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Sun coupled innovative Heat pumps

D8.8 – SunHorizon Positioning Paper and Policy documents

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Abbreviations

Acronym	Definition
CSM	Collective Self-Consumption
DHW	Domestic Hot Water
DUU	Design Under Uncertainty
EPBD	Energy Performance of Buildings Directive
GHG	Greenhouse Gases
H&C	Heating and Cooling
ICT	Information and Communications Technology
IRR	Internal Rate of Return
ESR	Effort Sharing Regulation
LCA	Life-Cycle Assessment
NECP	National Energy and Climate Plan
non-ETS	Emissions not covered by the EU Emissions Trading System
nZEB(s)	Nearly Zero Energy Building(s)
PEF	Primary Energy Factor
PV-T	Hybrid Photovoltaic - Thermal technology
RED III	Renewable Energy Directive
RES	Renewable Energy Sources
TPs	Technology Packages

Executive Summary

The aim of this deliverable is to give policy recommendations addressed to EU policy makers to support solar technologies (solar heat pumps, solar panels and heat storage) for decarbonising the residential sector.
The approach used to identify policy recommendations consists mainly in the assessment of the outcomes coming from stakeholders collected by consultations through dedicated Workshops, surveys/questionnaires and interviews with the aim to obtain the perspectives on solar technologies from stakeholders out of SunHorizon project.

Moreover, a brief overview about new policies and regulations aimed at improving the deployment of SunHorizon technologies and an analysis of the main EU heating and cooling (H&C) strategies have been made.

Finally, based on the earlier phases, identification of policy recommendations addressed to EU policy makers has been carried out. Recommendations are focused on what is missing at the EU level to support solar technologies as massive technologies for decarbonising the residential sector.

1 Introduction

1.1 Scope

The main objective of SunHorizon project is to demonstrate innovative and reliable heat pump solutions properly coupled with advanced solar panels and thermal energy storage that can provide heating and cooling to residential and tertiary buildings.

This deliverable represents the work carried out in Task 8.3 "Capacity building and policy promotion for solar and heat pump H&C application".

The purpose of this deliverable is to provide policy recommendations addressed to EU policy makers to support solar technologies for decarbonising the residential sector.

Within this Deliverable, besides Section 1 that constitutes the present introduction and the methodology approach, the following section are included:

- Section 2 explains the stakeholders' group outcomes;
- Section 3 gives a brief overview regarding new policies and regulations aimed at enhancing the deployment of SunHorizon technologies;
- Section 4 analyses the main EU heating and cooling (H&C) strategies, particularly referring to the SET-Plan and Energy Union Objectives for H&C;
- Section 5 provides some policy messages or recommendations addressed to EU policy makers, on what is still missing at the EU level to be done to fully support solar-driven HP/solar panels as massive technologies for decarbonising the residential sector;
- Section 6 gives the conclusion.

1.2 Methodology

In this section the approach/methodology used is shown, according to the following main steps:

1. An overview of the main outcomes coming from Stakeholders collected by means of dedicated Workshops, surveys/questionnaires and interviews. The aim was to obtain the perspectives on solar technologies (both solar panels and heat pumps) from stakeholders out of SunHorizon project. In particular, the attention was focused on technical details but also on policy aspects and on the identification of barriers and/or incentives that prevent or allow SunHorizon technologies to enter the market.
2. Assessment of technical and non-technical factors.

As regards technical factors, focus is done on preliminary studies undertaken to determine, analyze, and select the optimal configuration of SunHorizon innovative technology in six virtual demonstrators for a possible replicability of them in other buildings than the pilot sites of the SunHorizon project.

As regards non-technical factors, mainly barriers of different types such as legislative, social, legal, political and environmental barriers have been assessed.

To this aim some specific deliverables have been analyzed, specifically:

- Deliverable D7.4 - "Pre-feasibility Replication Studies";
- Deliverable D7.1 - "SunHorizon Technologies social and market acceptance";
- Deliverable D7.7 - "Report on standardization and non-technical barriers";
- Deliverable D7.2 - "SunHorizon Technologies benefit impact in terms of emissions".

3. A brief overview regarding new policies and regulations aimed at enhancing the deployment of SunHorizon technologies in countries where SH demo sites will be installed, and countries identified for the "virtual demonstrators" (deliverable D7.4) was carried out.
4. The EU Heating & Cooling Strategies have been analysed in a dedicated section with the aim to analyse the main policies and legislations at the EU level.

5. Some Policy Recommendations addressed to EU policy makers, on what it is still missing at EU level to be done to fully support solar driven heat pumps and solar technologies as massive technologies for decarbonising the residential sector, are shown in the last section of this deliverable.

2 Stakeholders' outcomes

In this section the main outcomes coming from Stakeholders' consultation are highlighted. Consultations were done through dedicated Workshops, surveys/questionnaires and interviews.

Two stakeholders' workshops (one dedicated to the solar and one for heat pump sector) have been organised to continuously query SunHorizon objectives and results from perspectives out of the SunHorizon consortium:

1. The first workshop, focused on solar technologies and innovation, aims to provide not only technical details but also give an overview on the policy aspects relevant for the solar market, thus to identify possible barriers and/or incentives.
   It emerges, from the SET plan historical analysis, that most of the calls were addressing all electricity solutions while not covering the heating source, supposing addressed under more general calls like Building, Industry or Transport, while 1.2 TWh is the highest contribution of renewable heating and cooling in the EU total final energy demand.
   On the possibility to include the combination of solar cooling (ST, PV, PVT) with geothermal cooling in the scope of "Task65 Solar cooling in the sunbelt", an observation has been made to remind that whenever each is to perform quite well with regard to the savings/cost's ratio, these technologies put together will show yet increased performance, but significantly increased costs as well, uncertain to still fit to a smooth transition from now on.
   SunHorizon is then paving the way in the directions drawn by external speakers' messages: indeed, within SunHorizon, all real demonstration cases are addressing thermal demand from solar thermal, and aggregated altogether, they achieve comparable scale to the power sector large-scale demonstrators.
   Further research could understand of how the cooling demand is pushing for PV solutions (increased local productivity when profuse solar resource available) for electrical vapour compression chillers (from preliminary assessment studies, these cases are achieving the highest CO_2 emissions savings scores among the SunHorizon demo sites).
2. The second workshop has been focused on heat pump (HP) technologies and innovation in this field within SunHorizon project. Furthermore, the ESCO perspective was given to share the business models associated with HPs. SunHorizon technology packages could be a solution in these cases as they lower the emissions compared to conventional solutions, are optimized, and, as they are combined with solar, the performance is higher.

Moreover, thanks to the survey, interview and analysis conducted in D7.4 "*Pre-Feasibility replication studies*", D7.1 "*SunHorizon Technologies social and market acceptance*", and D7.7 "*Report on standardization and non-technical barriers*", it is possible to analyse the factors - both technical and non-technical – that prevent or allow SunHorizon technologies to enter the market.

2.1 Technical factors

This section is focused on the "technical factors" that prevent or allow SunHorizon technologies to enter the market. In particular, focus is done on deliverable D7.4 - "Pre-feasibility Replication Studies".

The purpose of deliverable D7.4 is to present six Pre-feasibility studies of SunHorizon Technology Packages (TPs) focused on virtual demonstrators, i.e.: buildings of different typologies (residential and tertiary) and located in different climate zones.

It is worth mentioning that the analysis involves preliminary studies undertaken to determine, analyze, and select the best business scenarios. In fact, D7.4 considers a predesign and preliminary assessment of the SunHorizon TPs, to evaluate the optimal configuration of SunHorizon innovative technology in six virtual demonstrators for a possible replicability of them in other buildings than the pilot sites of the project.

The application of SunHorizon TPs has been assessed considering technical aspects, legal aspects as well as economic aspects (i.e.: feasibility of the installations). Partners of Task 7.3 were involved for the assessment of the

three above mentioned aspects, specifically CNR/ITAE, CARTIF and BDR for the technical aspects, VEOLIA for the economic aspects and SANT CUGAT for the legal aspects.

To perform the 6 Pre-Feasibility Replication studies for buildings of different typologies and located in different climate zones, RINA, proposed different possibilities in term of EU climate areas mapping systems (e.g.: EcoDesign Directive, Köppen-Geiger system, download data from PVGIS on a national level, classification used in SunHorizon D2.2).

T7.3 partners agreed on mapping EU using EcoDesign system mainly because is the one used to classify the seven Sunhorizon demo-sites and is the European Reference for climate conditions which divides Europe into 3 "Climate Zones for Heating Mode" with the aim of calculating the energy efficiency taking into consideration the actual regional ambient temperatures: cold (Northern Europe- annual temperature of Helsinki), average (Central Europe- annual temperature of Strasbourg) and warm (Southern Europe- annual temperature of Athens).

Based on this clusterization system and, according to the possible presence of local partners within T7.3 or the whole project Consortium partners, countries and cities were selected as follows:

Table 2.1: EU Climate Area

EU Climate Area	City and Country
Cold	Goteborg (Sweden)
Average	Rotterdam (Netherlands)
Warm	Rome (Italy)

T7.3 partners decided to split the 6 pre-feasibility studies into 3 residential (multi-family house) and 3 tertiary (offices) typology of virtual buildings. Therefore, the studies will be carried out on 2 buildings for Sweden cold zone (1 Res, 1Ter), 2 for Netherlands average zone (1Res, 1Ter) and 2 for Italy warm zone (1 Res, 1Ter).

Technical activities have been performed starting from the excel-based Tool developed by RINA-C in the WP4, Task 4.3. The tool is prepared and tested for both residential and non-residential buildings. In D7.4 it was applied to four Technology Packages (TPs):

- TP1 (BoostHeat heat pump; Ratiotherm tank; TVP solar panels) and TP2 (BoostHeat heat pump; Ratiotherm tank; Dual Sun PV-T panels) are meant for DHW and heating supply.
- TP3 (Fahrenheit sorption chiller; compression chiller; Ratiotherm tank; TVP Solar Panels) and TP4 (BDR air-to-water heat pump; heating/cooling Tank; DHW/Ratiotherm tank; BAXI PV panels; BAXI Solar Panels) are meant for cooling, heating and DHW supply.

