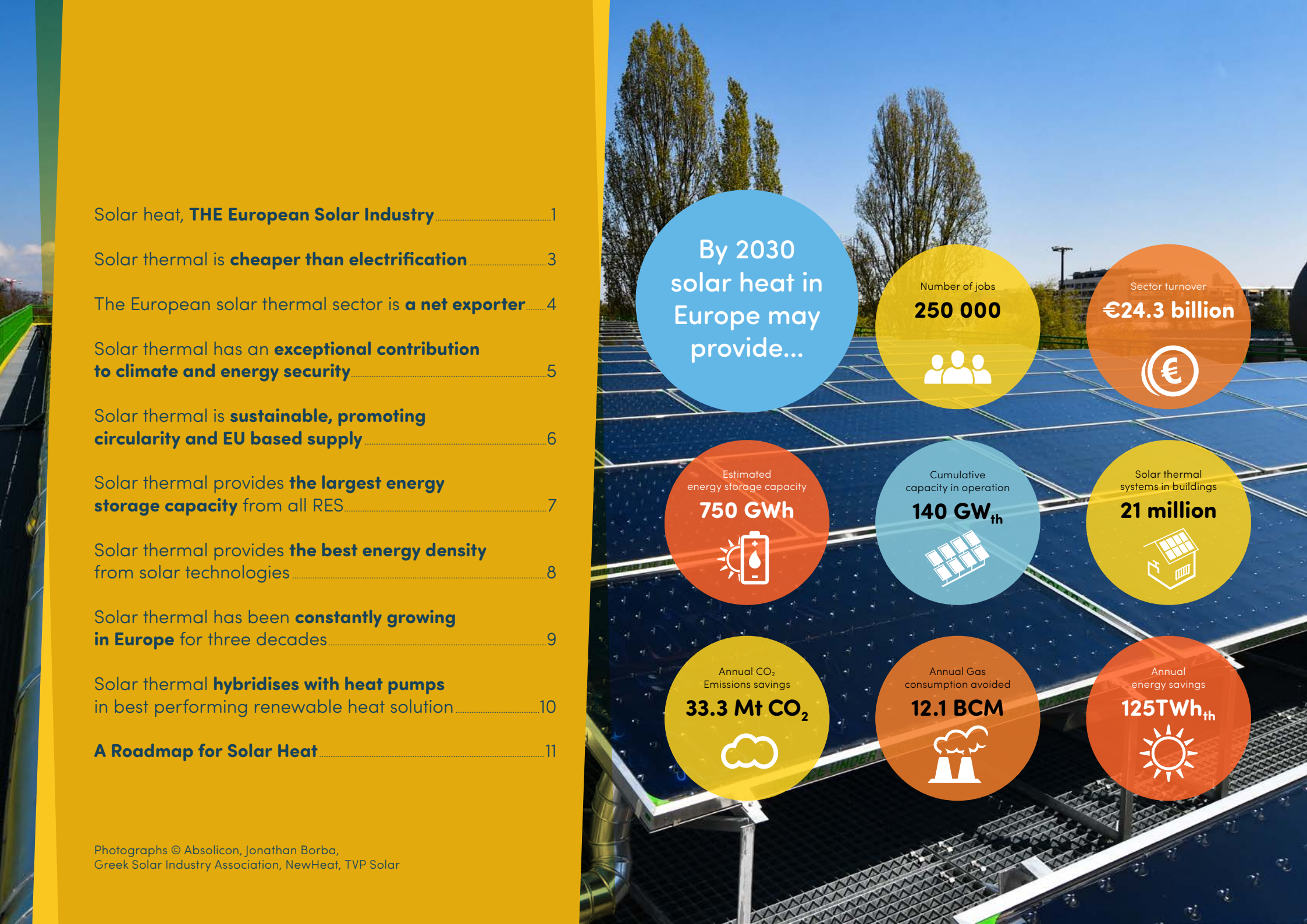
Solar Heat Europe
ESTIF

Energising Europe with Solar Heat

A Solar Thermal Roadmap for Europe

Achieving decarbonisation with an exceptional solution that...

- is **cheaper than electrification**
- has a **positive trade balance** for Europe
- has an **exceptional contribution to the climate and energy security**
- is sustainable, **promoting circularity** and EU based supply
- provides the **largest energy storage capacity** from all RES
- provides the **best energy density** from all solar technologies
- has been **constantly growing in Europe** for three decades
- **hybridises with heat pumps** in best performing renewable heat solution
- can provide **extraordinary socio-economic benefits** to Europe by 2030!



Solar heat, THE European Solar Industry

Solar thermal (or solar heat) is one of the three solar technologies, all of them with an exceptional potential and a key role in the energy transition.

Besides the technological differences, Solar Heat distinguishes itself as THE European solar industry. Besides the advantages it has in comparison with other renewable technologies, such as lower costs, better environmental footprint and recyclability, solar thermal distinguishes itself for having the hegemony of the supply to the European market, being a net exporting sector and having manufacturers spread all over the continent, from Finland to Greece.

Solar heat has a critical role to play in the energy transition, as a competitive and reliable source of heat for European homes and companies, industrial sector included. This is why solar thermal is already present in over 10 million households in Europe and has an increasing implantation in industrial heat processes.

The potential of this sector has been underestimated, in line with the overall renewable heat sector. While electrification of the heat sector is a reality and shall continue evolving, the complementarity with renewable heat supply needs to be further exploited. Renewable heat brings numerous advantages to the resilience, security and competitiveness of the energy sector.

It is critical to give to this sector the same level of political support that has been offered to solar PV or wind. The European Union cannot afford to disregard the potential of a sector that has a strong manufacturing capacity in Europe, requiring support to step up demand.

	Solar heat	**Solar PV[1]**
Target capacity 2025	45 GW_{th}	35 GW_p
Target capacity 2030	140 GW_{th}	100 GW_p
Critical mass of manufacturing capacity	Established, possible to ramp up	Not yet established
Financial capital cost	Manageable	Strong reduction needed
Operational cost	Manageable	Strong reduction needed
Demand (2021-22)	Demand growing but largely below potential	Available
Coverage of EU demand	High (over 90%)	Low (below 10%)
EU components supply	Available (aluminium, copper), increase needed for glass	Mostly dependent on Asian suppliers for polysilicon, small wafers and glass
EU technol. sovereignty	Leaders in main applications and collector types (except evacuated tubes)	Leaders on new technologies
Large investment in RD&I	Low and decreasing investment level at EU level	Large investments, priority area in EU RD&I programmes

[1] Adapted from ESMC: High-level event on the European Solar Strategy

Taking solar PV has a benchmark, we can identify that solar thermal already fulfils several important preconditions for growing further as a European based industrial sector.

It has a well-established manufacturing capacity in Europe, holding technology sovereignty and being the technological leader worldwide. The European solar thermal sector does not require critical minerals and has a variety of supply channels for its main components (copper, aluminium, glass). In addition, the barriers to entry are low, from technical to investment, allowing for a propagation of new solar thermal production plants all over the European Union, creating local jobs in manufacturing and other areas, from commercialisation to installation.

