photovoltaic and hybrid panels)* connected to storage solutions. RES city infrastructure connected to buildings (*solar plants and district heating*)	Owner and tenants, users of public buildings	Nantes (France), Hamburg (Germany), Helsinki (Finland)
MAtchUP	Residential buildings and public building administrative, market)	RES in buildings *(solar thermal, photovoltaic and hybrid panels)* connected to storage solutions / RES city infrastructure connected to buildings (district heating)	Owner and tenants, users of public buildings	Valencia (Spain), Dresden (Germany), Antalya (Turkey)
HOUSEFUL	Residential buildings	RES in buildings *(solar thermal and photovoltaic panels)*	Owner and tenants	Austria and Spain
ReUseHeat	Urban infrastructures: Underground, Hospital, Sewage plan, Data center	Systems based on recovery and reuse of waste heat available at the urban level	Citizens	Germany, Spain, France

Although projects evaluated did not deal with the same RES technologies of SunHorizon, this is not important since the projects analysed were similar: to demonstrate innovative RES technologies (TRL: 7, 8 and 9) at building scale by involving same target audience.

Evaluation approach on social issues in projects reviewed: methods and target audience

Apart to test energy efficient measures in residential and tertiary buildings, reviewed projects aimed to quantify the impacts of these solutions in the environment and economy as well as to measure the social acceptance of the affected citizens. Furthermore, these projects intended to evaluate the potential of replicability of these solutions on a wider European context through diverse methodologies and analysis, including social and market acceptance. The table below describes how the projects deal with social/market acceptance.

Table 18: Social/market acceptance in EU projects reviewed

Project name	Assessment of the demo		Replicability of the solution	
	Focus of the assessment analysis	Social acceptance in the demo	Focus of the assessment analysis	Social/Market acceptance in replicability studies
BRICKER	Energy and economic assessment of retrofitted buildings due to facade improvements and implementation of renewable energy systems	No	Analysis of energy reduction and investment of similar buildings	No
COMMON ENERGY	Energy, thermal comfort and sustainability assessment of retrofitted buildings due to facade improvements and implementation of renewable energy systems	No	Analysis of the energy and building specifications for the technology developments	No
R2CITIES	Energy, Environmental, Social and Economic assessment in retrofitted buildings due to in facade improvements and implementation of renewable energy systems	Social assessment: Social acceptance	Steps to follow to develop energy efficient district renovation	No
CITyFiED	Energy, Environmental, Social and Economic assessment of retrofitted buildings due to facade improvements and implementation of renewable energy systems	Social assessment: Social acceptance	Steps to follow to develop energy efficient district renovation	Social & Market acceptance
REMOURBAN	Energy, Environmental, Social and Economic assessment in retrofitted buildings due to facade improvements and implementation of renewable energy systems and introduction of e-Vehicles	Social assessment: Social acceptance	Application of diverse methods to priories the most replicable technologies of the project	No
SmartEnCity	Energy, Environmental, Social, Citizen engagement and Economic assessment in retrofitted buildings due to facade improvements and implementation of renewable energy systems and introduction of e-Vehicles	Social assessment: Social acceptance	Application of diverse methods to priories the most replicable technologies of the project	No
mySMARTLife	Energy, Environmental, Social, Citizen engagement and Economic assessment in retrofitted buildings and users of mobility actions	Social assessment: Social acceptance	Application of diverse methods to priories the most replicable technologies of the project	Social acceptance
MAtchUP	Energy, Environmental, Social and Economic assessment in retrofitted buildings due to facade improvements and implementation of renewable energy systems and introduction of e-Vehicles	Social assessment: Social impacts and social acceptance	Application of diverse methods to prioritize the most replicable technologies of the project	No
HOUSEFUL	Energy, Environmental, Economic and Social assessment in retrofitted buildings due to implementation of circular solutions	Social assessment: Social acceptance	Degree of circularity of buildings based on building specifications for the technology developments, user acceptance and business models.	Social acceptance
ReUseHeat	Energy, Environmental, Social and Economic assessment	Social assessment: Social acceptance and social media impacts	Analysis of energy reduction and investment in similar urban infrastructure	No

These are the main findings from the table above:

- All the projects develop an assessment for measuring the performance of project solutions as well as the impacts in energy, environment and economic. However, social acceptance is not considered in all the cases.
- For the case of replicability studies, the approach followed is different in each project. Some projects deal the replicability through the analysis of the buildings requirement to implement project solutions, others by evaluating the potential of energy savings and the most suitable financing schemes/business models. Thus, only a low number of projects focus the replicability on social acceptance/market acceptance as SunHorizon.
- Although the number of projects is reduced, they can be a suitable sample to identify the main topics to be explored in current deliverable for these reasons:
    - The studies performed cover all the European territory,
    - First EU demonstrative projects aimed to test the technology and was not focused in social aspects or replicability.