The excel-based Tool was applied to each of the **six buildings** to check if the energy produced by heat pumps and solar panels can cover the heating, cooling, and DHW demand of each TP for each building (e.g., residential and tertiary). For each building, based on the optimal combination of discomfort rate and costs, the Tool selected the proper configuration of TPs and pieces of equipment. In particular, the excel Tool estimated the equipment size, the energy produced by the equipment included in each TP (e.g.: heat pumps, solar panels), and both capital and energy costs of each piece of equipment considering the uncertainties related to the input parameters for the peak load and the energy demand calculation.

As regards the economic aspects, by means of Business Models, the financial parameters (e.g.: IRR, NPV, Pay-back time, cash flows, savings) for each TP of each building were calculated to assess the economic feasibility of each installation.

The outcomes showed that, in the case of moderate/Mediterranean climates, the most suitable options are both TP1 with IRRs between 10.17% and 20.21%, and TP4, ranging from IRRs between 19.09% and 19.95%.

TP2 seems to be not so profitable since it couples hybrid PV-T RES generation with BoostHeat gas-driven heat pump. The higher cost of energy generation and the need of relying on quite a significant amount of operating hours of BoostHeat heat pump provides more efficient gas consumption (up to 40% of thermal savings) but provides a surplus of electric energy that right now is not consumed in the building; therefore, it must be fed into the grid with

a poor compensation in return in most of EU countries right now. More details on this aspect are shown in Section 3.

Although moderate/Mediterranean climates do have significant cooling demands, the proposed TP3 option seems to be quite oversized as the DUU excel Tool considers very significant peak loads for those scenarios.

In the case of severe/Northern climates, TP4 is the best choice, although the irradiance is significantly lower. It matches with the needs of a reversible and electrically driven heat pump like BDR's coupled to PV-only or PV-T generation. In an even more harsh cold climate like Sweden, TP4 offers an IRR of about 10% and a payback period of about 8 years, showing that this technology coupling is great even in further northern areas.

Concerning the legal aspects, the aim was to investigate the legal building requirements in European countries, with a focus on the three countries with different climatic conditions identified as locations of the six virtual demonstrator buildings (Italy, The Netherlands and Sweden). A total of 11 answers from five countries (Sweden, Netherlands, Italy, France, and Spain) were obtained. The outcomes deriving from the answers provided by the respondents of the EU legal survey showed that:

- All countries have support mechanisms to promote the use of RES. Some with specific rules and regulations and others apply for aid and financial support for the installation of solar panels.
- All information received is at the country level but there is a lack of regulation at the regional and local levels. Two national strategies can be observed: one in the production of renewable energies and the other one in the reduction of energy consumption in buildings and the limitation of fossil fuel consumption.
- Regarding mechanisms to control *architectural or aesthetical restrictions* in existing or new buildings, local regulations are strong enough to forbid the use of panels on the roofs of buildings.
- As regards the Regulation that establishes *thermal comfort requirements* in temperature and humidity in existing and new buildings, the responses received do not provide enough information to differentiate the criteria of thermal comfort for each of the countries, but all countries have regulations governing it.
- As regards the presence of *support incentives schemes* for energy self-consumption, from the responses provided in the survey it emerged that all countries, except Sweden, have subsidies and aids for the installation of renewable energy in their buildings.

2.2 Non-technical factors

In this section "non-technical factors" that prevent or allow SunHorizon technologies to enter the market are highlighted. Non-technical factors are mainly barriers of different types such as economic, social, legislative, and environmental barriers. In particular, the main outcomes arising from some deliverables are highlighted in the following.

For example, deliverable D7.1- "SunHorizon Technologies social and market acceptance" explores the needs and requirements of relevant stakeholders in terms of social and market acceptance. 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.

In D7.1, the heat pump market analysis showed an increasing trend in the EU and further growth is expected for heating, cooling and sanitary water. The two main barriers identified for the heat pump market are 1) the initial investment cost, and 2) the price ratio between electricity and natural gas and energy systems issues, such as expansion capacity in the power grid.

The solar market analysis identified solar as a growing market within the EU for electricity generation and thermal energy. The two main barriers identified are: 1) the lack of access to finance, and 2) that EU legislation on energy performance only covers new buildings which is a minority of the total building stock. More details about this aspect are provided in Section 3.

The EU policies addressed decarbonizing the H&C sector, increasing the share of renewable in the energy system and the energy efficiency in the building, are the main opportunities for SunHorizon technology. As new buildings are estimated to account only for 25% of Europe's building stock in 2050, it is necessary to implement stricter energy requirements on the existing building stock and increase the renovation rates. More details about this aspect are shown in Section 3.
The scientific literature review identified three main aspects of the adoption of renewables:

- The availability of information about technology. It 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, that 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 the main barriers to adoption. These observations from the literature review have been confirmed by the results of the survey.
- Socio-demographic factors (e.g.: income level and educational level). 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.

Moreover, 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 of incentives and information appear to be more influential.
Finally, the survey conducted in D7.1 was completed by 153 respondents of which 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, perceive that technology negatively impacts 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 the investment cost as a barrier to adoption. In Latvia, Belgium and Spain legal and political aspects were also identified as barriers. In Spain, aspects related to 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 perceive the least number of barriers and all barriers are related to economic aspects.

In deliverable D7.7 - "Report on standardization and non-technical barriers", **people's perceptions** about heat pump and solar thermal integration as potential turnkey technologies of Heating & Cooling (H&C) sector and consequent aspects that may pose limitation to market entry of these technologies and how to overcome those possible barriers are explored.
As results from the investigation, the main non-technical barriers that may pose limitation to market entry of coupled innovative heat pumps in buildings, have been identified in:

- **Economic** aspects: large initial investment (CapEx) and long payback periods.
  Suggestions to alleviate the economic barriers that came up during the surveys: carbon tax on fossil fuels and materials; cost reduction of the Technology Packages; digitalization of the H&C sector to reduce costs; better communication of the long-term benefits

- **Social** barriers are linked with the resistance to change and limited space available in homes or the lack in competence, knowledge and/or awareness for people involved in the installation and maintenance phases of TPs that combine heat pumps with photovoltaic and/or solar thermal technologies.
  Suggestions to alleviate the social barriers: marketing solar technologies, public awareness of the economic advantages of renewable H&C technologies; increased market scale; cooperation between suppliers.
- **Legal** barriers: lack of specific regulation for heat networks, lack of knowledge for regulatory authorities (approval process for project proposals, new technologies' need to ensure compliance with requirements), need of certification of complete technology package (heat pump with solar integration).
  Policy support do not consider certain technology packages or combinations products such as Photovoltaic Thermal (PVT) although both solar thermal and solar PV can be supported by existing policies.
  Suggestions to alleviate legal barriers: decision support for policy makers; certification and standardization of the package technology aiming at increased acceptance by end-users and key stakeholders (e.g.: engineering consultants, manufacturers, etc.).
- **Political** obstacles: incumbent fossil energy; need of increased support to solar energy
  Suggestions to alleviate political barriers: Compulsory target of low-carbon heat and cooling production on EU and/or national level; phase out of fossil gas; ban on gas heating.

In deliverable D7.2 "SunHorizon Technologies benefit impact in terms of emissions" the main environmental performance and monetized health and climate benefits from the implementation of SunHorizon technologies have been investigated. Although the project developed five TPs, no empirical data has been available for TP4 and TP5.

The life-cycle assessment (LCA) is focused on the environmental impacts of SunHorizon technologies installed at the demonstration sites compared to the corresponding impacts in the baseline scenario (with existing H&C technologies and no new SunHorizon technologies). The analysis considers environmental impacts such as global warming, ozone depletion, fossil abiotic depletion, photochemical ozone creation, acidification and eutrophication.

The preliminary results show as a general trend that the deployment of SunHorizon technologies has an environmental investment cost for the production, distribution, installation and final use of equipment (solar panels, heat pumps, accumulation tanks), but this environmental cost is a trade-off, compensated by environmental benefits in the operational stage in most impact categories. For all technology packages, the scenario where SunHorizon technologies are deployed results in higher impacts for abiotic depletion of resources and lower impacts for global warming, ozone depletion, fossil abiotic depletion and photochemical ozone creation. Meanwhile, acidification and eutrophication result in lower impacts for all technology packages except TP1.

Health and climate benefits from the implementation of SunHorizon technologies are estimated for target years 2030 and 2050 for three SunHorizon scenarios:

1. SunHorizon technology package 1 (SH_TP1).
2. SunHorizon technology package 2 (SH_TP2).
3. SunHorizon combo (SH_c), including TP1 and TP2.

The total monetized health and climate benefits in EU-28 from the implementation of SunHorizon technologies are presented in the table below.

Table 2.2: Total health and environmental benefits in EU-28 from the implementation of SunHorizon technologies in the residential and tertiary sector.

Impacts	2030			2050		
	SH_TP1	SH_TP2	SH_c	SH_TP1	SH_TP2	SH_c
Human Health, low	7 100	8 400	7 800	14 500	17 800	16 200
Human Health, mid	17 700	21 000	19 300	43 300	53 100	48 200
Human Health, high	41 600	49 300	45 500	103 000	126 100	114 500
CO_2, low	2 400	2 500	2 450	6 000	6 200	6 100
CO_2, mid	11 600	12 000	11 800	28 900	30 100	29 500
CO_2, high	21 800	22 800	22 300	54 600	56 900	55 700
Total, low	**9 500**	**10 900**	**10 250**	**20 500**	**24 000**	**22 300**
Total, central	**29 300**	**33 000**	**31 100**	**72 200**	**83 200**	**77 700**
Total, high	**63 400**	**72 100**	**67 800**	**157 600**	**183 000**	**170 200**

When estimating health and environmental effects due to the use of SunHorizon technologies in comparison to the use of conventional heating and cooling technologies, significant benefits are found. For most of the emitted substances included in the analysis, emission factors for SunHorizon technology packages are lower than for conventional H&C technologies, which results in an emission decrease in SunHorizon scenarios, compared to the baseline development in 2030 and 2050. The benefits partly occur from reduced climate impact of emitted greenhouse gases, but mostly – from reduced negative health effects caused by air pollution. Emission reductions are larger in the SH_TP2 scenario than in SH_TP1, which is explained by lower life-cycle emission factors for air pollutants of TP2 technologies. Lower emissions of main pollutants from SunHorizon technologies, compared to conventional technologies, result in lower concentrations of primary and secondary PM 2.5 and ground-level ozone, and subsequently reduced premature mortality and other negative health effects.