The aspects that the solar thermal sector is lacking the most are market support measures to increase demand of solar thermal systems, such as financial incentives addressing the higher upfront investment, regulatory measures addressing barriers to the deployment in buildings and cities or measures to active large consumers such as industries. Solar thermal has potential to continue growing its installed capacity in the buildings segment, which has been the most relevant segment insofar. By 2030, solar heat can reach 73 GW_{th} in the building segment, which corresponds to 0.16 kW_{th} per EU citizen. This level of deployment is equivalent to what is currently the solar thermal installed capacity ***per capita*** in Germany.

[2] https://www.heinekenespana.es/heineken-y-engie-avanzan-hacia-las-cero-emisiones-netas-con-una-nueva-planta-termosolar-en-sevilla/

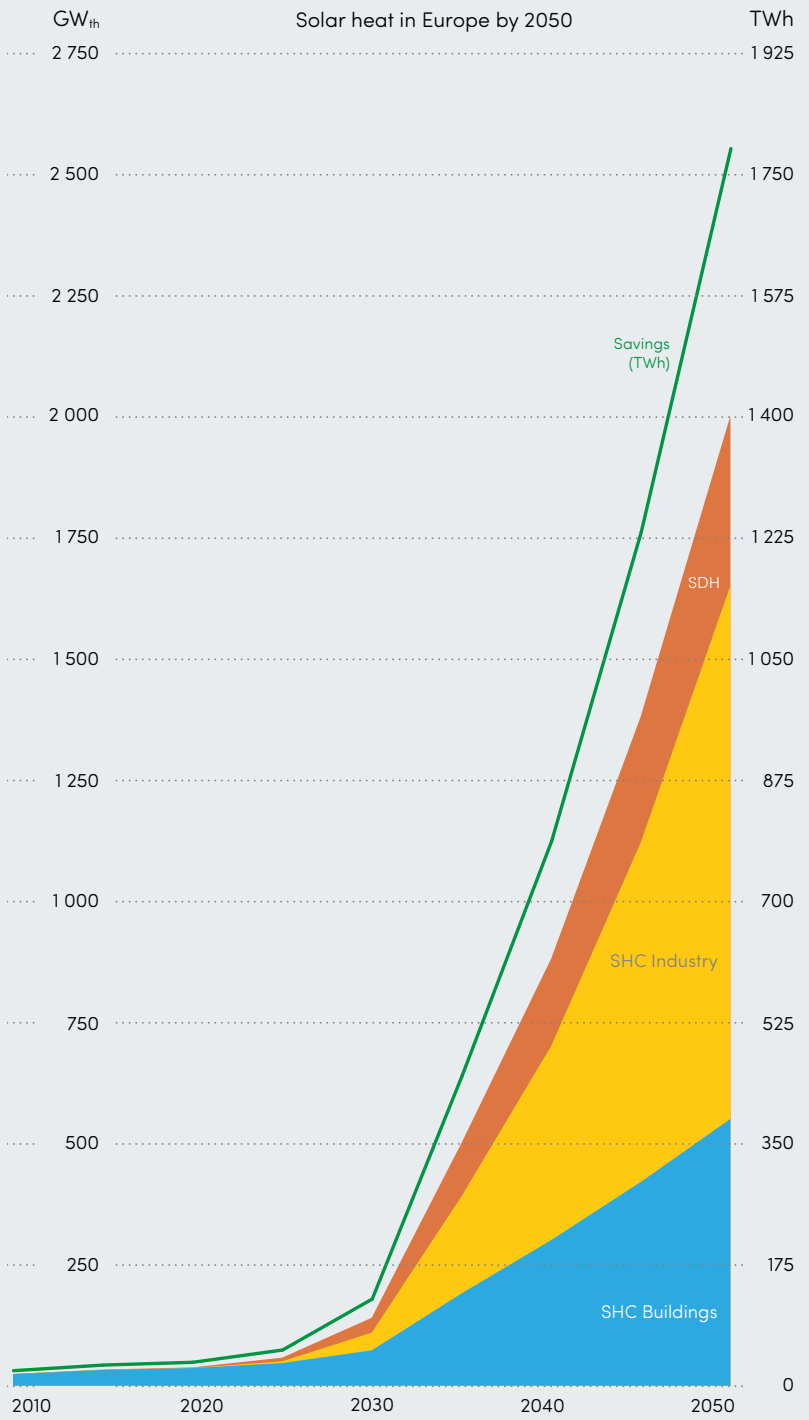
In addition, solar thermal could grow much more in large scale systems for district heating or industrial process heat. For district heating, solar thermal can reach 31 GW_{th} by 2030, which would allow to cover 16% of derived heat produced from solid fossil fuels in Europe in 2019.

Finally, for industrial process heat, solar heat can reach 36 GW_{th} by 2030. This can cover over 10% of the consumption of an industrial sector such as food, drinks and tobacco, which uses predominantly low and medium temperature heat. SHIP (solar heat for industrial processes) experiences an impressive growth in Europe.

In 2019 the largest SHIP in Europe (4 MW_{th}) started operating in a paper mill in France, doubling in size the previous record. Since then more and larger SHIP have been installed, and today a system of 20 MW_{th} is being built in Croatia while a 30 MW_{th} system has been contracted in Spain[2].

The total installed solar thermal capacity in Europe can reach 140 GW_{th} by 2035, 500 GW_{th} by 2035 and continue growing up to 2000 GW_{th} by 2050.

The European Union needs to reduce its dependency from gas, and in particular Russian supplies, urgently. **With solar thermal it is possible to deploy considerable numbers in the short term, creating added value and jobs in Europe.**