From the previous table, it can be stated that the EU projects reviewed deal with social evaluation under three focuses:

Focus 1: Social acceptance of the interventions of the affected citizens

Focus 2: Social acceptance of project solutions in other locations

Focus 3: Market acceptance of project solutions

Following this scheme, table below compiles the methods and target audience of the diverse studies performed in the projects selected as well as the current status of the activity of social acceptance.

Table 19: Approach of social & market acceptance in demo sites in EU projects reviewed

Project name	Focus of evaluation	Data source	Process	Target audience	Status
R2CITIES	Social acceptance of the intervention of the affected citizens	Questionnaire	Before and after intervention	Owner and tenants of residential buildings	Design, delivery and evaluated
CITyFiED	Social acceptance of the intervention of the affected citizens	Questionnaire, Focus group	Before and after intervention	Owner and tenants	Design, delivery and evaluated
	Social acceptance of project solutions in other locations	Focus group	Before intervention	Municipalities, residents (or representative), designers, contractors, financers, energy companies and building companies, coordinator/main partners of public funded projects	Design, delivery and evaluated
	Market acceptance of project solutions	Questionnaire	Before intervention	Stakeholders	Design, delivery and evaluated
REMOURBAN	Social acceptance of the intervention of the affected citizens	Questionnaire	Before and after intervention	Owner and tenants	Design, delivery and evaluated
SmartEnCity	Social acceptance of the intervention of the affected citizens	Questionnaire, Individual interview, Focus group	After intervention	Owner and tenants	Design (draft)
mySMARTLife	Social acceptance of the intervention of the affected citizens	Questionnaire, Individual interview, Focus group	After intervention	Owner and tenants, users of public buildings	Design (draft)
	Social acceptance of project solutions in other locations	Questionnaire, Individual interview, Focus group	Before intervention	Citizens	Design
MAtchUP	Social acceptance of the intervention of the affected citizens	Questionnaire	Before and after intervention	Owner and tenants, users of public buildings	Design
HOUSEFUL	Social acceptance of the intervention of the affected citizens	Questionnaire, Focus group	Before and after intervention	Owner and tenants	Unknown
ReUseHeat	Social acceptance of the intervention of the affected citizens	Questionnaire	Unknown	Unknown	Unknown

6.5 Data collection in EU projects on social issues in the reviewed projects

This section aims to describe the tool for data collection as well as the procedure followed to evaluate the social/market acceptance for those projects that have designed and/or delivered the questionnaire or performed the interview. In the previous section it was identified that the reviewed EU projects deal with social evaluation under three focuses:

- Social acceptance of the interventions of the affected citizens
- Social acceptance of project solutions in other locations
- Market acceptance of project solutions

6.5.1 Focus 1: Social acceptance of the intervention of the affected citizens

Table 20: Data collection for measuring social acceptance in demo sites

Project & City name	Format	Type of questions	Delivery	Target audience
R2CITIES: Valladolid (Spain)	Questionnaire (paper)	Closed questions with YES/NO or Likert scale response. Open questions	During informative sessions to inform citizens about the interventions	Owner and tenants
R2CITIES: Genova (Italy)	Questionnaire (paper)	Closed questions with YES/NO or Likert scale response. Open questions	During informative sessions to inform citizens about the interventions	Owner and tenants
R2CITIES: Kartal (Turkey)	Questionnaire (paper)	Closed questions with YES/NO or Likert scale response. Also the questionnaire includes open questions	During informative sessions to inform citizens about the interventions	Owner and tenants
CITyFiED Laguna (Spain)	Questionnaire (paper) Focus group	Closed questions with YES/NO or Likert scale response. Also the questionnaire includes open questions	Distributed in mail boxes	Owner and tenants
REMOURBAN Valladolid (Spain)	Questionnaire (paper)	Closed questions with Likert scale response. Also the questionnaire includes open questions	Distributed in mail boxes	Owner and tenants
MAtchUP: Valencia (Spain), Dresden (Germany), Antalya (Turkey)	Questionnaire (paper)	Closed questions with Likert scale response. Also the questionnaire includes open questions	During informative sessions	Owner and tenants

6.5.2 Focus 2: Social acceptance of project solutions in other locations

Table 21: Data collection for measuring social acceptance in other locations

Project name	Format	Type of questions	Number of questions	Target audience (type and number)
CITyFiED	Focus group	Open questions	13	4-5 from this typology: Municipalities, residents (or representative), designers, contractors, financers, energy companies and building companies, coordinator/main partners of public funded projects