Quantification of environmental and health effects and setting monetary values on the related benefits provides investors and strategic decision-makers with scientific background analysis for justification of SunHorizon technologies' wider deployment in the coming years.

The results of the LCA show that the implementation of the different SunHorizon technologies across the different demonstration sites results in significant environmental benefits in terms of climate change and consumption reduction of fossil fuels. This means that the large-scale deployment of SunHorizon technologies replacing conventional heating and cooling technologies would largely reduce the environmental footprint of the building stock, contributing to the objectives of carbon neutrality that the European Union has set for the next decades. However, these benefits are coupled to increased consumption of resources, because of the construction and installation of the different components that are part of SunHorizon technologies. Suitable strategies to reduce the consumption of raw materials should be adopted, such as the use of secondary raw materials and service-life extension.

3 New Policies/Regulations aimed at encouraging the development and deployment of solar technologies

The aim of this section is to provide a brief overview regarding new EU policies and regulations and legislation aimed at encouraging the development and deployment of solar technologies including the excess of PV's electric energy production, the energy performance on refurbished buildings and new buildings and the incentives or tax exemptions.

Focus has been made on both countries where demo sites are installed (e.g.: Spain, Germany, Romania and Latvia) and on countries identified for the assessment of the replicability of SH technologies in six virtual demonstrators (e.g.: Italy, Sweden and The Netherlands).

3.1 Spain

New regulations in Spain are boosting Local Energy Communities regarding the excess of PV's electric energy production. Buildings' owners can share this energy with any other building (public or private with an energy distribution contract); it is possible to share with other buildings up to 2Km distance.

New policies are designed to encourage the development and deployment of solar technology by providing financial incentives, setting performance standards, and creating frameworks for the integration of systems into existing grids.

For example, for the Real Decreto-law 20/2022, in Spain:

- More than one licensee could be using the same roof with different photovoltaic installations.
- Renewable energy communities can be the "Self-consumption manager" of a representative of consumers.
- Administrative simplification for any small renewable generation facility up to 500 kW.

3.2 Germany

As regards Germany focus is on a new version of the German Renewable Energy Law, the "EEG 2023- Renewable Energy Sources Act (EEG), Federal Government Promotes Energy Transition"[1] encouraging the generation of renewable energy. The government has also agreed on mandatory photovoltaic systems for commercial buildings[2] while, for residential new buildings, the coalition wants the installation of **photovoltaic** systems to become the rule.

The lowering of the electricity price is also of central importance for the new federal government to more strongly electrify the heating and transport sectors, in particular. In the coming year, the EEG surcharge should therefore be financed through the federal budget and no longer through the electricity bills paid by consumers. The government hopes that **heat pumps** and electric cars will become more attractive.

With regards to German incentives about solar technologies the following list recaps the most important points:

- Anyone operating a photovoltaic system with an output of up to 30 kW on a single-family home or commercial property will no longer have to pay income tax on the electricity yield from the beginning of 2023. The German government approved the measure in its Annual Tax Act 2022[3].
- This tax exemption also applies to multi-family houses and mixed-use properties owning a PV system with an output of 15 kW
- In addition, the value-added tax (VAT) will no longer be due on the purchase, import, and installation of photovoltaic systems and energy storage systems. The prerequisite for this is that the systems are installed

[1] https://www.thesmartere.de/industry-news/eeg-2023-federal-government-promotes-energy-transition

[2] https://www.pv-magazine.com/2022/01/12/new-german-government-presents-new-package-of-measures-to-support-pv/

[3] https://www.pv-magazine.com/2022/09/16/germany-introduces-tax-breaks-for-rooftop-pv/

on or near private homes and apartments as well as on public and other buildings that are used for activities serving the common good.

- Call for decentralized PV solutions: Community energy cooperatives will be allowed to install systems with a capacity of up to 6 MW without requiring a tender in the future. When it comes to subsidized tenant power installations, the capacity limit of up to 100 kW has been abolished.

3.3 Romania

As regards Romania, focus is on the "Romania Renewable Energy Policy Handbook, 2023 Update".

This report covers policy measures and incentives used by Romania to promote renewable energy; it offers comprehensive information on major policies governing the renewable energy market in the country and provides information on renewable policies/developments at a regional/municipal level.

Romania Plans RON 3 billion Allocation for Residential PV Deployments Under National Green House Photovoltaic Program of Romania[4] to Face Energy Crisis.

The government is looking at expanding the access of energy through solar PV panels under the program to 'as many people as possible'.

The main Romanian solar incentives are shown in the following:

- The Romanian parliament adopted a reduction from 19% to 5% on value-added tax (VAT) on PV panels for use in residential homes and public buildings;
- The law does not provide any installation size limit to benefit from the reduction;
- 2023- simplifying permitting and installation requirements to 'avoid excessive bureaucracy' which doesn't help the government or citizens;
- Romania introduced the "Casa Verde Fotovoltaice project" in 2019 to cover up to 90% of capital expenses of solar systems for residential segment with a minimum capacity of 3 kW;
- Romania authorizes bilateral PPAs, raises size limit for solar under net metering to 400kW[5]: with Emergency Ordinance no. 143/2021, the Romanian government has restored legal certainty for bilateral power purchase agreements (PPAs) and has created more favorable conditions for solar power generators under net metering regime.

3.4 Latvia

Latvia has a high level of hydro in its energy mix, and less incentive to build PV. However, the Baltic States are far behind the EU average in terms of use of solar panels, and Latvia's contribution to total installed capacity in the region is only 2%[6].

Yet, there is no plan nor target or auctions for the installation of solar technologies. This does not give investors enough visibility for their investments. A specific plan should be set to encourage prosumers, based on support schemes, tax exemptions, and the development of collective self-consumption.

[4] https://taiyangnews.info/markets/romania-to-boost-residential-solar-installations/

[5] https://www.pv-magazine.com/2022/01/13/romania-authorizes-bilateral-ppas-raises-size-limit-for-solar-under-net-metering-to-400kw/

[6] https://www.bluorbank.lv/latvija/en/the-state-of-solar-power-in-latvia-the-sun-isnt-shining-yet

3.5 Italy

The Italian government has published a new package of measures, the DL Energia decree[7], to reduce energy bills for Italian households and businesses; in particular:

- The new provisions include an *extreme simplification of permits to install commercial rooftop PV* systems with a capacity of between 50kW and 200kW, which in Italy are allowed to operate under the country's net metering scheme, known as the "Scambio sul posto."
- The Italian government has also decided to allocate €267 million ($294 million) to help small- and medium-sized enterprises to deploy PV systems for self-consumption. The funds will be used for rebates that will help businesses cover some of the costs to buy and install the solar arrays.
- In industrial areas the installation of PV and thermal solar plants covering a surface area of no more than 60% of a relevant industrial area is allowed. These plants may be installed on specially built supporting structures.
- Fiscal sweeteners will also be granted to enterprises operating in the southern Italian regions of Abruzzo, Basilicata, Calabria, Campania, Molise, Puglia, Sardegna and Sicilia. The incentives will be provided to companies that decide to reduce their energy bills by investing in solar or energy efficiency.
- July 2022- Italy publishes new national guidelines for agrovoltaic plants:
  - ✓ Agrovoltaic systems that can, at a minimum, ensure an interaction between energy production and agricultural production; and
  - ✓ Advanced agrovoltaic systems, which are also eligible for incentives.
- https://www.wfw.com/articles/italys-energy-decree-innovations-and-observations-regarding-renewables/
- Under the Energy Decree, a plant operator can produce and store renewable electricity for its own consumption (and become a "self-consumer") by means of one or more renewable energy production plants located in buildings or sites other than those where the self-consumer operates, provided that such buildings or sites are at the self-consumer's disposal. In these cases:
  - ✓ a) the plant may be connected to the final customer by a direct connection that does not exceed 10 km, and which shall not be connected to users other than those of the production unit and the consumption unit. The direct connection cable between the production plant and the consumption unit, if underground, is authorized in the same way as the production plant. The self-consumer plant may be owned or operated by a third party under certain conditions; and
  - ✓ b) the self-consumer may use the existing distribution grid to share the energy produced by the renewable energy plants and consume it at the collection points owned by the self-consumer itself.

3.6 Sweden

From January 1st, 2022, Swedish government has expanded the exceptions from the so-called network concession in the Electricity Act, *enabling sharing of electricity between buildings using local* low voltage networks in Sweden. Such local networks can be built within a building/property as well as between several properties. If the network covers more than one property, each property must still have a connection to the national power grid since the low voltage networks are mean to be a complement to the national grid. No maximum area/length of network is stated, instead the technical design of a low voltage network is refered to as the limiting factor regarding size.

The new terms for building local grids is expected to enable production, sharing, storage and use of electricity in a more optimized way. It can enhance the flexibility in electricity demand towards the national grid and therefore support a more dynamic national electricity production. Thereby it enables an increased share of renewable electricity both locally and on a national/regional level.

The basis of the Swedish building regulations (BBR) is that it applies to new construction. But it also means that relevant parts must be applied during renovation. So, for energy for example, there are requirements for SFP-

[7] https://www.wfw.com/articles/italys-energy-decree-innovations-and-observations-regarding-renewables/

values for ventilation that can be applied during the reconstruction of ventilation systems, and requirements for U-values that can be applied during the reconstruction of the building envelope.

There is also a law on energy declarations, which requires property owners to provide an energy declaration for their building if it is being sold, rented out, or if there is a major renovation taking place. The property owners must display an energy label in a visible location in the building, however the law has no specific requirements for energy class (performance) in renovation.

Since 2015, individuals and legal entities producing renewable solar energy in Sweden receive a tax reduction on the solar energy they sell to the power grid.

Starting from January 1st, 2021, you can receive a tax deduction for parts of the cost if you hire a company for the installation of green technology. The deduction can be up to 20% for the installation of solar panels and 50% for the installation of systems for storing self-produced electricity or installation of charging points for electric vehicles.

Moreover, there are also administrative simplifications for any small renewable generation facility up to 500 kW.