Solar thermal is cheaper than electrification

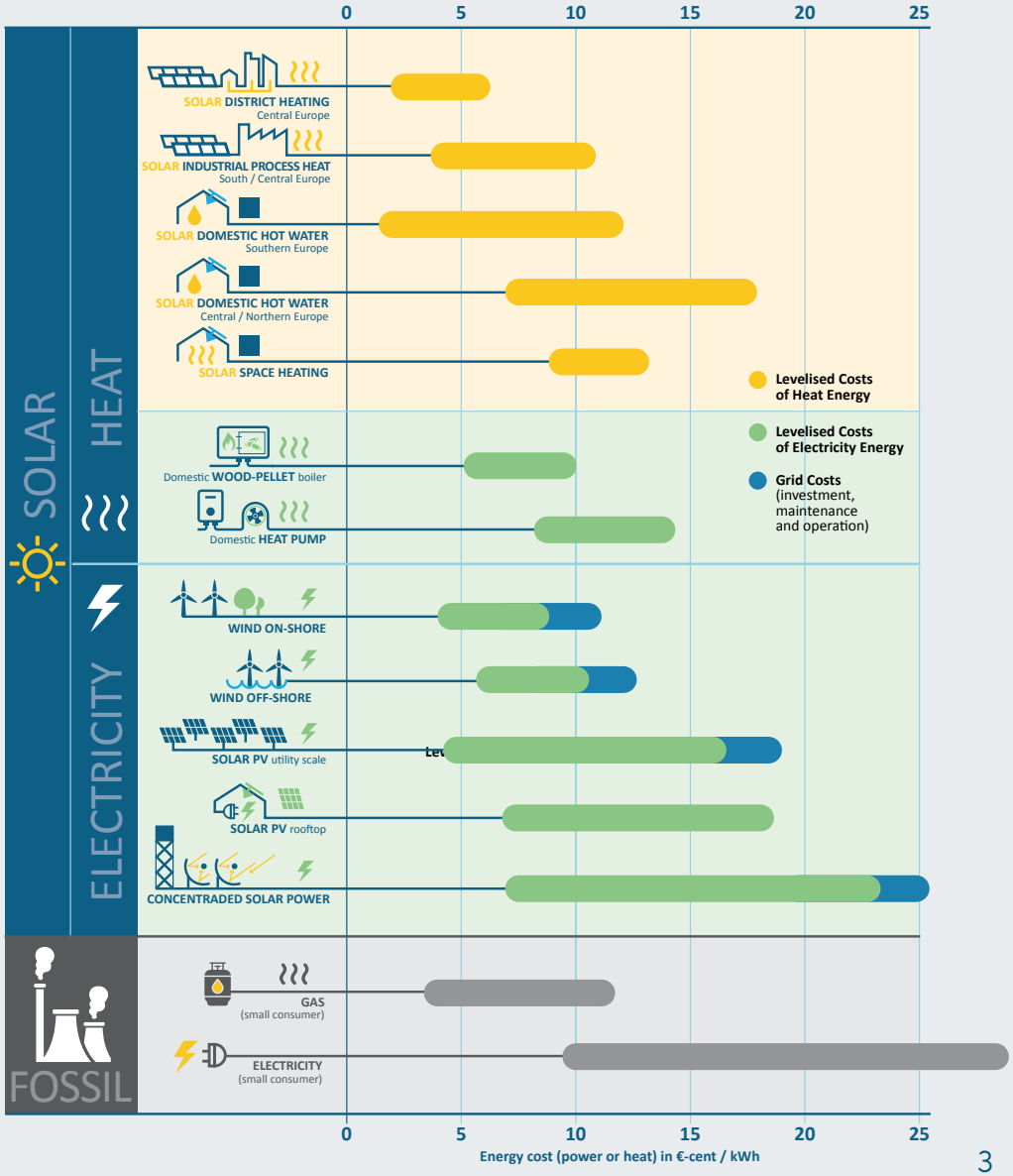
One of the axis of EU energy policy is based on the promotion of electrification of the heating and transport sectors. The main argument is that this is the easiest way to decarbonise these sectors. Electrification of heating should only happen when it is supplied by renewable sources and when using efficient heating solutions such as heat pumps.

Solar thermal must be placed at least at the same level of priority. In fact, considering that is represents the main low-hanging fruit among the available solutions for decarbonisation, it should be a higher priority. Solar thermal means completely clean supply of heat, not being dependent on the carbon content of the electricity supply. In addition, it is the most competitive in terms of costs for several applications.

For instance, a small, low-cost thermo-siphon system (2.8 kW_{th}) with diurnal thermal storage (12.7 kWh_{th}), can supply domestic hot water in a Mediterranean country for less than 2 €-cents per kWh. On the other hand, a large solar district heating system (35 MW_{th}) with seasonal thermal storage (142 MWh_{th}) in Denmark, achieving remarkable generation costs of only 3.5 €-cents per kWh.

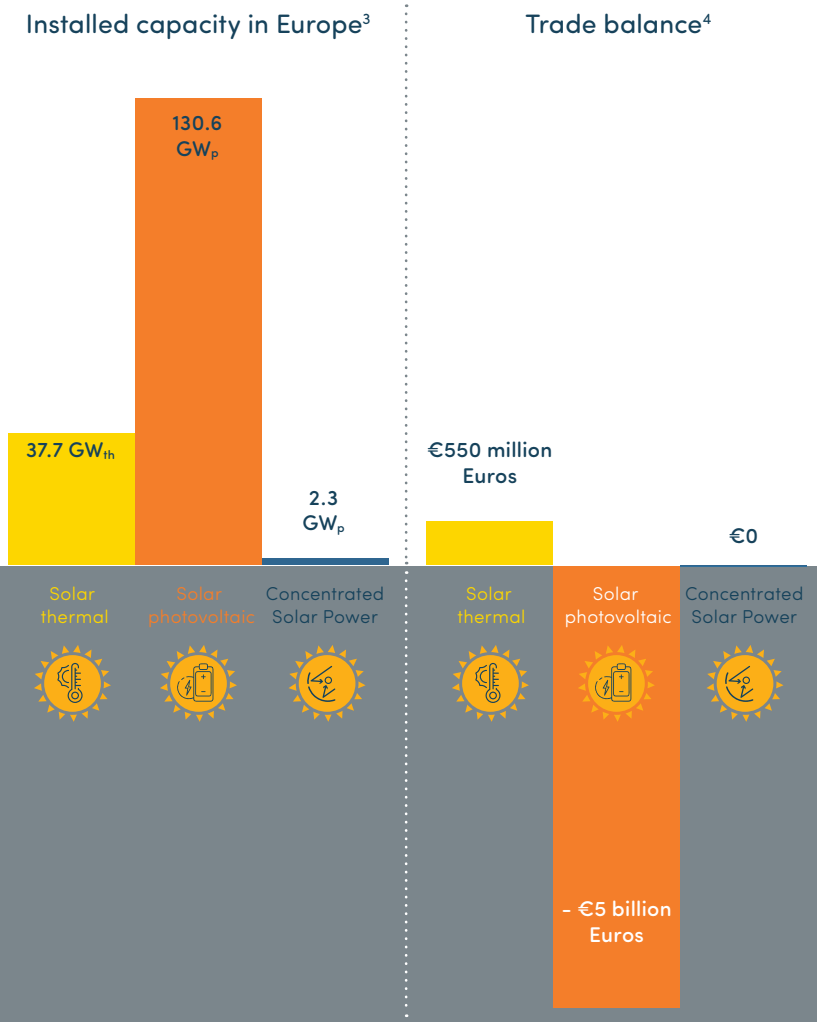
Solar thermal is clearly the most competitive renewable energy source. In a period where we need a fast transition to renewables while reducing energy costs and our dependency from energy imports, solar thermal must be a priority.

LCOE (Levelised Cost of Energy) per kWh for different Energy Sources



The European solar thermal sector is a net exporter

One of the aspects that distinguishes solar thermal is that it is an exporting sector, with a small share of imports into the EU market.



Solar Photovoltaics, for instance, has today a large market in Europe , fuelled by outstanding public investments. Nevertheless, the supplies of this industry are almost exclusively coming from imports to the EU, in its majority from Asia. Concentrated Solar Power on the other hand, has manufacturing capacity in Europe but has a limited market in Europe and limited exports. Solar heat, besides supplying the majority of the European solar thermal market demand, has a positive trade balance. For instance, the Greek solar thermal industry exports 65% of its production.

Driving demand in Europe is an important condition to increase the competitiveness of the European manufacturers. This means that additional growth in demand in the common market can also lead to additional exports.