6.5.3 Focus 3: Market acceptance of project solutions

Table 22: Data collection for measuring market acceptance

Project name	Format	Type of questions	Number of questions	Delivery	Target audience (type and number)	Number of respondents
CITyFiED	Questionnaire (online)	Closed questions (selection of the most suitable answers). Also the questionnaire includes open questions	Questionnaire 1: 33 Questionnaire 2: 48 Questionnaire 3: 48	Massive email, publication in website, social media and newsletters of project	Q1: municipalities, residents (or representative), designers, contractors, financers, energy agencies Q2: energy service companies and building companies Q3: Coordinators or main participants of public funded projects	73 answers were collected: *(Q1: 47;* *Q2: 6 ;* *Q3: 26)*

B. Survey results: Summary tables

*Table 23: Summary of Social Acceptance for Latvia. Mean values (M), Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P). *If number of respondents in a category is <4 the results won't be displayed.*

LATVIA		**Business- persons**			**Public building owners**			**Private Building owners**			**The public**			**Total**		
Number of respondents		**6**			**1***			**5**			**7**			**18**		
		M	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**
Negative statement	**Positive statement**															
Does not generate economic savings	Generates economic savings	5.7	1	5				6	0	5	4.1	4	3	5.2	5	13
Waste of money	Good value for money	4.6	2	3				5	1	3	4.7	2	5	4.7	5	11
I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood	3.7	4	2				4.2	2	3	3.7	4	3	3.8	10	8
No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed	4.5	4	2				4	2	3	3.3	6	1	3.9	12	6
The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking	2.8	5	1				4.4	3	2	4.9	2	5	4.1	10	8
Unreliable technology for heating and electricity	Reliable technology for heating and electricity	5.7	1	5				4.8	1	4	4.7	3	4	5.1	5	13
Decreases social status	Increases social status by displaying environmental commitment to others	5.6	1	4				5.8	0	5	5.6	1	6	5.7	2	15
I am not interested in the technology	I am interested in the technology	6.5	0	6				6.4	0	5	6.3	0	7	6.4	0	18
Does not improve quality of my everyday life	Improves quality of my everyday life	5.3	1	5				5.4	1	4	5.5	0	6	5.4	2	15
Noisy	Silent	5.7	1	5				6.4	0	5	5.7	0	3	6.0	1	13
Decreases thermal comfort	Increases thermal comfort	5	2	3				6.2	0	5	5.2	0	5	5.5	2	13
The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology	5	2	4				6	0	5	4.4	3	4	5.0	5	13
Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now	5.5	1	5				5.8	0	5	4.4	3	4	5.2	4	14
The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape	4.5	2	4				5	2	3	5.6	2	3	5.0	6	10
It is a dirty technology that increases pollution	It is a clean technology that reduces pollution	5.7	2	4				6.6	0	5	5.9	0	7	6.0	2	16

*Table 24: Summary of Social Acceptance for Germany. Mean values (M), Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P). *If number of respondents in a category is <4 the results won't be displayed.*

Germany		**Business- persons**			**Public building owners**			**Private Building owners**			**The public**			**Total**		
Number of respondents		6			0*			10			4			20		
		M	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**
Negative statement	**Positive statement**															
Does not generate economic savings	Generates economic savings	5.3	2	4				5.5	3	7	6	0	4	5.5	5	15
Waste of money	Good value for money	5.7	2	4				5	3	7	6.3	0	4	5.5	5	15
I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood	4.7	3	3				5.3	3	6	5	1	2	5.1	7	11
No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed	5.5	1	5				5.3	3	7	5.3	1	3	5.4	5	15
The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking	5.2	2	4				5.6	2	7	5.3	1	3	5.4	5	14
Unreliable technology for heating and electricity	Reliable technology for heating and electricity	6.3	0	6				5.9	2	8	6.3	0	4	6.1	2	18
Decreases social status	Increases social status by displaying environmental commitment to others	6.5	0	4				4.9	2	6	6	0	3	5.5	2	13
I am not interested in the technology	I am interested in the technology	6.8	0	5				5.9	2	8	7	0	3	6.3	2	16
Does not improve quality of my everyday life	Improves quality of my everyday life	5.2	2	4				5.3	2	5	5.3	1	2	5.3	5	11
Noisy	Silent	5.8	1	5				6.2	1	4	7	0	3	6.2	2	12
Decreases thermal comfort	Increases thermal comfort	5.5	1	5				6	0	3	7	0	2	5.9	1	10
The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology	5.2	2	4				6.3	0	8	6.7	0	3	6.0	2	15
Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now	5.2	3	3				5.4	1	8	4.7	1	2	5.2	5	13
The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape	3.8	3	2				5	2	6	6	0	3	4.8	5	11
It is a dirty technology that increases pollution	It is a clean technology that reduces pollution	6.7	0	6				6	2	7	5.8	1	3	6.2	3	16