3.7 The Netherlands

As regards The Netherlands in 2022 the current legislation in the Netherlands does not define "Energy Communities" but allows recognized associations of citizens (e.g.: cooperatives**)** to install and own local grids and to participate in the electricity market with a limited number of rights**.**

In recent years, attempts to implement a successive experiment regulation have failed due to their ambitious scope extension and interference with new EU regulations. The most relevant legal development in this regard is the new Energy Law, a comprehensive law to replace the Electricity and Gas Act (1998) foreseen to be effective by the end of 2022. This law is intended to become the foundation for the energy transition in the Netherlands, aiming to develop a future-proof regulatory framework for the rapidly changing electricity market and system.

The energy performance requirements in existing buildings: similarly, to new buildings, major renovations are required to have a building permit that meets minimum requirements for building components, e.g., the R-value of walls, roof and floor, and the U-value of windows and doors. Renovation is major when more than 25% of the building envelope is renovated. The calculation of the energy performance coefficient is also mandatory for large renovations in houses and offices. For minor renovations, there are only minimum requirements for the R-value of walls, roof and floor, and U-value of windows and doors. In such cases, no energy performance calculation or building permit is required.

It is worth mentioning that there is a sustainable energy transition subsidy scheme (SDE++) for renewable electricity[8]. This subsidy is intended for companies and organizations (non-profit and otherwise) in sectors such as industry, mobility, electricity, agriculture and the built environment[9].

[8] https://business.gov.nl/subsidy/sustainable-energy-production/

[9] https://english.rvo.nl/subsidies-programmes/sde - Stimulation of sustainable energy production and climate transition (SDE++)

4 EU H&C Strategies

In this section the main policy and legislations at the EU level have been analyzed.

4.1 Renewable Energy Directive (2018/2001/EU)

The original Renewable Energy Directive (2009/28/EC) establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets.

In December 2018, the revised Renewable Energy Directive 2018/2001/EU entered into force, as part of the Clean energy for all Europeans packages. The Directive establishes a binding renewable energy target for the EU for 2030 of at least 32%.

In July 2021, the European Commission proposed a revision of the Renewable Energy Directive (RED III). The proposal is focused on increasing the EU-wide target for renewable energy sources in the overall energy mix to at least 40% by 2030. Also, it establishes a comprehensive framework for the deployment of renewables in all sectors of the economy. The sector integration of renewable energy is important to develop renewable heating and cooling systems; this is possible by supporting innovative technologies, such as heat pumps, geothermal and solar thermal technologies.

The Renewable Energy Directive will:

- Make easier to integrate renewables into the grid (e.g., developing new technologies by integrating renewable energy sources)
- Provide stronger incentives for electrification (e.g., heat pumps)
- Encourage energy efficiency and circularity
- Set a new EU-level target of 40% renewables in the energy mix
- Set a benchmark of 49% of renewables in buildings
- Increase the use of renewable energy in heating and cooling by 1.1 % point every year
- Raise the use of renewable energy in district heating and cooling by 2.1 % points every year

The heat pump industry strongly supports high renewable energy targets from which it indirectly benefits. Indeed, the heat pump is a renewable energy technology making using of ambient, geothermal energy or energy in sewage water. Heat pumps also contribute to renewable energy targets, both the overall targets and the new specific (yearly increase) target on renewable heating and cooling introduced as non-binding request to Member States under the 2018 Renewable Energy Directive. The Renewable Energy Directive also promotes minimum shares of renewable energy in buildings.

In order to incentivize the application of these innovative technologies in residential areas, it is required by the Directive the simplification of administrative permit-granting procedures and set clear deadlines for the authorities. Moreover, policymakers should encourage more effective handling of the processes and lower administration costs. Indeed, long administrative processes are expensive and a major administrative barrier. According to the Directive, Member States should ensure guidance to all relevant actors, especially planners and architects. Hence, they are able to consider the appropriate combination of energy from renewable sources when planning constructions in industrial, commercial or residential areas.

4.2 REPowerEU

Through the REPowerEU, the European Commission outlines a plan to make Europe independent from Russian fossil fuels well before 2030, starting with gas, considering Russia's invasion of Ukraine. This plan also outlines a series of measures to respond to rising energy prices in Europe and to replenish gas stocks for next winter. REPowerEU seeks to diversify gas supplies, speed up the roll-out of renewables and replace gas in heating and power generation. It aims to reduce EU demand for Russian gas by two-thirds before the end of 2022.

Renewable energies are the cheapest and cleanest, and since they can be produced domestically, it lessens the demand for energy imports. The Commission recommended raising the EU's 2030 renewable energy target from its current 40% to 45%. By 2030, the REPowerEU Plan will increase the overall renewable energy generating capacity to 1.236 GW, up from Fit for 55's projection of 1.067 GW.

The implementation of photovoltaic energy will be accelerated by the EU Solar Energy Strategy. This Strategy, which is part of the REPowerEU plan, intends to double the amount of solar photovoltaic capacity now installed by 2025 to over 320 GW and to reach over 600 GW by 2030. By 2027, this frontloaded extra capacity will replace the yearly use of 9bcm of natural gas.

The REPowerEU Communication includes a fast-forward target of 10 million hydronic heat pumps to be installed by 2026 aiming at doubling the installation rate, and a total of 30 million newly installed hydronic units by 2030/31. Extrapolating this to all heat pump technologies covered in EHPA statistics would represent more than 18 million heat pumps by 2026 and 53 million heat pumps by 2031.

4.3 Directive on Energy Efficiency (2018/2002)

In 2018, as part of the 'Clean energy for all Europeans package', the new amending Directive on Energy Efficiency (2018/2002) was agreed to update the policy framework to 2030 and beyond. The key element of the amended directive is a headline energy efficiency target for 2030 of at least 32.5%. Under the amending directive, EU countries will have to achieve new energy savings of 0.8% each year of final energy consumption for the 2021-2030 period. Other elements in the Directive include stronger rules on metering and billing/allocation of costs of thermal energy, an updated primary energy factor (PEF) for electricity generation and new rules on comprehensive assessments on heating and cooling.

In July 2021, the European Commission put forward a proposal for a new Directive on Energy Efficiency as part of the package "Delivering on the European Green Deal". Among others, the proposal intends:

- To raise the targets to 39% of energy efficiency savings in primary energy consumption and 36% of energy efficiency savings in final energy consumption
- Introduce indicative Member State contributions to the EU-level energy efficiency target
- Introduce a legal requirement to put energy efficiency first in planning and investment decisions
- Establish a new target for Member States to reduce energy use in the public sector by 1.7% every year

Member States shall encourage and support regional and local to prepare local heating and cooling plans. It contains increased requirements on waste heat in the comprehensive assessments for heating and cooling. And most important, energy savings - as a result of policy measures regarding the use of direct fossil fuel combustion - shall not count towards the fulfilment of energy savings obligation as from 1 January 2024.

The heat pump industry strongly supports high energy efficiency targets from which it indirectly benefits and strongly contributes. Furthermore, the Energy Efficiency Directive contains specific provisions that promote efficiency in heating and cooling. A lower PEF better reflects the efficiency of heat pumps and the industry supports its revision on a regular basis for consistent use in EU energy product regulations, such as Ecodesign.

4.4 Fit For 55

The road to cutting greenhouse gas emissions by 2030 requires effort from across society and sectors. The European Union finalised its plan against greenhouse gas emissions through the Fit for 55 package to set the path for the next ten years.

Released in two batches in July and December 2021, the Fit for 55 package includes drafts of EU climate and energy legislation with the aim to cut greenhouse-gas emissions by at least 55% in 2030 compared with 1990 levels. This target is even more ambitious than the previously agreed 40% reduction goal for 2030. It is set within

the framework of EU's aim to become climate-neutral by 2050 – and to spur the rest of the world to act under the 2015 Paris Agreement to fight climate change.

The package is the biggest revision of climate and energy legislation to date. As a set of interconnected proposals, the industrial objectives of the package are:

- To reduce reliance on fossil fuels including coal, oil and natural gas
- To expand the use of renewable energy sources including solar, wind and hydropower
- To accelerate the development of electric cars
- and to spur clean-energy options for aviation and shipping

According to the Fit for 55, all buildings in the EU should be zero-emissions buildings by 2050. This is going to be done through several actions:

- Energy performance certificates will be obligatory for all new buildings
- Solar energy technology must be installed on all new/under renovation public and non-residential buildings, and on all new residential buildings by 2030
- Setting up sector-specific sub-target and measures for 2030:
  - ✓ Buildings have to use 49% of renewables by 2030
  - ✓ Heating and cooling sector has to use +0.8% of renewables annually until 2025; then, it becomes +1.1% until 2030

The document also suggests EU incentives to encourage renovations, such as financial help, tax reduction, and administrative support.

4.5 EU Strategy on Energy System Integration

Sector integration aims at linking the various energy carriers - electricity, heat, cold, gas, solid and liquid fuels - with each other and with the end-use sectors, such as buildings, transport or industry. This allows the optimisation of the energy system, rather than decarbonising and making separate efficiency gains in each sector independently. The new EU Strategy involves various existing and emerging technologies, processes and business models, such as information and communications technology (ICT) and digitalisation, smart grids and meters and flexibility markets. However, several barriers still prevent energy system integration from fully materialising and allowing citizens and industries to embrace cleaner energy alternatives.

The cross-sectoral links in the EU's current system need to become stronger to create the conditions, which enable and encourage further integration. The objective is to have different energy carriers capable to compete on a level playing field and to use every opportunity to reduce emissions.

An energy system's integration is also necessary to achieve cost-effective decarbonisation of the EU economies. It will build a more flexible, more decentralised, and digital energy system, in which consumers are empowered to make their energy choices.

It is important to consider that the system integration will likely follow different pathways in each EU country, depending on their respective starting points and policy choices. Some of these are already reflected in the National Energy and Climate Plans for 2021-2030.

As part of the European Green Deal and to encourage this smart sector integration, the Commission presented an EU Strategy for energy system integration on 8 July 2020. The energy system integration is facilitated by the correct and timely implementation of the eight legal acts of the Clean energy for all Europeans package, adopted in 2018-2019.