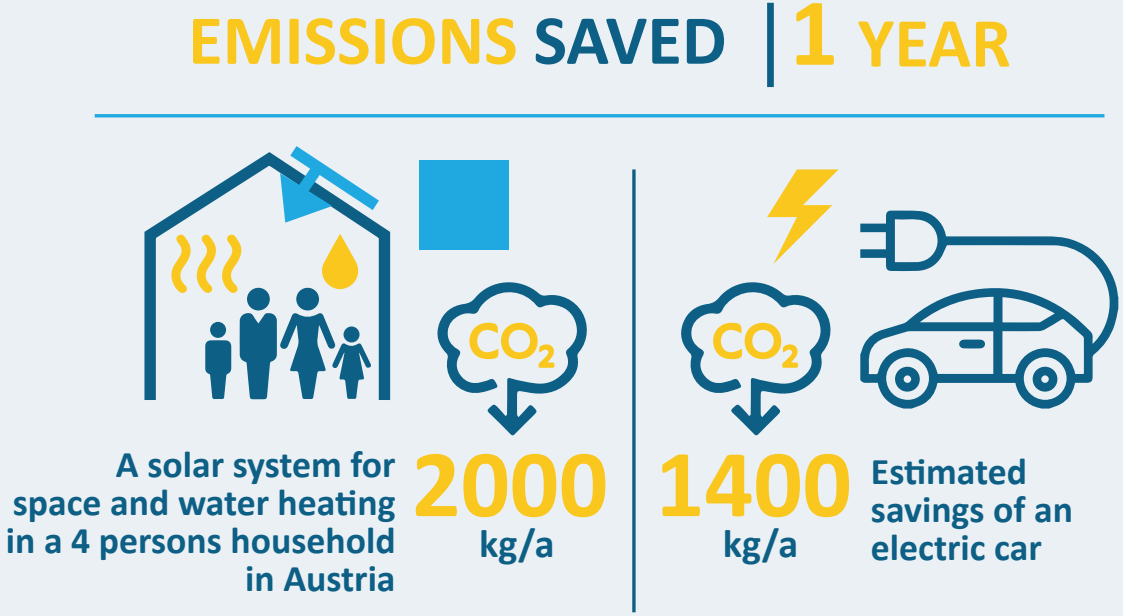
[3] EurObserv'ER: Solar thermal and concentrated solar power barometer 2021, Photovoltaic barometer 2020
[4] Study on impacts of EU actions supporting the development of renewable energy technologies (PP-05441-2017), European Union, 2019. Reference year used: 2015

Solar thermal has an exceptional contribution to climate and energy security

Solar thermal is a well proven solution in terms of its contribution to the reduction of CO_2 emissions, and among the most environmentally friendly renewable solutions, when considering the full product lifecycle, from manufacturing to decommissioning, and recycling.

A solar thermal system for space and hot heating saves around 2 tons of CO_2 per year when replacing an oil-based heater. This corresponds to more than one year of driving (14 000 km) with a small car (100 g CO_2 / km) with a fraction of the investment. And an area of 10 m^2 of solar thermal collectors, it can save emissions equivalent to planting 140 trees, considering a forest with different tree varieties.

The **emissions saving potential of solar thermal is severely underestimated**. Solar thermal needs to be properly considered as an alternative to investments in other renewable energies or even electric cars. **While all solutions are needed to reach our decarbonisation targets, solar thermal is a low-hanging fruit waiting to be harvested.**



Solar thermal is sustainable, promoting circularity and EU based supply

Besides the savings on carbon emissions, solar thermal presents other advantages, being environmentally friendly. It is an excellent solution in what concerns circularity. The recyclability rate of a solar thermal systems exceeds 95%, including both the solar panel and storage (thermal energy). The collection process does not require special recycling means or channels[5].

For instance, one of the main components of solar thermal systems, copper, is 100% recyclable. It can be used over and over with no loss of properties. Furthermore, around 50% of EU demand for copper is met through recycling[6].

In addition, the energy payback time of solar thermal systems is of 1 year, in average, considering gas[7] as a reference. This means that a solar thermal system generates in one year the equivalent to the energy required to produce such system.

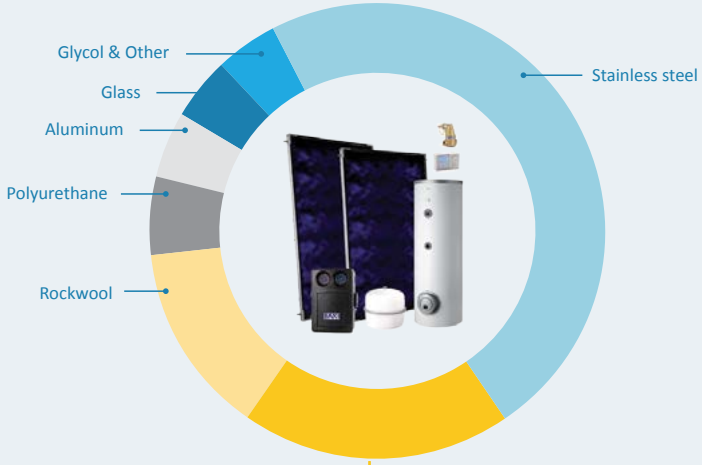
Furthermore, the manufacturing of solar heat systems requires materials that are widely available, from a broad number of suppliers. While most of the supplied components are coming from within Europe, it is also possible to have such components supplied from a diversity of sources (countries/companies). This is particularly important considering the expected increase in demand due to accelerated deployment of solar thermal systems and the need to quickly boost the production of these solar thermal systems in Europe.

The decarbonisation of the energy system needs to be done in full compliance with the principles of a circular economy. Solar thermal, made in EU, holds the best performance along a number of criteria relevant for assessing sustainability in comparison with other renewable energy technologies.

As EU demand for solar rises, **it is essential to provide a sustainable solution**, based on domestic (EU-based) production with, what is by large, an EU based supply chain.

>95%
RECYCLABILITY (MASS & VOLUME)

1 YEAR
ENERGY PAYBACK TIME



COPPER

50% of EU demand met through recycling

100% recyclable

[5] Water heaters, Review study Task 5 - Environment & Economics, Final report
[6] Copper Alliance : https://copperalliance.org/wp-content/uploads/2021/10/Circular-Economy-Cube.pdf
[7] Travaux de l'Observatoire sur l'acceptabilité et avenir du solaire, IEA-SHC, Daniel Mugnier, 2022

Solar thermal provides the largest energy storage capacity from all RES

The total thermal energy storage coupled with solar thermal systems by the end of 2021 is currently estimated at almost 190 GWh.

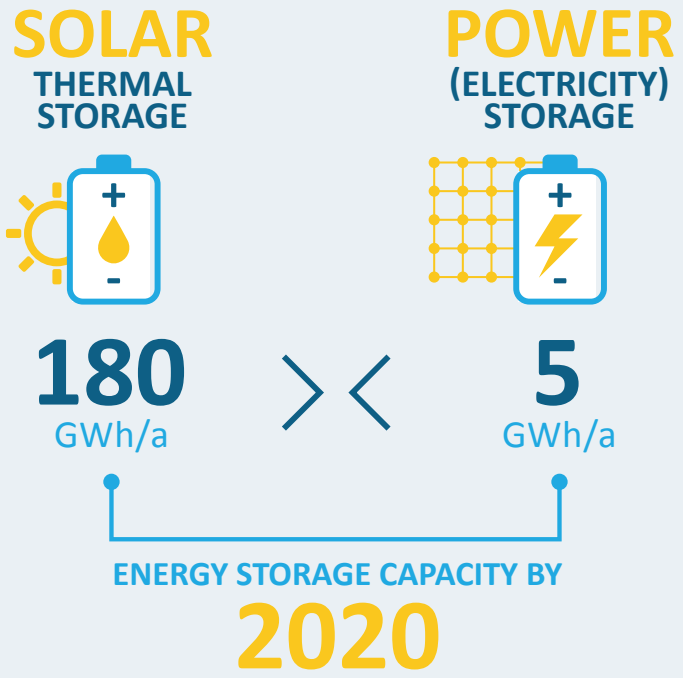
In comparison the total electric storage capacity by the end of 2021 amounts to 8.3 GWh[8]. In brief, solar thermal systems installed in Europe have a combined energy storage capacity 20 times higher than the total power storage capacity available.