*Table 25: Summary of Social Acceptance for Spain. Mean values (M), Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P). *If number of respondents in a category is <4 the results won't be displayed.*

SPAIN		**Business- persons**			**Public building owners**			**Private Building owners**			**The public**			**Total**		
Number of respondents		9			7			3*			14			30		
		M	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**
Negative statement	**Positive statement**															
Does not generate economic savings	Generates economic savings	5.7	2	7	5.8	0	6				5.5	2	11	5.6	4	24
Waste of money	Good value for money	5.9	1	7	5.3	1	5				5.3	2	8	5.5	4	20
I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood	4.1	5	4	4.4	2	5				4.1	7	7	4.2	14	16
No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed	4.1	7	2	5.1	2	5				3.4	13	1	4.0	22	8
The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking	5.3	3	6	4.9	2	5				3.8	9	5	4.5	14	16
Unreliable technology for heating and electricity	Reliable technology for heating and electricity	6.2	1	8	5.3	1	6				5.5	1	9	5.7	3	23
Decreases social status	Increases social status by displaying environmental commitment to others	6	1	8	5.4	2	5				5.1	3	7	5.5	6	20
I am not interested in the technology	I am interested in the technology	6.8	0	9	6.9	0	7				6.1	2	12	6.5	2	28
Does not improve quality of my everyday life	Improves quality of my everyday life	6.1	0	9	5.3	1	6				4.9	5	9	5.4	6	24
Noisy	Silent	6.2	1	8	5	1	4				5.2	5	7	5.5	7	19
Decreases thermal comfort	Increases thermal comfort	6.1	1	8	5.6	1	6				5.2	5	8	5.6	7	22
The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology	4.4	4	4	5.3	2	4				4.3	4	4	4.6	10	12
Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now	4.1	5	3	4.5	2	4				4.8	6	7	4.5	13	14
The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape	6	1	6	5	3	4				4.2	5	4	5.0	9	14
It is a dirty technology that increases pollution	It is a clean technology that reduces pollution	6.7	0	9	6.6	0	7				6		1	13.0	0	17

*Table 26: Summary of Social Acceptance for Belgium. Mean values (M), Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P). *If number of respondents in a category is <4 the results won't be displayed.*

		Business- persons			**Public building owners**			**Private Building owners**			**The public**			**Total**		
Number of respondents		3*			5			8			12			25		
		M	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**
Negative statement	**Positive statement**															
Does not generate economic savings	Generates economic savings				5.6	0	5	5.3	2	6	5.7	1	10	5.5	3	21
Waste of money	Good value for money				5.6	0	5	5.3	2	6	5.5	2	9	5.5	4	20
I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood				3.8	3	2	4.1	6	2	5.3	4	8	4.6	13	12
No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed				4.2	3	2	4.8	4	4	4.7	6	6	4.6	13	12
The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking				4.4	3	2	3.8	6	2	4.5	5	7	4.3	14	11
Unreliable technology for heating and electricity	Reliable technology for heating and electricity				6	0	5	5.1	1	6	5.6	1	11	5.5	2	22
Decreases social status	Increases social status by displaying environmental commitment to others				5.4	1	4	5	2	6	6	1	11	5.6	4	21
I am not interested in the technology	I am interested in the technology				6.4	0	5	5.3	1	7	5.8	2	10	5.8	3	22
Does not improve quality of my everyday life	Improves quality of my everyday life				5.3	0	3	4.1	5	3	4.3	5	4	4.4	10	10
Noisy	Silent				5.3	1	2	5.3	1	7	5.3	3	7	5.3	5	16
Decreases thermal comfort	Increases thermal comfort				5.7	0	3	5.1	3	5	5.1	3	6	5.2	6	14
The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology				4.3	2	1	5.1	3	4	4.1	5	6	4.5	10	11
Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now				5.7	0	3	4.3	3	5	4.2	7	3	4.5	10	11
The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape				3.8	3	1	4	6	2	3.9	9	1	3.9	18	4
It is a dirty technology that increases pollution	It is a clean technology that reduces pollution				6	0	5	5.8	1	7	5.3	2	10	13.0	3	22

*Table 27: Summary of Market Acceptance for Latvia. Mean values (M), Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P). *If number of respondents in a category is <4 the results won't be displayed.*