The new EU Strategy - in synergy with a new dedicated strategy on hydrogen in Europe - will lay the foundation for the decarbonised European energy system of the future.

To prepare the Strategy, the Commission invited stakeholders and citizens to provide feedback on the strategy roadmap, through direct or online contributions, which closed on 8 June 2020.

The heating in the residential sector across Europe is still dominated by fossil fuels. According to the latest data, in 2020 natural gas is used for 74.5% of space heating and 19.3% for water heating in the EU[10]. The load profiles of solar PV and heat pumps are well-matched year-round, and when used together, they maximize the reduction of consumers' energy bills. In 2022 we assisted in a record growth of both technologies. The solar PV market grew by 47% with 414 GW of annual installations in 2022[11]; while heat pump installations increased by 42% to reach 2.4 million units in the same period[12].

According to the SolarPower Europe Report, the combination of solar PV and heat pumps brought the highest savings for households in the three countries analysed (Germany, Spain and Italy) during the energy crises in 2022. The heat pump's electricity needs are met by solar PV, which also helps both households reduce their carbon footprint and lower their energy bills. For a successful combination of solar PV and heat pumps and to fully realize the commercial potential of these technologies, it is essential to install a buffer storage tank alongside a heat pump. In SolarPower Europe's study, they used an average buffer storage size of 400 litres (for Italy, Spain, and Germany) to 800 litres. In this way, the warm water can be collected and used later, increasing the home's capacity for self-consumption. The system integration has also an economic impact. Indeed, when compared to the medium-sized household case study, where the only source of electricity is the grid and the only source of heating is a gas boiler, solar PV and heat pumps reduced the owners' bills by up to 84% in 2022.

4.6 EU Strategy on Heating and Cooling

The European Commission issued an EU Strategy on Heating and Cooling, as part of the sustainable energy security package – adopted on 16 February 2016. This non-legislative communication cites some heating- and cooling-related measures to be addressed in future legislative proposals. In particular, the Strategy indicates how the heating and cooling sector should be adapted to improve energy efficiency, promote renewable energy sources and combat climate change.

Regarding energy efficiency in general, the Strategy announces the following priorities:

- Energy efficiency in buildings sector should be improved with special tools and mechanisms to support sustainable and efficient heating and cooling
- Supporting energy efficiency in industry
- Taking advantage of integrating heating and cooling in the electricity system

It becomes apparent that the sector of heating and cooling in the EU is still strongly dependent on fossil fuels (66%)[13] with a more modest but growing share of renewable energy (14%)[14]. The remaining 20%[15] is based on the

[10] SolarPower Europe (2023): Solar Heat Report – How Solar PV empowers households to turn down fossil gas and save on energy bills. https://www.solarpowereurope.org/press-releases/new-report-solar-pv-heat-pump-combos-saved-europeans-up-to-84-on-household-energy-bills-in-2022

[11] SolarPower Europe (2023): Solar Heat Report – How Solar PV empowers households to turn down fossil gas and save on energy bills. https://www.solarpowereurope.org/press-releases/new-report-solar-pv-heat-pump-combos-saved-europeans-up-to-84-on-household-energy-bills-in-2022

[12] European Heat Pump Association. Market report (2022)

[13] Source: https://energy.ec.europa.eu/system/files/2016-04/Summary%2520WP1%2520and%2520WP2_0.pdf

[14] Source: https://energy.ec.europa.eu/system/files/2016-04/Summary%2520WP1%2520and%2520WP2_0.pdf

[15] Source: https://energy.ec.europa.eu/system/files/2016-04/Summary%2520WP1%2520and%2520WP2_0.pdf

secondary energy carriers, such as electricity and district heating. The residential sector is dominated by space heating and water heating with a share of 76%[16] and 16%[17] respectively, whereas the remaining end-uses such as cooking and space cooling account for only 7%[18] and 1%[19] of heating and cooling respectively. However, the proportions of each energy carrier are varying across different end-use categories. Indeed, heating is characterised by a diverse mix of energy carriers, cooling is almost predominantly generated by electricity.

The Commission proposes to increase the use of renewable energy sources (RES) as a source for heating and cooling and support local authorities in this shift to renewables. Indeed, the Strategy also covers issues relating to electricity supply. The Commission underlines that 'linking heating and cooling with electricity networks will reduce the cost of the energy system'. RES should be used more extensively as a primary energy source for heating and cooling and the Commission suggests several ways to achieve it. Regarding this, on 13 September 2016, the European Parliament voted an own-initiative resolution on 'An EU strategy on heating and cooling'. In particular, the Parliament called to:

- Connect the electricity and heating and cooling sectors, by requesting that the Commission include the heating and cooling sector in the legislative initiative on electricity market design
- Include specific measures for heating and cooling in the Commission's upcoming legislative proposals updating the Energy Efficiency Directive (2012/27/EU), the Renewable Energy Directive (2009/28/EC) and the Energy Performance of Buildings Directive (2010/31/EU)
- Update the EU's heating and cooling system so that it helps to achieve the 2030 energy and climate goals
- Create national strategies for sustainable heating and cooling with special attention to "combined heat and power, cogeneration, district heating and cooling, preferably based on renewables", as stated in Article 14 of the Energy Efficiency Directive
- Put the "energy efficiency first principle" into practice because an investment in energy efficiency - especially in buildings - is key to achieving a successful transition towards a secure, resilient and smart heating and cooling sector
- Replace unsustainable and old individual or district heating and cooling technologies with efficient district heating and cooling systems
- Phase-out subsidies for heating and cooling fuelled by fossil fuels to gradually decarbonise the sector
- Address the interconnectivity of smart technologies in the Commission's Energy Union proposals. These technologies could be used in smart buildings and have an impact on decreasing the consumption of heating and cooling by helping consumers understand their consumption patterns
- Secure access to finance for investment in modernising the heating and cooling sector.

4.7 EU Directive 2018/844 on the energy performance of buildings

The Energy Performance of Buildings Directive (EPBD) has been revised in 2018, and it aims to reduce the energy consumption of buildings, by reaching the building and renovation goals set out in the European Green Deal. Together with the Directive Energy Efficiency, the EPBD aims to boost energy performance of buildings. The directives promote policies that will help:

- Achieve a highly energy efficient and decarbonised building stock by 2050. As of 2030 all new buildings must be zero-emission, new buildings must be zero emission already by 2027
- Create a stable environment for investment decisions

[16] Souce: https://energy.ec.europa.eu/system/files/2016-04/Summary%2520WP1%2520and%2520WP2_0.pdf

[17] Souce: https://energy.ec.europa.eu/system/files/2016-04/Summary%2520WP1%2520and%2520WP2_0.pdf

[18] Source: https://energy.ec.europa.eu/system/files/2016-04/Summary%2520WP1%2520and%2520WP2_0.pdf

[19] Source: https://energy.ec.europa.eu/system/files/2016-04/Summary%2520WP1%2520and%2520WP2_0.pdf

- Enable consumers and businesses to make more informed choices to save energy and money, e.g., through energy performance certificates

The Directive amending the EPBD (2018/844/EU) introduced new elements:

- Introduction of minimum energy performance requirements for new/existing buildings
- Long-term renovation strategies to decarbonise the national building stock by 2050
- Enhanced long-term renovation strategies to be renamed national Building Renovation Plans
- Increased reliability, quality and digitalisation of energy performance certificates
- Definition of deep renovation and the introduction of building renovation passports
- Modernisation of buildings and their system, and better energy system integration for heating, cooling, ventilation, renewable energy.

Buildings account for approximately 40% of the EU's overall energy consumption and for 36% of the EU's overall GHG emissions[20]. With its efficient and renewable solutions, the heat pump industry can greatly contribute to the effort of reducing the energy consumption of buildings and to reaching the nZEBs (nearly Zero Energy Buildings) goals.

The heat pump sector is in favour of ambitious renovation strategies and a 2050 vision towards a decarbonised building stock, as it is in line with the objectives of a 100% emission free heating and cooling sector by 2050. The heat pump industry is also enthusiastic about strengthened focus on smart readiness of buildings and the new financial tools.

Financial instruments that promote renovations and the introduction of smart, efficient and innovative technologies in existing buildings are an appropriate way of encouraging investments in higher energy efficiency and energy savings. Regarding this, the new Social Climate Fund – funded by revenues from emissions trading in road transport and buildings, will provide financial support to citizens to invest in renovation or heating systems and ensure a fair transition.

4.8 National Energy and Climate Plans for 2021-2030

The EU has committed to a clean energy transition that will help achieve the climate change goals of the Paris Agreement and provide clean energy to everyone. To fulfill this commitment, the EU has established legally binding climate and energy targets for 2030, including a minimum 40% reduction in greenhouse gas (GHG) emissions, a minimum 32.5% increase in energy efficiency, a minimum 32% increase in the share of renewable energy in EU energy use, and a minimum 15% electricity interconnection level between neighbouring Member States.

Each Member State is required by EU legislation to create a 10-year National Energy and Climate Plan (NECP), outlining how to achieve its national targets, including the legally binding national target, to ensure that the EU targets are met.

An analysis of the NCEP of the Member States involved as demo sites in the SunHorizon project is presented in the following sub-chapters.

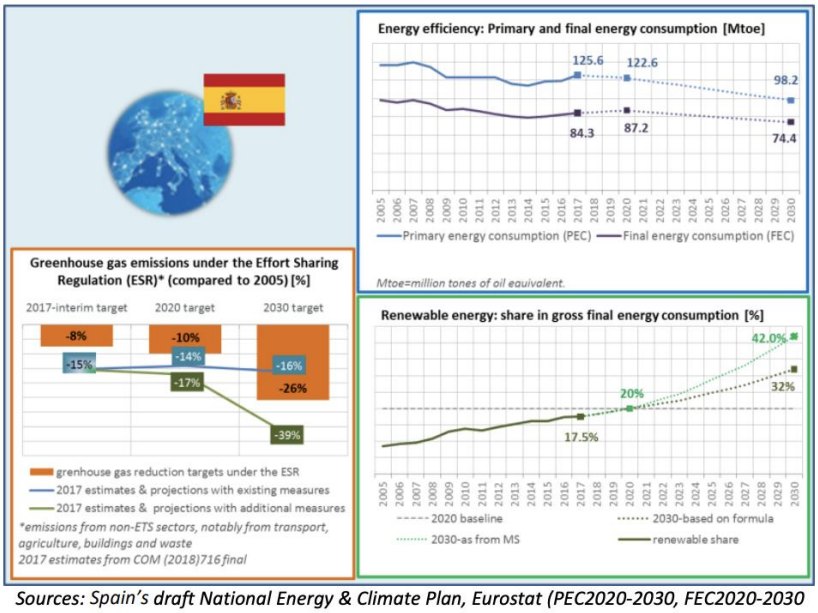
4.8.1 Spain

The framework for a carbon neutral economy by 2050 is laid out in the Spanish draft integrated NECP[21]. While addressing all aspects, the draft NECP is especially thorough regarding the goals and contributions, as well as the policies and initiatives related to the energy efficiency and decarbonization dimensions, including renewable

[20] Source:https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

[21] Source: https://energy.ec.europa.eu/system/files/2019-06/es_swd_en_0.pdf

energy. Equally ambitious policies on the security of supply, internal market, and research, innovation, and competitiveness dimensions are required to support a carbon neutral economy.