Storage capacity is essential for the flexibility of the energy system. The heat demand in Europe is more than double of the power demand and on top of that as much more extreme peaks.

The fact that every solar thermal system integrates, by default, storage capacity is a major added value to the energy system.

There are millions of small thermal energy storage units in European households. One of this storage units with a volume of 300 litres has an energy storage capacity of 22.5 kWh_{th}. In addition, large scale thermal energy stores can provide additional flexibility to the energy system, as they can provide also seasonal storage. These can reach capacities above 142 MWh_{th}.

The European Union needs an exponential increase of storage capacity in Europe, both power and thermal storage. Solar thermal offers this extraordinary value to the European energy system in each system installed.



[8] European Market Monitor on Energy Storage, EMMES 5.0

Solar thermal provides the best energy density from solar technologies

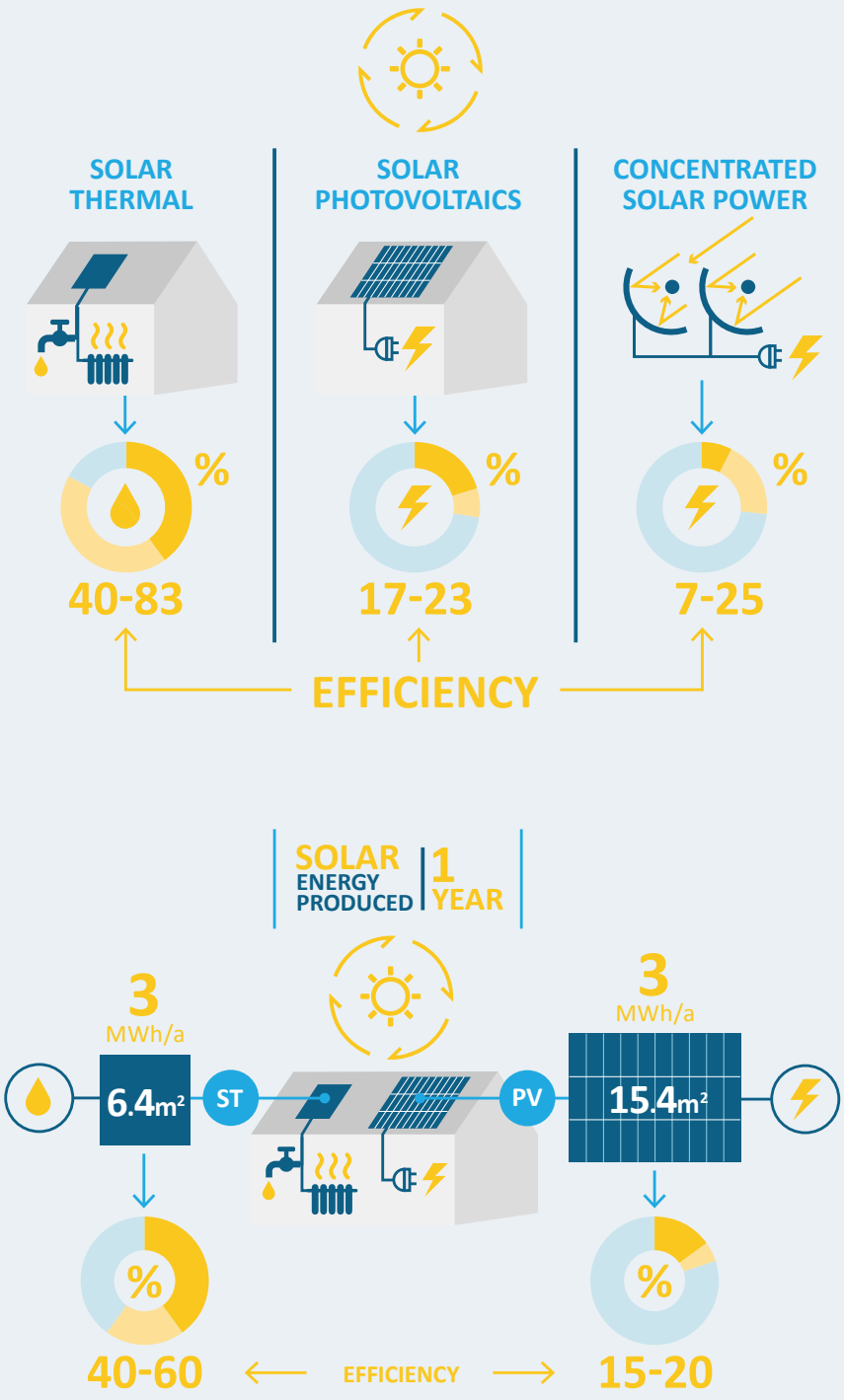
When discussing the challenges of the energy transition, the required area for installing renewable technologies must be an important part of the discussion.

Solar thermal has better efficiency that other solar technologies, being able to provide over three times more energy than solar PV and CSP (Concentrated Solar Power) can.

Considering the relevance of promoting decentralised energy generation, it is essential to consider the available area in cities. It must be noted that the availability of suitable land or rooftop space is an important constraint for solar thermal, that needs specific measures. Still, considering that it can produce the same energy within one third of the area required by a solar PV system, the benefits for our cities are evident.

For instance, on a rooftop, solar thermal can produce heat in excess of 3 MWh per year in an area below 6.5 m^2, while a solar PV system would require more than 15 m^2 for an equivalent power generation.

Europe needs to generate more energy, be it heat or electricity, **within urban areas** and for that we need to take most of the available land and rooftops, meaning that **the deployment of solar thermal must be a priority!**