LATVIA		**Business- persons**			**Public building owners**			**Private Building owners**			**The public**			**Total**		
Number of respondents		6			1*			5			7			18		
Barrier	**Motivator**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**
High investment cost	Low investment cost	3.7	4	2				2.8	5	0	1.3	6	0	2.6	15	2
Availability of governmental support is unpredictable	Availability of governmental support is predictable	1.8	6	0				2.2	5	0	1.8	6	0	1.9	17	0
Not enough subsidies available	Subsidies available	1.8	6	0				2.6	5	0	1.8	6	0	2.0	12	5
Decreases value of a property	Increases the value of a property	5.2	2	4				6.4	0	5	6	1	5	5.8	3	14
High maintenance costs	Low maintenance cost	5.2	1	5				4.4	3	2	4	3	1	4.5	7	8
There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable	4.3	2	4				4.2	2	3	2.5	6	0	3.6	10	7
Too complex technology	Easily understood technology	5.2	1	5				5.2	0	5	4.3	4	3	4.9	5	13
Uncertain cost savings potential	Certain cost savings potential	4.5	2	4				5.4	1	4	3.5	4	2	4.5	7	10
Uncertain performance of technology	Certain performance of technology	5.5	0	6				5.4	0	5	4.6	3	2	5.1	3	13
New and innovative technology is risky	New and innovative technology is an opportunity	6.2	0	5				4.8	2	3	3.7	4	3	4.9	6	11
Requires more maintenance than existing heating system	Easy maintenance	5.3	1	5				5.2	0	5	4.4	4	1	4.9	5	11
Not enough solar irradiation	Good solar irradiation	5.7	0	6				4.8	2	3	3.9	6	1	4.9	8	10
Lack of suitable business models	Suitable business models are available	5	2	4				4.6	1	4	2.4	5	0	4.0	8	8
Not enough professional competence available	Enough professional competence available	4.7	3	3				5.3	0	4	2.5	5	1	4.0	8	8
Not enough information is available about the technology	Sufficient information is available about the system	3.7	5	1				4.8	1	4	4.3	2	4	4.2	8	9
Untrustworthy actors on the market	Trustworthy actors on the market	4.3	3	3				5.2	1	4	4	4	1	4.5	8	8
Difficult permit procedure	Easy permit procedure	4.7	2	4				5.2	2	3	2.7	5	1	4.1	9	8
Unsupportive legal framework	Supportive legal framework	3.5	6	0				4.2	2	3	2.7	6	0	3.4	14	3
Unpredictable legal framework	Predictable legal framework	3.5	5	1				4	3	2	2.8	5	1	3.7	13	4

*Table 28: Summary of Market Acceptance for Germany. Mean values (M), Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P). *If number of respondents in a category is <4 the results won't be displayed.*

GERMANY		**Business- persons**			**Public building owners**			**Private Building owners**			**The public**			**Total**		
Number of respondents		6			0*			10			4			20		
Barrier	**Motivator**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**
High investment cost	Low investment cost	3	5	1				3.9	6	4	4	3	1	3.7	14	6
Availability of governmental support is unpredictable	Availability of governmental support is predictable	4.2	3	3				5.2	3	6	4	3	1	4.6	9	10
Not enough subsidies available	Subsidies available	4.8	2	4				4.5	4	6	3.5	3	1	4.4	9	11
Decreases value of a property	Increases the value of a property	5.8	1	5				6.3	1	9	6	0	4	6.1	2	18
High maintenance costs	Low maintenance cost	5.2	2	4				5.8	2	6	5.3	1	2	5.5	5	12
There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable	5	2	3				4.4	5	4	5.3	1	3	4.8	8	10
Too complex technology	Easily understood technology	4.3	2	4				5.6	2	8	5.5	0	4	5.2	4	16
Uncertain cost savings potential	Certain cost savings potential	5	2	4				4.9	3	7	5.5	1	3	5.1	6	14
Uncertain performance of technology	Certain performance of technology	5.7	0	6				5.2	2	8	5	2	1	5.3	4	15
New and innovative technology is risky	New and innovative technology is an opportunity	5.7	1	5				6.2	2	8	5	1	3	5.8	4	16
Requires more maintenance than existing heating system	Easy maintenance	5.2	2	4				6.4	0	9	5.7	0	3	5.9	2	16
Not enough solar irradiation	Good solar irradiation	5	2	3				6	1	8	5	1	2	5.5	4	13
Lack of suitable business models	Suitable business models are available	4.8	3	3				4	3	5	4.25	2	2	4.3	8	10
Not enough professional competence available	Enough professional competence available	4.7	2	3				5.4	4	5	3.8	3	1	4.9	9	9
Not enough information is available about the technology	Sufficient information is available about the system	4.7	2	3				5.1	3	7	3	3	1	4.6	8	11
Untrustworthy actors on the market	Trustworthy actors on the market	4	3	3				5.8	2	8	4.8	1	3	5.1	6	14
Difficult permit procedure	Easy permit procedure	4.7	2	4				5.7	2	7	5	1	1	5.3	5	12
Unsupportive legal framework	Supportive legal framework	4.3	3	3				5.6	1	8	5	1	1	5.1	5	12
Unpredictable legal framework	Predictable legal framework	5	1	4				5.2	3	6	3.3	2	1	4.8	6	11