Sources: Spain's draft National Energy & Climate Plan, Eurostat (PEC2020-2030, FEC2020-2030 indicators and renewable SHARES), COM (2018) 716 final (2017 GHG estimates)

Figure 4.1: SPAIN – National targets and contributions foreseen in the draft National Energy and Climate Plan

Spain's 2030 target for GHG emissions not covered by the EU Emissions Trading System is -26% compared to 2005, as set in the ESR.

According to the formula in Annex II of the Governance Regulation, the planned national ambition level of 42% of energy from renewable sources in gross final energy consumption in 2030 is significantly higher than the share of 32% in 2030 and represents an above-average increase from the 2020 target level. A lower goal of 35% is set in the Spanish draft law on climate change and energy transition. A reference point for 2025 is included in the trajectory leading to Spain's ambition level in 2030, but not for 2022 or 2027. It would be advantageous for the final plan to go into more detail about the policies and procedures that allow for the achievement of the contribution as well as other sectorial measures.

The proposed plan outlines extensive measures to support renewable energy for transportation, heating and cooling. To make sure a solid final plan achieves the challenging renewable energy contribution in a timely manner, more in-depth quantitative data on some of the measures would be beneficial.

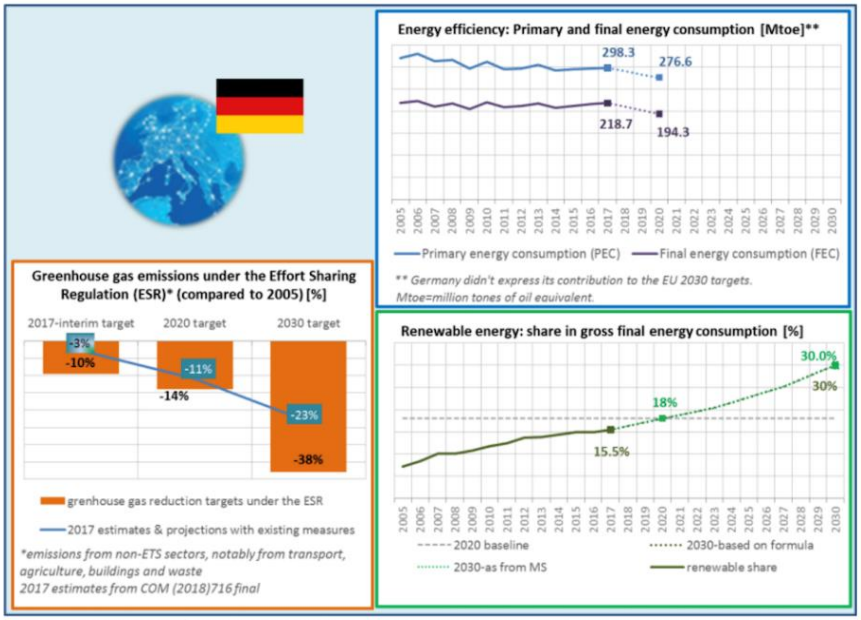
The primary energy consumption target for 2030 represents a 39.6% reduction in energy efficiency when compared to the baseline projections. The goals were sufficiently ambitious, considering the need to step up joint efforts to meet the Union's 2030 energy consumption goals. More information about policies and measures would be beneficial for the final plan.

4.8.2 Germany

The energy transition in Germany is addressed in the country's draft integrated NECP[22], which is based on three political goals: affordability, supply security, and environmental soundness. Although there has been a strong emphasis on electricity and emission reductions so far, other policies are also closely related to the energy transition. Because several political processes are still in progress, the draft plan largely relies on existing

[22] Source: https://energy.ec.europa.eu/system/files/2019-06/de_swd_en_0.pdf

documents. Except for the national contribution to the Union's 2030 headline targets on energy efficiency, the setup of national targets outlined in the German draft plan could offer a good basis for addressing policy interactions by providing clarity on measurable forward-looking objectives for almost all Energy Union dimensions.



Sources: Germany's draft National Energy & Climate Plan, Eurostat (PEC2020-2030, FEC2020-2030 indicators and renewable SHARES), COM (2018) 716 final (2017 GHG estimates)

Figure 4.2: GERMANY – National targets and contributions foreseen in the draft National Energy and Climate Plan

According to the Effort Sharing Regulation (ESR), Germany's 2030 target for GHG emissions not covered by the EU Emissions Trading System is -38% compared to 2005. Germany is not on track to meet this objective with the current policies and initiatives outlined in the draft NECP.

The German long-term strategy, the National Climate Plan 2050, is in line with the country's 2030 national and sectoral GHG emission reduction targets; however, these targets are not always reflected in sector-specific national contributions, such as to the EU energy efficiency target, and policies and measures, such as in buildings.

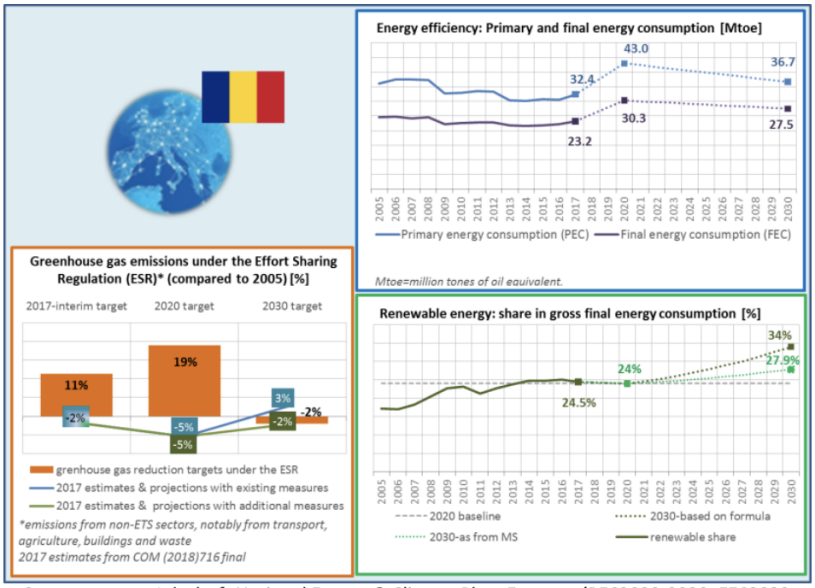
The Commission bases its assessment of Member States' contributions to renewable energy on the results of the formula under the Governance Regulation, and Germany's proposed share of 30% of energy from renewable sources in the gross final consumption of energy in 2030 is in line with this target. Germany also plans to deliver its national contribution to renewables at a more ambitious pace than the required reference levels in the years 2022, 2025, and 2027. The final plan would benefit from a more in-depth discussion of the sector-specific measures and policies necessary to achieve the contribution.

For all sectors of renewable energy, the information provided on policies and measures from a 2030 perspective is too general to allow for an evaluation of the policies' and measures' sufficiency considering the level of national ambition for renewables. This is also true when evaluating sector-specific renewable energy goals, such as those for electricity and heating and cooling.

Germany has a 2050 goal for energy efficiency, but the draft plan is unclear about how Germany will contribute to the EU's 2030 target of 32.5% energy efficiency. Therefore, no inferences about the level of ambition of Germany's contribution to the Union's top energy efficiency goals for 2030 can be made.

4.8.3 Romania

The draft integrated NECP[23] for Romania is organized in accordance with the Energy Union dimensions and pursues a holistic approach, serving as a solid foundation for the creation of a comprehensive and cogent final plan. The National Strategy on Climate Changes and Economic Growth based on Low-Carbon Emissions for the period of 2016–2030 are both mentioned frequently; as a result, the relationship between the NECP and these strategies, and any related policies and measures, could be made clearer in the final plan.



Sources: Romania's draft National Energy & Climate Plan, Eurostat (PEC2020-2030, FEC2020-2030 indicators and renewable SHARES), COM (2018) 716 final (2017 GHG estimates)

Figure 4.3: ROMANIA – National targets and contributions foreseen in the draft National Energy and Climate Plan

If Romania implements policies and measures in line with the provided projections, particularly in the transport and agricultural sectors, it may be able to achieve its 2030 GHGG emission target of -2% compared to 2005 for sectors not covered by the EU Emissions Trading System. The final plan would benefit from considering whether domestic overachieving the ESR target through additional building-related measures, for example, would be cost-effective in light of use for transfers to other Member States and would help create jobs and economic growth.

Given that the formula in Annex II of the Governance Regulation yields a renewable share of at least 34% in 2030, which is what the overall contribution to renewable energy is, the final plan would also need to have an indicative trajectory that reaches all reference points in accordance with the national contribution. The final plan would benefit from more in-depth discussion of the sector-specific measures and policies necessary to achieve the contribution. The ambition level of the anticipated contributions in the draft plan also appears to be very low, especially considering Romania's potential stated in the draft plan to play a significant role in achieving the EU 2030 energy efficiency targets.