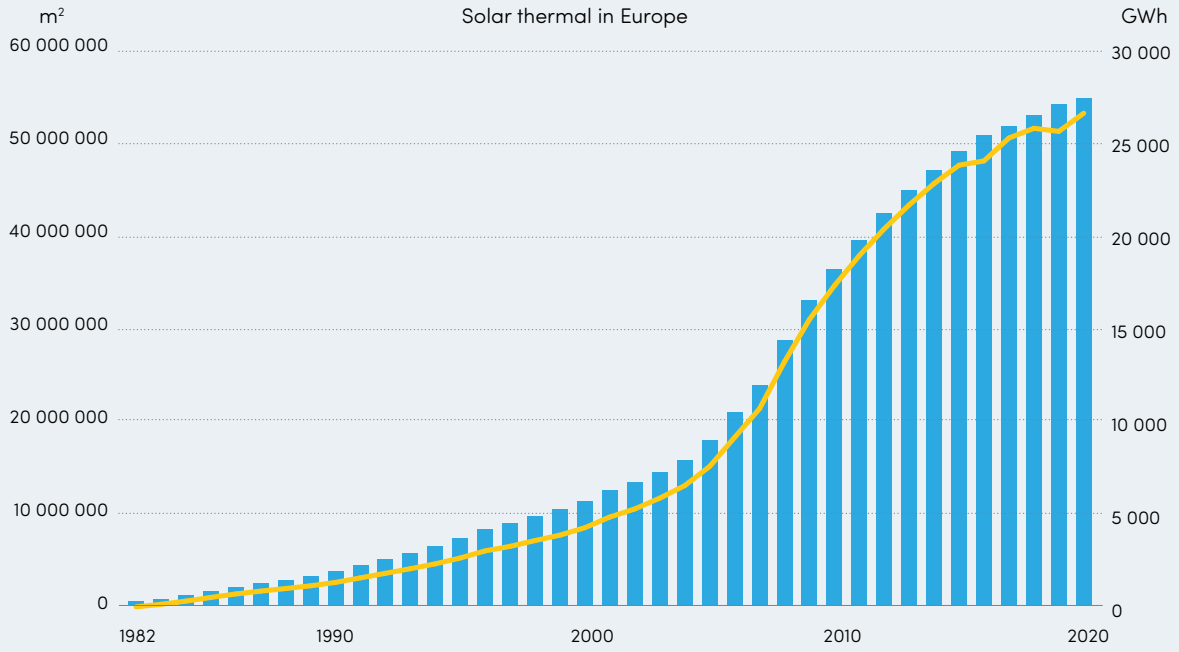


Solar thermal has been constantly growing in Europe for three decades

The solar thermal sector initially grew by the hand of enthusiasts, as an alternative addressing the oil crisis of the 70's and later, post- Chernobyl, as part of the solutions to reduce the dependency from nuclear energy. From this point on it became a solid industrial segment in Europe.

The growth of the sector has been steady, even if it has not benefitted from the public support that has been offered to other renewable technologies. Remarkably, even when competing with ***"financial"*** investments such as solar PV under Feed-in-Tariffs, the total solar thermal installed capacity continued to increase, even if at a slower pace, far from the pace reached in its record year of 2008, when the newly installed capacity more than doubled.

The growth of the solar thermal sector has been done achieved over decades and is predominantly based on the residential segment. It is possible to continue this growth, while also exploring large scale solar thermal installations for industry and district heating.



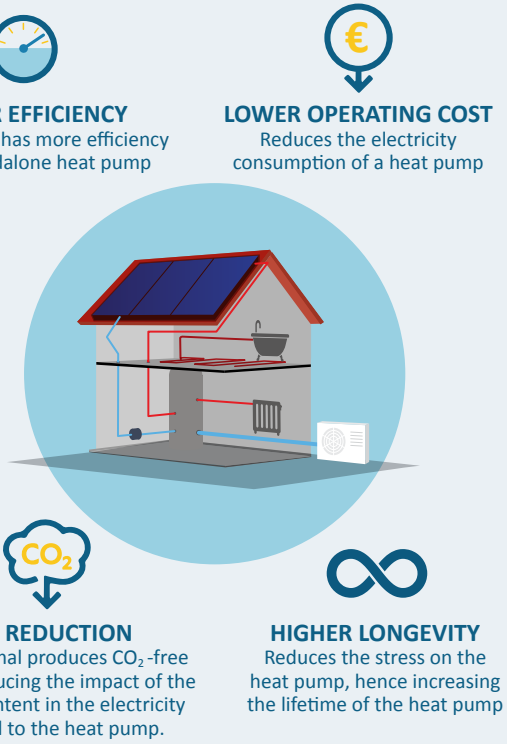
The main challenges of the solar thermal sector are not in manufacturing but on the increase of demand. **The solar thermal sector can ramp up production and reach again high growth rates in the EU market if the appropriate demand-oriented measures are in place.**

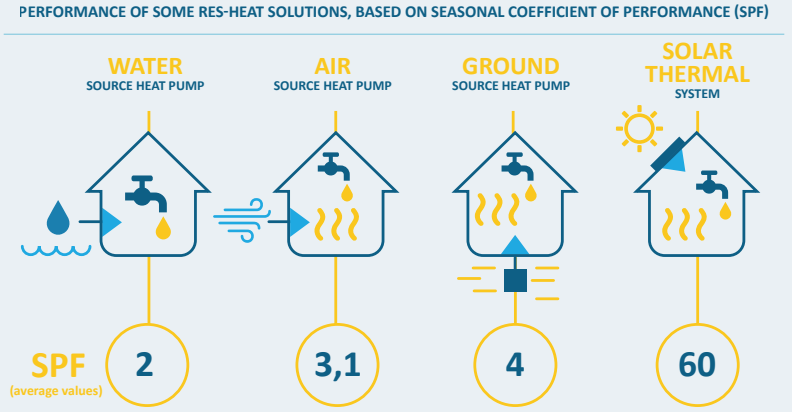
Solar thermal hybridises with heat pumps in best performing renewable heat solution

The combination of solar thermal and heat pumps is an option that allows to combine the strengths of two robust renewable heat solutions.

Heat pumps use a combination of renewable supply (e.g.: ambient heat) and efficiency to provide heat with a lower use of input energy (usually electricity). The ratio of the heat output over the electrical input (COP[9]) can reach values over 5 for the best performing systems (ground-source). A solar thermal system can reach COP values well over 60, fifteen-fold better than the best heat-pumps.

Therefore, this hybrid solution – heat pump and solar thermal – has higher performance and several benefits, as illustrated here. The advantages in performance are clear and reflected in the energy labelling of space and/or water heating packages[10], where hybrids using a heat pump and a solar thermal system reach the highest energy efficiency classes[11].





The urgency of the decarbonisation of heating and cooling in Europe, **requires the promotion of the most performant solutions,** such as solar thermal or hybrid solutions, such as the combination of heat pumps and solar thermal.

[9] CoP (Coefficient of Performance) is the ratio of heat output (in kilowatts) over the electrical input (in kilowatts). When the CoP is averaged for a full heating season it is designated Seasonal performance Factor (SPF).
[10] Commission Delegated Regulation (EU) No 811/2013 - Energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device.
[11] Online tools such as the Labelpack A+ or the HARPa tool allow to calculate and/or compare these combinations.

A Roadmap for Solar Heat

The rapid deployment of solar thermal implies commitment and support from public authorities. As such, the solar heating and cooling industry is calling on European, national, regional, and local policy makers to take decisive action. This call for action includes both demand- and supply-side-oriented measures:

Overarching measures

It is essential to develop a framework that is fit-for-purpose, meaning a steadfast reduction of carbon emissions, providing clean and affordable solutions, which create jobs and reduce the dependency from fossil fuel imports.

Higher targets for better results

It is essential that EU legislation promotes a stronger ambition, committing EU and its Member States and giving a clear signal to all stakeholders.

- Increase the overall renewable energy target to 45% in gross final energy demand by 2030, combined with national binding targets;
- Increase the binding target for renewable heat deployment to 2 percentual points per year;
- Set up a target for the renovation of old heating systems, at of 6% per year.

A game-changing carbon-pricing mechanism

Implement carbon-pricing mechanisms that reflect adequately negative externalities of fossil fuels consumption across the European economy and adjust their prices while protecting the global competitiveness of the European industry. Such revenues should be fully reverted to families and companies, to support their investments into energy efficiency and renewable energy sources.