*Table 29: Summary of Market Acceptance for Spain. Mean values (M), Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P). *If number of respondents in a category is <4 the results won't be displayed.*

SPAIN		**Business- persons**			**Public building owners**			**Private Building owners**			**The public**			**Total**		
Number of respondents		9			7			3*			14			30		
Barrier	**Motivator**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**
High investment cost	Low investment cost	4	6	3	3.9	5	2				3.3	8	2	3.7	19	7
Availability of governmental support is unpredictable	Availability of governmental support is predictable	2.9	6	2	4.4	3	4				2.8	9	0	3.3	18	6
Not enough subsidies available	Subsidies available	2.7	8	1	3.9	3	4				2.6	10	0	3.0	21	5
Decreases value of a property	Increases the value of a property	5.9	1	8	5.9	0	7				5.3	2	8	5.7	3	23
High maintenance costs	Low maintenance cost	4.3	5	4	4.4	4	3				4.1	7	2	4.3	16	9
There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable	3.9	6	3	4.1	4	3				3.9	6	2	4.0	16	8
Too complex technology	Easily understood technology	5.3	2	7	5	2	5				4.8	4	5	5.0	8	17
Uncertain cost savings potential	Certain cost savings potential	5.2	3	6	4.6	4	3				4.4	3	4	4.8	10	13
Uncertain performance of technology	Certain performance of technology	5.2	3	6	5.3	1	6				4.9	4	5	5.1	8	17
New and innovative technology is risky	New and innovative technology is an opportunity	5.8	1	8	5.6	2	5				4.9	4	5	5.4	7	18
Requires more maintenance than existing heating system	Easy maintenance	4	5	4	5	3	4				3.8	7	1	4.2	15	9
Not enough solar irradiation	Good solar irradiation	5.9	2	7	6.7	0	7				6.3	1	8	6.3	3	22
Lack of suitable business models	Suitable business models are available	2.9	8	1	4.3	3	4				4.1	4	3	3.7	15	8
Not enough professional competence available	Enough professional competence available	3.9	6	3	4.6	3	4				4.6	3	4	4.3	12	11
Not enough information is available about the technology	Sufficient information is available about the system	3.8	5	4	4.3	4	3				3.8	6	3	3.9	15	10
Untrustworthy actors on the market	Trustworthy actors on the market	4.7	4	5	5.1	2	5				4.3	5	3	4.7	11	13
Difficult permit procedure	Easy permit procedure	3.4	6	3	4.7	3	4				3.6	5	2	3.9	14	9
Unsupportive legal framework	Supportive legal framework	3.9	5	4	4.9	3	4				3.8	6	2	4.2	14	10
Unpredictable legal framework	Predictable legal framework	3.4	6	3	4.3	3	4				3.6	6	2	3.7	15	9

*Table 30: Summary of Market Acceptance for Belgium. Mean values (M), Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P). *If number of respondents in a category is <4 the results won't be displayed.*

BELGIUM		**Business- persons**			**Public building owners**			**Private Building owners**			**The public**			**Total**		
Number of respondents		3*			5			8			12			25		
Barrier	**Motivator**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**	**M**	**N**	**P**
High investment cost	Low investment cost				3.4	5	0	3.4	5	3	3.3	9	3	3.4	19	6
Availability of governmental support is unpredictable	Availability of governmental support is predictable				2.6	5	0	2.6	6	2	2.2	11	0	2.4	22	2
Not enough subsidies available	Subsidies available				2	5	0	3	4	3	3	10	1	2.8	19	4
Decreases value of a property	Increases the value of a property				5.2	1	4	5.1	2	6	5.6	1	11	5.4	4	21
High maintenance costs	Low maintenance cost				4.3	3	1	5.4	1	7	4.3	7	5	4.7	11	13
There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable				5.5	1	3	4.6	5	3	4.4	8	4	4.7	14	10
Too complex technology	Easily understood technology				5.4	0	5	4.6	4	4	4.9	4	8	4.9	8	17
Uncertain cost savings potential	Certain cost savings potential				5.6	0	5	5.1	1	7	4.9	4	8	5.1	5	20
Uncertain performance of technology	Certain performance of technology				5.4	0	5	5.6	0	8	5.1	3	9	5.3	3	22
New and innovative technology is risky	New and innovative technology is an opportunity				5.8	0	5	5.5	0	8	4.8	5	7	5.2	5	20
Requires more maintenance than existing heating system	Easy maintenance				4.6	2	3	5.1	2	6	4.7	6	6	4.8	10	15
Not enough solar irradiation	Good solar irradiation				5.2	1	4	5.3	3	5	5	5	6	5.1	9	15
Lack of suitable business models	Suitable business models are available				4.3	2	2	3.8	3	1	4.2	6	5	4.1	11	8
Not enough professional competence available	Enough professional competence available				4.6	1	4	4	3	1	4.6	6	6	4.5	10	11
Not enough information is available about the technology	Sufficient information is available about the system				5.2	1	4	4.6	3	5	4	6	6	4.4	10	15
Untrustworthy actors on the market	Trustworthy actors on the market				4.2	4	1	4.1	5	2	4.4	8	4	4.3	17	7
Difficult permit procedure	Easy permit procedure				6.3	0	4	5.3	2	5	4.4	7	4	5.0	9	13
Unsupportive legal framework	Supportive legal framework				4.6	2	3	4.5	3	5	3.9	9	2	4.2	14	10
Unpredictable legal framework	Predictable legal framework				3.3	4	0	3.3	7	1	3.5	9	2	3.4	20	3