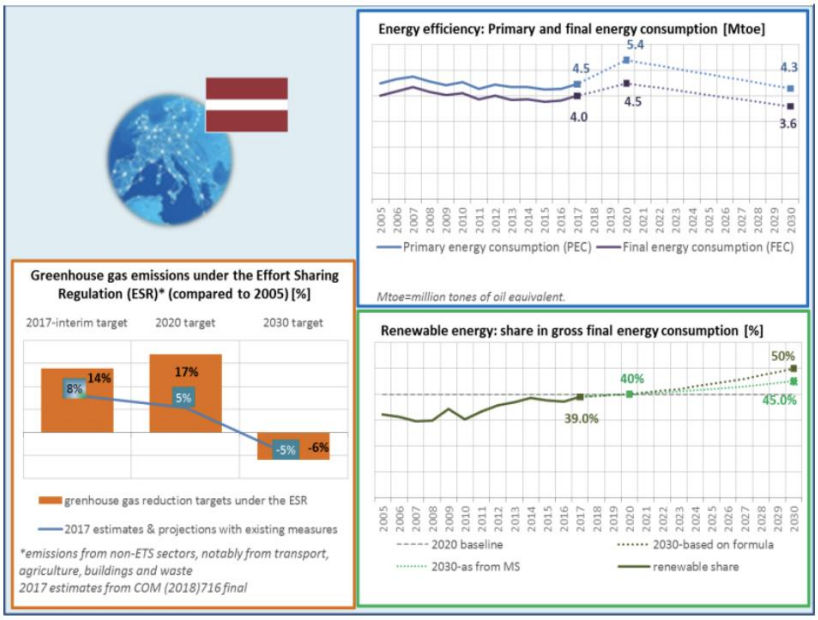
4.8.4 Latvia

The overall goal of Latvia's draft plan[24] is to ensure the transition to a low-carbon economy that is competitive in the area and globally by creating an effective and balanced energy policy based on market principles that supports the continued growth of the Latvian economy and the welfare of society. The draft plan highlights the importance

[23] Source: https://energy.ec.europa.eu/system/files/2019-06/ro_swd_en_0.pdf

[24] Source: https://energy.ec.europa.eu/system/files/2019-06/lv_swd_lv_0.pdf

of regional cooperation and makes clear connections to the programming of EU funds, which reflect the importance of many energy and climate challenges on a global scale.



Sources: Latvia's draft National Energy & Climate Plan, Eurostat (PEC2020-2030, FEC2020-2030 indicators and renewable SHARES), COM(2018)716 final (2017 GHG estimates)

Figure 4.4: LATVIA – National targets and contributions foreseen in the draft National Energy and Climate Plan

Regarding the decarbonization component, the ESR sets a 2030 target for GHG emissions in Latvia of -6% compared to 2005 for those not subject to the EU Emissions Trading System. By a small margin, Latvia would fall short of this target under the projections' primary scenario, but overall emissions for the years 2021 through 2030 would be in line with Latvia's anticipated emissions budget. A sensitivity analysis, however, reveals that it is also possible for emissions to go over the budget.

For 2030, Latvia has committed to making at least 45% of its total energy consumption from renewable sources, which is significantly less than the 50% share predicted by the formula in Annex II of the Governance Regulation. Due to this circumstance, the final plan also needs to include an indicative trajectory that reaches all reference points in line with the national contribution.

The policies and measures in the draft plan's existing scenario, which primarily consist of existing measures, are insufficient to accomplish this goal. The final plan would benefit from more detail on other pertinent sectorial measures as well as potential policies and measures to enable the achievement of these contributions and targets.

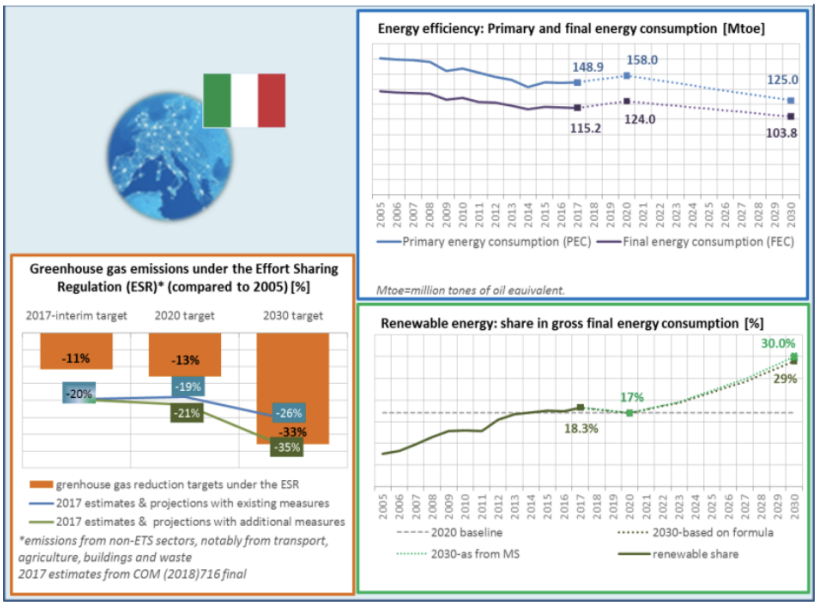
In 2030, Latvia has set its national contribution to energy efficiency at 4.3 Mtoe of primary energy consumption, which has been converted to 3.6 Mtoe of final energy consumption. Considering the level of effort needed at the EU level to collectively reach the Union's 2030 efficiency target, the proposed target may be considered to have low ambition for primary energy consumption and modest ambition for final energy consumption. The final plan would benefit from more specific policies and actions, such as their anticipated energy savings and implementation schedules.

4.8.5 Italy

The Italian draft integrated NECP[25] is intended to implement a vision of broad economic transformation, in which decarbonization, energy efficiency, and renewables priorities contribute to the goals of a more environmentally

[25] Source: https://energy.ec.europa.eu/system/files/2019-06/it_swd_en_0.pdf

friendly economy. The draft NECP largely builds on the Italian Energy Strategy of 2017. The results are very ambitious under several aspects, and the draft NECP includes a number of targets for the Energy Union's various dimensions. It will take a strong and comprehensive set of policies and measures, along with careful monitoring and follow-up, to achieve the proposed targets and results. Overall, the Italian draft NECP is well-developed and largely complies with the Regulation's requirements. Most dimensions are covered by a lengthy list of 101 policies and measures.



Sources: Italy's draft National Energy & Climate Plan, Eurostat (PEC2020-2030, FEC2020-2030 indicators and renewable SHARES), COM (2018) 716 final (2017 GHG estimates)

Figure 4.5: ITALY – National targets and contributions foreseen in the draft National Energy and Climate Plan

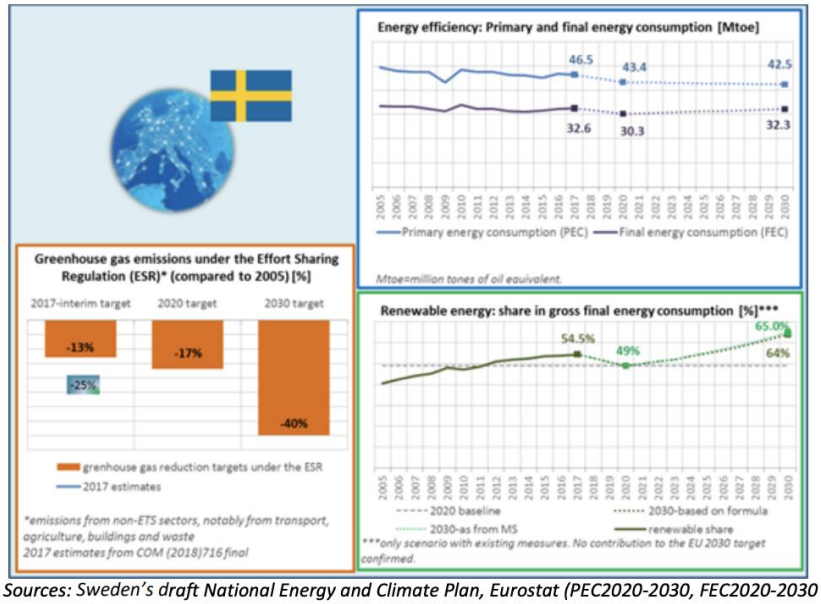
According to the ESR, Italy's 2030 target for GHG emissions that are not covered by the EU Emissions Trading System is a 33% reduction from 2005 levels. According to the information given, Italy would be able to achieve this goal with the help of the planned policies and initiatives, with the building and transportation sectors playing a particularly significant role.

The proposed contribution, which is expressed as 30% of energy from renewable sources in gross final energy consumption in 2030, is slightly higher than the share obtained using the formula in Annex II of the Governance Regulation. More support for renewable energy sources, along with sufficiently specific plans for ensuring their implementation, would be beneficial. This is especially true regarding the use of renewable energy in the electricity and heating sectors, where new support measures have not yet been implemented. Thus, more detail on the policies and programs that enable the achievement of the contributions as well as other pertinent sectorial programs would be beneficial for the final plan.

The suggested contribution to the collective EU energy efficiency goal for 2030 seems to have enough ambition. The planned policies rely on partially completed, already-existing instruments that could be advanced and completed. They will also need to be closely monitored over time to make sure they produce the anticipated savings.

4.8.6 Sweden

The Energy Bill and the current climate framework are the main inspirations for the Swedish draft integrated NECP[26]. As a component of a larger framework to encourage the transformation of the Swedish economy to become sustainable and climate neutral by 2045, it describes a wide range of current policies for reducing GHG emissions. Equally ambitious policies on the security of supply, internal market, and research, innovation, and competitiveness dimensions must support this transformation.



Sources: Sweden's draft National Energy and Climate Plan, Eurostat (PEC2020-2030, FEC2020-2030 indicators and renewable SHARES), COM(2018)716 final (2017 GHG estimates)

Figure 4.6: SWEDEN – National targets and contributions foreseen in the draft National Energy and Climate Plan

According to the ESR, Sweden's goal for GHG emissions in 2030 that aren't covered by the EU Emissions Trading System is a 40% decrease from 2005. The European Commission believes that based on Swedish projections, current policies may be adequate to meet this goal. Assessments of the effects of specific policies and measures or sets of related policies and measures would be beneficial to include in the final plan. In addition to its ESR target, Sweden has established a more ambitious national goal for non-ETS emissions for the year 2030. The Swedish government's ambitious climate policy is well known. Sweden has set a high goal for lowering emissions from transportation. According to the draft NECP, Sweden uses energy and carbon taxes as crucial policies to achieve this target.