Demand oriented measures

Such measures shall promote private investments in renewables and energy efficiency. They shall financially support consumers and businesses and incentivise them to make sustainable choices regarding their households or production sites. This can be done by recurring to:

1

Phasing out of fossil fuels and actively promote planned replacement

Phase-out measures that promote the use of fossil fuels for space and water heating and actively promote the planned replacement of older space or water heating systems with efficient and renewable option, such as solar thermal. This can be done through awareness raising campaigns, coupled with measures tackling energy poverty as schemes (e.g.: cash-for-scrap) that compel consumers to replace their old and ineffective systems.

2

Prioritise solar thermal and other RES in urban planning

Local authorities shall be encouraged and supported to include solar thermal options in urban energy planning, including the identification of priority areas (close to district heating or industries) and the facilitation of dual-land use for energy generation. Building codes shall include staged renovation in order to decouple the heating system replacement from the full building renovation when needed, for instance when a heating system replacement is likely needed before the building renovation.

3

Accelerated deployment programs for buildings, such as a Solar Rooftop Program

Develop a framework programme to be deployed in cooperation with EU Members that allows for the large scale and fast deployment of solar energy, solar thermal and/or solar PV in European rooftops. This framework programme shall promote the adoption at national level of solar obligations, including the use of solar (thermal or PV) and green-roof solutions in new buildings and large renovations and prioritise the use of solar thermal for domestic hot water preparation. Such solar obligations shall be complemented with flanking measures, such as facilitate the process of permitting, installation and decision within co-ownership associations.

4

Promote the use of on-site thermal energy storage coupled with solar thermal

The combination of solar thermal with thermal energy storage increases the resilience and flexibility of the energy system. On-site solar energy (thermal and PV) has a large potential for deployment. Both solar thermal and thermal energy storage are pivotal for the 'Zero-emissions Building' concept and must be strongly promoted in the implementation of the Renovation Wave. Thermal energy storage shall be included in building requirements, namely promoting common thermal energy storages in multi-family buildings.

5

Combination of push and pull measures

The urgency inherent to the reduction of our dependency from fossil fuels requires that regulatory requirements and financial support schemes be combined when it comes to heating and cooling. Even in the case where the use of renewables is required in buildings codes, Members States shall provide citizens with soft loans (i.e., 5 to 10 years, with 0% interest), considering even the combination with other support schemes. Families facing fuel poverty shall be fully supported to install solar thermal systems and other on-site renewables, rather than being subsidised to use fossil fuels. As for industry, individual mandates requiring a minimum level of heat demand covered by renewable heat should be combined with support measures facilitating project financing.

Additional measures shall focus on pushing companies to invest in locally generated efficient and renewable solutions. These shall help mobilise new investments and contribute to building a new Green Economy paradigm aligned with the decarbonised energy vector.

6

Accelerated deployment programs for industry

The European industry has an enormous potential for decarbonisation, in particular in low to medium temperature ranges, that represent half the heat consumed in industrial processes. Member states shall define individual mandates for companies to incorporate a higher percentage of renewables in their heat demand, for instance 5% by 2025 and 10% by 2030. The EU, in cooperation with EIB and financial entities shall create dedicated investment vehicles for renewable heat solutions, such as solar thermal. The use of Heat Purchase Agreements (HPAs) shall be enhanced, in parallel to PPAs, considering also heat as an element of the Guarantees of Origin. The decarbonisation of the EU industrial sector requires that this be made also a priority for RD&I, leading to the creation of a new Horizon Europe partnership: Clean Industry.

7

Sectoral-oriented measures for investments in RES

Incorporate in economic stimulus packages, either general or for specific sectors (e.g., tourism) an incremental support applicable (and conditional) to investments in renewable energy (or RES supply), in particular, those promoting locally generated RES for heating and cooling. These can be applied both to commercial and industrial sectors.

8

Public sector investment

Step up the public sector efforts to invest in renovation of public buildings and social housing, with a high proportion of in-loco renewable heat generation, pushing the development of such competencies within the construction sector and setting the example for individual and corporate citizens.

9

Promote climate friendly infrastructural investments

General investments in infrastructure should be in line with our climate goals, focusing on solutions that allow for an uptake of renewable energy solutions. Therefore, investments in district heating networks (new and upgrade) using RES and/or thermal storage solutions in districts or buildings should be promoted and locally generated RES further integrated in hospitals and clinics.

Supply Oriented Measures

Support from European authorities should focus on companies manufacturing in Europe, such as solar heating and cooling. This is a relevant matter regarding job creation and bringing added value to European regions and cities. It is also strategically relevant, contributing to render Europe more competitive at a global scale. This requires specific measures addressing European producers, including solar thermal manufacturers.

1

Engage in the development of a qualified workforce

The deployment of renewable solutions will require multi-valent installers, able to install different renewable solutions, often in combination. This will require large training and qualification programmes reskilling and upskilling a large workforce. Training, qualification and certification schemes shall be modular, facilitating the acquisition of new competencies that can allow to cover more technologies. For this large installers workforce, it is essential to mobilise new generations for this new occupation, while promoting the requalification of workers from other sectors.

2

Support an increase in industrial capacity

Solar thermal can increase rapidly its manufacturing capacity all over Europe. Locally manufactured RES should be a priority target (among other essential sectors) for new investment, including in terms of equity and debt financing tools, directed either to renewable industries or to renewable heat projects and utility-scale solar thermal installations.

3

Stimulate Research & Innovation

R&I funding with dedicated calls on renewable heat are needed in order to keep EU-based companies competitive and facilitate their investments in research and innovation. Dedicated calls at European and national level should prioritise SMEs and facilitate regional cooperation. For speeding up the integration of solar heat in industry, it is required to increase substantially the investment in demonstration projects.

4

Enhance exports

Help companies to develop new export channels by promoting European industry and financing of trade missions, including provision of financial support for exporting activities (e.g., financing up to 3 months of new orders) or providing credit insurance.

5

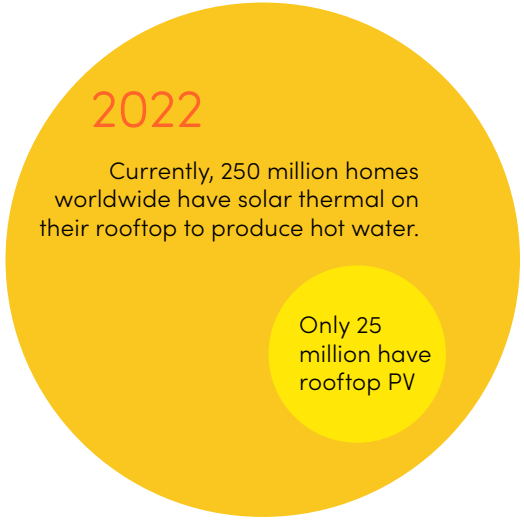
Help in creation of new channels to market