Table 31: Summary of social acceptance for all countries divided by stakeholder group. Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P).

ALL COUNTRIES		**Business- persons**		**Public building owners**		**Private Building owners**		**The public**	
Number of respondents		48		15		32		58	
Negative statement	**Positive statement**	**N**	**P**	**N**	**P**	**N**	**P**	**N**	**P**
Does not generate economic savings	Generates economic savings	11	37	0	14	8	23	12	44
Waste of money	Good value for money	13	32	1	13	9	21	11	41
I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood	27	21	7	8	17	14	28	29
No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed	27	21	7	8	15	17	34	24
The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking	21	27	8	7	14	17	27	30
Unreliable technology for heating and electricity	Reliable technology for heating and electricity	7	41	2	13	6	25	10	43
Decreases social status	Increases social status by displaying environmental commitment to others	5	39	3	12	6	22	8	45
I am not interested in the technology	I am interested in the technology	1	46	0	15	5	27	5	52
Does not improve quality of my everyday life	Improves quality of my everyday life	10	37	2	10	10	18	17	34
Noisy	Silent	9	35	3	7	6	20	14	32
Decreases thermal comfort	Increases thermal comfort	13	32	2	10	4	20	12	32
The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology	18	25	5	6	6	22	17	30
Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now	21	22	3	9	8	22	27	26
The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape	13	28	9	5	15	13	27	18
It is a dirty technology that increases pollution	It is a clean technology that reduces pollution	4	44	0	15	3	27	7	51

Table 32: Summary of market acceptance for all countries divided by stakeholder group. Number of negative respondents (answered <5 to a statement) (N) and number of positive respondents (answered >4 to a statement) (P).

ALL COUNTRIES		**Business- persons**		**Public building owners**		**Private Building owners**		**The public**	
Number of respondents		48		15		32		58	
Barrier	**Motivator**	**N**	**P**	**N**	**P**	**N**	**P**	**N**	**P**
High investment cost	Low investment cost	32	14	13	2	22	9	43	9
Availability of governmental support is unpredictable	Availability of governmental support is predictable	30	16	10	5	20	10	41	8
Not enough subsidies available	Subsidies available	29	16	10	4	18	22	44	5
Decreases value of a property	Increases the value of a property	9	39	2	13	4	27	7	45
High maintenance costs	Low maintenance cost	24	24	9	5	10	18	28	19
There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable	21	25	8	6	16	14	33	16
Too complex technology	Easily understood technology	22	26	5	10	8	23	17	36
Uncertain cost savings potential	Certain cost savings potential	15	33	6	9	8	23	18	32
Uncertain performance of technology	Certain performance of technology	11	37	3	12	3	28	18	32
New and innovative technology is risky	New and innovative technology is an opportunity	6	40	4	11	6	25	16	37
Requires more maintenance than existing heating system	Easy maintenance	20	26	6	8	7	23	28	20
Not enough solar irradiation	Good solar irradiation	11	36	1	13	7	23	22	27
Lack of suitable business models	Suitable business models are available	28	20	8	6	10	14	25	20
Not enough professional competence available	Enough professional competence available	29	19	7	8	12	13	20	27
Not enough information is available about the technology	Sufficient information is available about the system	29	18	8	7	11	20	24	28
Untrustworthy actors on the market	Trustworthy actors on the market	25	23	8	6	11	19	25	25
Difficult permit procedure	Easy permit procedure	25	23	3	9	9	20	24	15
Unsupportive legal framework	Supportive legal framework	31	15	7	7	11	19	28	13
Unpredictable legal framework	Predictable legal framework	32	13	8	5	19	11	31	11