According to the draft NECP, current policies and initiatives will lead to a 65% share of renewable energy in total energy consumption. This would represent a sizeable share, slightly higher than the 64% resulted from the formula. However, it is not made clear whether this share, which comes from a scenario based on already-adopted policies, can be regarded as a contribution to the EU's 2030 renewable energy target. The expected share reached in 2025 falls short by 3% points for the reference points of the indicative trajectory Sweden proposed. The final plan would benefit from more in-depth discussion of the sector-specific measures and policies necessary to achieve the contribution.

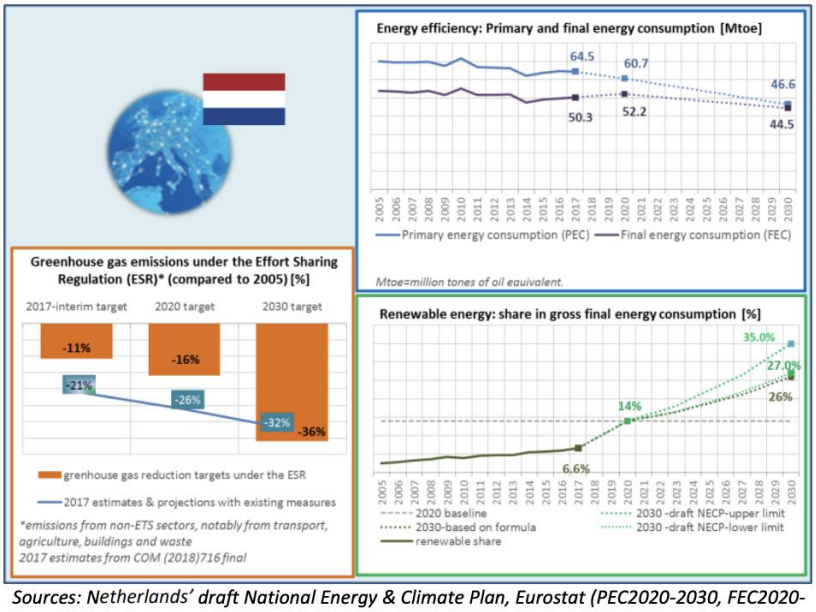
According to the Swedish draft plan, Sweden's energy use should be 50% more efficient in 2030 than it was in 2005. The target, which is based on a scenario reflecting existing measures adopted before 30 June 2016, is expressed in terms of primary energy use in relation to gross domestic product. Sweden will contribute 42.5 Mtoe of primary energy consumption and 32.3 Mtoe of final energy consumption to the EU's overall 2030 target. In

[26] Source: https://energy.ec.europa.eu/system/files/2019-06/se_swd_en_0.pdf

particular, the ambition for final energy consumption seems low. The proposed reductions in energy consumption are modest in comparison to the efforts required to achieve the EU headline target. This runs the risk of passing up chances for growth and employment. More information on appropriate policies would be helpful for the final plan.

4.8.7 The Netherlands

The 2017 Coalition Agreement and the 2013 Energy Agreement serve as the main policy pillars on which the draft integrated NECP[27] is based. The final NECP will be based on the Climate Agreement. The extensive work done there was not yet reflected in the draft NECP because this wasn't finalized when it was being prepared. The national contributions could still differ depending on the finalized National Climate Agreement, and information on planned policies and measures as well as their anticipated effects could be greatly strengthened.



Sources: Netherlands' draft National Energy & Climate Plan, Eurostat (PEC2020-2030, FEC2020-2030 indicators and renewable SHARES), COM (2018) 716 final (2017 GHG estimates)

Figure 4.7: THE NETHERLANDS – National targets and contributions foreseen in the draft National Energy and Climate Plan

According to the ESR, the Netherlands' 2030 target for GHG emissions not already covered by the EU Emissions Trading System is a -36% reduction from 2005 levels. A national total GHG emission target of -49% by 2030 compared to 1990 is also included in the draft NECP. It is well known that climate policy has high ambitions. The draft NECP does not propose any new policies or measures; instead, it mainly describes the ones that already exist. Based on this, it is possible to miss the binding target for 2030 under the ESR by a small margin of 4.6 Mt CO2eq.

As a contribution to the EU's 2030 renewable energy target, the draft NECP includes a bandwidth of 27% to 35% of energy from renewable sources. This potential range is higher than the result of the formula in Annex II of the Governance Regulation, which predicts a share of 26% in 2030. There has not yet been specified national support for the EU's renewable energy goals. The draft NECP does not yet contain the indicative trajectory to arrive at the Dutch contribution in 2030, which includes achieving the reference points of 18% by 2022, 43% by 2025, and 65% by 2027. It would be advantageous for the final plan to go into more detail about the policies and procedures that allow for the achievement of the contribution and other pertinent targets.

[27] Source: https://energy.ec.europa.eu/system/files/2019-06/nl_swd_en_0.pdf

5 Policy recommendations

In this section, some policy messages or recommendations addressed to EU policy makers, on what is still missing at the EU level to be done to fully support solar-driven HP/solar panels as massive technologies for decarbonising the residential sector are provided. The analysis of the EU policies shows that there is still room for improvement. Some of the actions to be considered regarding the Renewable Energy Directive (2018/2001/EU) are:

- Keep reminding the Member States who fail to account for air heat pumps under their final renewable energy use.
- Lobby for the sectorial target to be increased and made binding. For this purpose, EHPA closely monitors the still-to-be-started works on a European definition of renewable cooling.
- Alongside the heat pump industry, to look at the implementation of the new Directive at national level and reflect on possible on future improvements for its upcoming revision.
- To assess and create a position on further cooling discussions.
- To support innovative technologies, such as heat pumps, geothermal and solar thermal technologies, it is important to require that Member States carry out an assessment of their potential of energy from renewable sources.

According to the REPowerEU, it is important to stress that the sector is ready to scale up, but an empowerment is required in the form of:

- Creating trust in long term ambition for all heat pump technologies.
- Making clean heating economically the most attractive.
- Avoiding disruption through legislation (F-gas regulation and Eco-design).
- Focusing on skills for the energy transition.
- Increasing the research and development sector.
- Creating a heat pump accelerator to bring all stakeholders together and push this forward.

The Commission asserts that there is a sizable potential to reduce energy demands, increase efficiency, and transition to renewable sources across all building sectors, including residential, industrial, and services. To ensure that owners and tenants benefit equally from increases in energy efficiency and to find solutions to this issue in multi-apartment buildings, Member States should review their poverty laws in the construction industry. It is crucial to put the needs of the consumer at the centre of this strategy by encouraging them to use cutting-edge, efficient, clever, and sustainable solutions. Furthermore, those who live in the most impoverished areas can access specialized funding that is needed to address energy poverty.

The Energy Performance of Buildings Directive will help reach the building and renovation goals, but there are opportunities to improve:

- To make heat pumps the most preferred technology in renovations
- To increase the renovation rates and the quality of renovated buildings, where heat pumps can offer optimal thermal comfort
- To support the inclusion of indoor air quality in the revised EPBD, by using heat pumps
- To call for the strengthening of financial instruments to promote a green and digital recovery

According to the SolarPower Europe Report, by combining a PV system with a heat pump, consumers are simultaneously protected from fluctuations in gas prices and reduced risk of increases in retail electricity prices. Five policy recommendations are outlined in the report, and, taken together, they can cut the payback periods for new solar PV and heat pumps from around 20 years to under 10 years:

1. Member States should provide CAPEX support. Moderate increase in CAPEX support for solar PV and heat pump installations significantly reduces payback times. This can be done with several instruments, e.g.: Member States can either directly support with a fixed amount or an amount relative to the CAPEX investment, and the technology used.

2. Member States should offer low-interest rate loans to citizens for solar and heat pumps, as high initial investment is a barrier for low-income households.
3. Countries with high heating demand should consider a carbon price floor via the EU Emission Trading System for Transport and Heating, and Member States should stop all CAPEX and OPEX support for residential gas use.
4. Member States should promote collective self-consumption (CSM). CSM allows citizens to share and receive self-generated electricity with their neighbors on a contractual basis, in a quick- and accessible manner.
5. The need for electricians and installers should be evaluated by Member States, including local authorities, who should also establish training and upskilling initiatives. They should also establish frameworks that include financial incentives, such as tax breaks, at the individual and corporate levels.

6 Conclusions

The main objective of SunHorizon project is to demonstrate innovative and reliable heat pump solutions properly coupled with advanced solar panels and thermal energy storage that can provide heating and cooling to residential and tertiary buildings.

This deliverable represents the work carried out in Task 8.3-" Capacity building and policy promotion for solar and heat pump H&C application".

The purpose of this deliverable is to provide policy recommendations addressed to EU policy makers to support solar technologies for decarbonising the residential sector.

The methodological approach used to provide policy recommendations is based on the following main steps:

a. an overview of the stakeholders' outcomes collected by consultations through dedicated Workshops, surveys/questionnaires and interviews. The aim was to obtain the perspectives on solar technologies (both solar panels and heat pumps) from stakeholders out of SunHorizon project;
b. an overview about new policies and regulations aimed at enhancing the deployment of SunHorizon technologies;
c. analysis of the main EU heating and cooling (H&C) strategies, particularly referring to the SET-Plan and Energy Union Objectives for H&C;
d. identification of policy recommendations addressed to EU policy makers, on what is still missing, at the EU level, to be done to fully support solar-driven HP/solar panels as massive technologies for decarbonising the residential sector.

It is worth mentioning that in all building sectors, including residential, there is significant potential to reduce energy demand, increase efficiency, and switch to renewable sources. This, however, implies the presence of numerous barriers and opportunities for improvement. It is critical that:

- Member States assess their renewable energy potential.
- Prioritize consumer needs in these strategies, encouraging the use of efficient and sustainable solutions, e.g.: through funded supports and upskilling of sector professionals.
- Member States should provide CAPEX support. Moderate increase in CAPEX support for solar PV and heat pump installations significantly reduces payback time.
- Member States should offer low-interest rate loans to citizens for solar and heat pumps, as high initial investment is a barrier for low-income households.
- Increased research and development on these new integrated technologies.