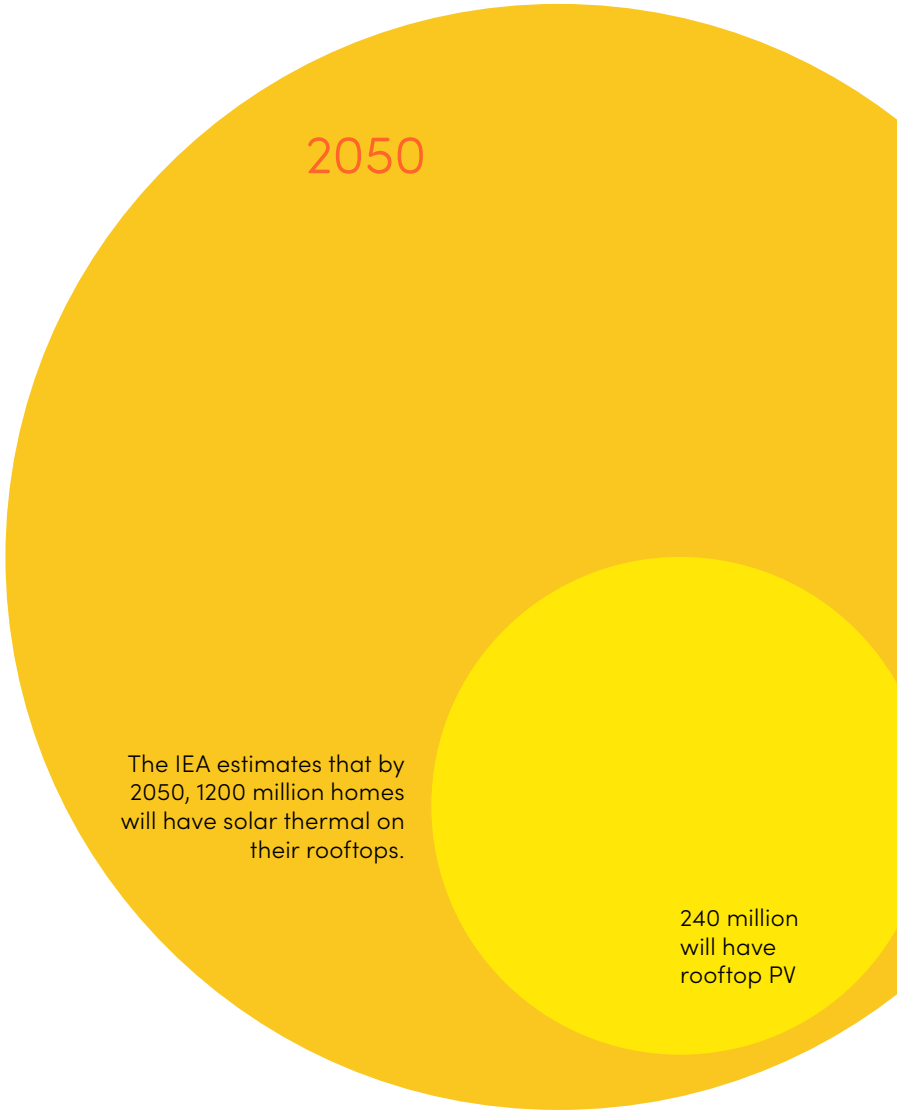
Recent events, from the pandemic to the disruption in logistics, have already changed the usual modus operandi of companies all over Europe (and beyond). Further changes will be required, and companies and sectors will develop innovative solutions, including new channels to market, supporting the digitalisation of European SMEs.

Is solar thermal better than other energy sources?

For domestic hot water in single houses
Yes, solar thermal is better!

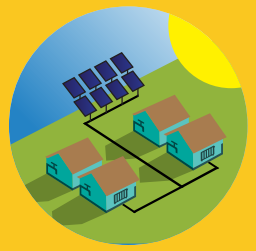
Now	**2050**
IEA: 250 million homes worldwide have solar thermal on their rooftop to produce hot water. Only 25 million have rooftop PV.	IEA[12]: 1200 million homes with solar thermal on rooftops in 2050. PV expected on 240 million rooftops.
In most part of the world solar thermal is the cheapest way with lowest CO_2/kWh to get hot water: 2–3-year payback and 20 gr/kWh[13].	Technical advance and combination with heat pump systems will further reduce CO_2 emissions and energy cost.
Solar heat is annually replacing 350 TWh of fossil energy worldwide for domestic hot water.	Solar heat will replace 2000 TWh of fossil energy worldwide for domestic hot water.





[12] Net Zero by 2050 - A Roadmap for the Global Energy Sector, IEA 2021
[13] Evaluating the Environmental Performance of Solar Energy Systems Through a Combined Life Cycle Assessment and Cost Analysis, 2019

Is solar thermal better than other energy sources?



For district heating in small and medium cities
Yes, solar thermal is better!

Now	**2050**
IRENA: Solar District Heating (SDH) plants surpass 1 GW_{th} installed in Europe, cost in Denmark €40/MWh, down to €20/MWh if built in Spain with 24 h energy storage.	IRENA[14]: SDH has a learning rate better than wind, 17% cost reduction for each doubling of installed capacity.
200 of European district heating networks (3%) already use SDH. Oldest running installation in Sweden, built in 1985.	PlanEnergi[15]: A majority of Europe's 6000 district heat networks has suitable conditions for SDH. If recycling reduces combustion of waste, solar thermal will replace the missing the energy also in large cities.
DEA[16]: With seasonal storage, solar heat can be stored from summer to winter with 5-15% energy loss and €0,4/kWh in cost compared to €200/kWh for electrical batteries	Cost for thermal energy storage will continue to decrease and can also store excess electricity from PV from summer to winter.
SDH has replaced 500 MWh/a of gas already	Forecast to replace 100 TWH gas in 2050 (30% of European district heating)

2022

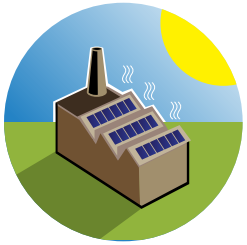
SDH has replaced
500 MWh/a of gas already

2050

Forecast to replace
100 TWH gas in 2050

[14] IRENA report highlights falling solar heat project costs, solarthermalworld.org 2021
[15] Solar District Heating -Trends and Possibilities, IEA-SHC 2018
[16] Technology Data for Energy storage

Is solar thermal better than other energy sources?



For heating industrial processes below 400°C
Yes, solar thermal is better

Now	**2050**
Quickly growing market with 200+ installations. Many large multinationals signing up – PepsiCo, Ab InBev, Colgate-Palmolive, Carlsberg, Tata, Novartis and many more.	IEA[17]: 11% of all industrial heat below 400°C will come from solar thermal.
Investments in installations solar thermal fields in food & beverage, mining, chemical industry and more	IRENA[18]: €700 billion will be invested in industrial heat up to 2050 compared to only €250 billion in biofuels.
Lowest cost of heat for numerous applications and lowest CO_2 emissions – down to 6 gr/kWh. A large number of industries do not have today other cost-efficient alternatives to replace gas.	Will be able to provide 100% of heat all year around to industries with less than 4 gr/kWh. Cost for complete system with energy storage €30/MWh.
Each hectare of land used for solar thermal replaces 4 GWh. Same are with PV replaces only 1 GWh/hectare.	Solar Thermal can replace 200 TWh of fossil energy used for industrial processes in Europe[19]

By 2050

€700 billion

will be invested in industrial heat

€250 billion

in biofuels

[17] Future role of solar heat in IEA's Net Zero Roadmap - solarthermalworld.org 2021
[18] Transforming the energy system, IRENA 2019
[19] Potential for Solar Heat in Industrial Processes, IEA-SHC/SolarPaces 2008 (adjusted from 3,8% to 11%)

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