C. Survey: Key to abbreviations of variables

Table 33: Key to the variables for the respondent profile section

	Respondent profile							
RPQ1	**Involved in SunHorizon**							
	Yes			No		I don't know		
	RPQ1_Yes			RPQ1_No		RPQ1_IDK		
RPQ2	**Age**							
	18-34		35-50		51-65		>65	
	RPQ2_18_34		RPQ2_35_50		RPQ2_51_65		RPQ2__66	
RPQ3	**Gender**							
	Female			Male				
	RPQ3_F			RPQ3_M				
RPQ4	**Highest education level**							
	University degree		Secondary school		Primary school		Other	
	RPQ4_Uni		RPQ4_Sec		RPQ4_Other		RPQ4_Other	
RPQ5	**Respondent category**							
	Businessperson		Private building owner		Public building owner		The public/residents/end-users	
	RPQ5_Businessperson		RPQ5_PrBO		RPQ5_PuBO		RPQ5_Public	
RPQ6	**Occupants in household**							
RPQ7	**Household annual income**							
RPQ8	**Employment status**							
	Employed in private sector	Employed in public sector	Self-employed	Unemployed	Student	Retired	Other	
	RPQ8_EPr	RPQ8_EPu	RPQ8_SEE	RPQ8_UNE	RPQ8_Other	RPQ8_RET	RPQ8_Other	
RPQ9	**Country of residence**							
	Germany	Spain	Belgium	Latvia	Other	Italy	Sweden	France
	RPQ9_DE	RPQ9_ES	RPQ9_BE	RPQ9_LV	RPQ9_Other	RPQ9_IT	RPQ9_SE	RPQ9_FR
RPQ10	**Already adopted similar technology in company or building**							
RPQ9_EI	**Environmental index**							

Table 34: Key to the variables for the social acceptance section

	Negative statement	**Positive statement**
SAQ11	Does not generate economic savings	Generates economic savings
SAQ12	Waste of money	Good value for money
SAQ13	I do not see these technologies around the city/ region/ neighbourhood	I see the technologies frequently installed around the city region/ neighbourhood

SAQ14	No one I know has solar systems or heat pumps installed	Many people I know have solar systems or heat pumps installed
SAQ15	The media (newspapers, tv, websites) does not present these technologies as innovative and forward looking	The media (newspapers, tv, websites) present these technologies as innovative and forward looking
SAQ16	Unreliable technology for heating and electricity	Reliable technology for heating and electricity
SAQ17	Decreases social status	Increases social status by displaying environmental commitment to others
SAQ18	I am not interested in the technology	I am interested in the technology
SAQ19	Does not improve quality of my everyday life	Improves quality of my everyday life
SAQ20	Noisy	Silent
SAQ21	Decreases thermal comfort	Increases thermal comfort
SAQ22	The design and size of my home are appropriate for this technology	The design and size of my home is not sufficient for this technology
SAQ23	Comfort is not good in my home now and some technologies need to be replaced	I am very happy with my home as it is now
SAQ24	The technology will look bad in my roof and effect negatively the visual landscape	Positive effect on the visual landscape
SAQ25	It is a dirty technology that increases pollution	It is a clean technology that reduces pollution

Table 35: Key to the variables for the market acceptance section

	Barrier	**Motivator**
MAQ28	High investment cost	Low investment cost
MAQ29	Availability of governmental support is unpredictable	Availability of governmental support is predictable
MAQ30	Not enough subsidies available	Subsidies available
MAQ31	Decreases value of a property	Increases the value of a property
MAQ32	High maintenance costs	Low maintenance cost
MAQ35	There is a lot of uncertainty with regards to recouping the investment costs	Investment is recoupable
MAQ34	Too complex technology	Easily understood technology
MAQ35	Uncertain cost savings potential	Certain cost savings potential
MAQ36	Uncertain performance of technology	Certain performance of technology
MAQ37	New and innovative technology is risky	New and innovative technology is an opportunity
MAQ38	Requires more maintenance than existing heating system	Easy maintenance
MAQ39	Not enough solar irradiation	Good solar irradiation
MAQ40	Lack of suitable business models	Suitable business models are available

MAQ41	Not enough professional competence available	Enough professional competence available
MAQ42	Not enough information is available about the technology	Sufficient information is available about the system
MAQ43	Untrustworthy actors on the market	Trustworthy actors on the market
MAQ 44	Difficult permit procedure	Easy permit procedure
MAQ45	Unsupportive legal framework	Supportive legal framework
MAQ46	Unpredictable legal framework	Predictable legal framework

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