



**Solar Heat**  
**Europe**  
ESTIF

# European Perspectives on Emerging Market Opportunities for Solar Heat to Decarbonize Industrial Processes

April 7<sup>th</sup> 2023

**Pedro Dias, Policy Director**



## MEMBERS

## MARKET SEGMENTS



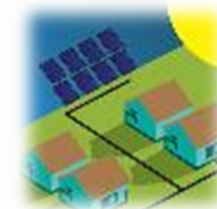
*Residential*



*Commercial*



*Industrial*



*District*

# Topics on Solar Heat for Industrial Processes

**Heat is Half!**

**Solar Heat Technology**

**Solar heat market & projections**

**Solar Heat for Industrial Processes**

**Strategic net-zero industrial sector**



**The  
a**

**ENERGY CRISIS**

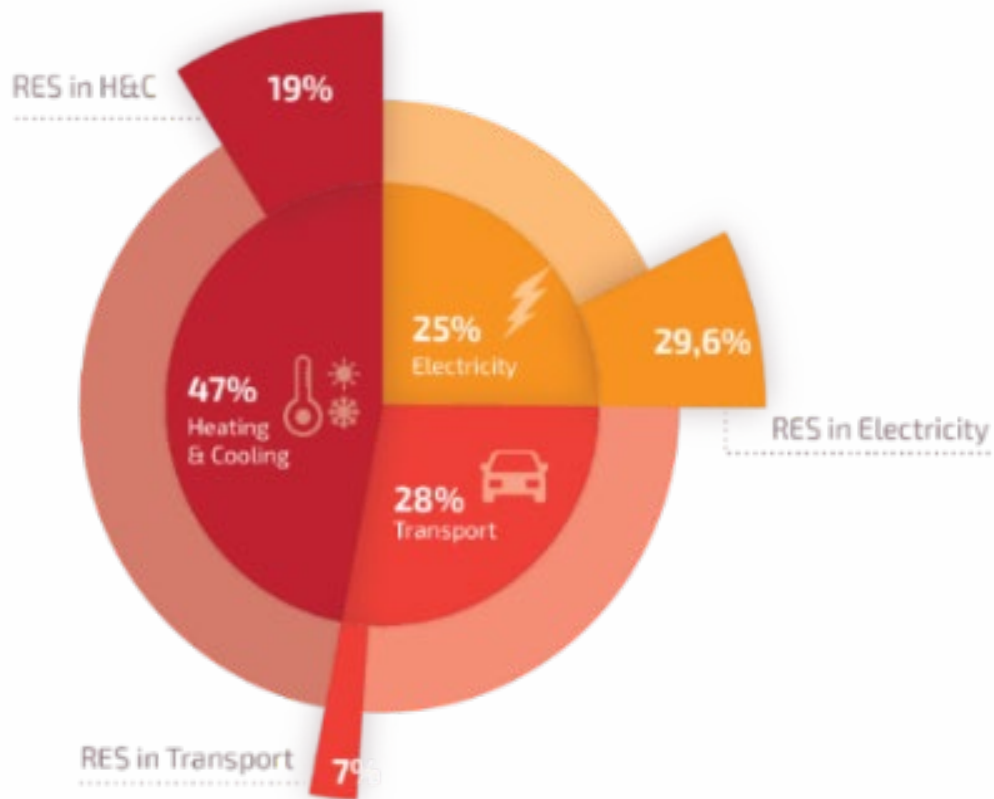
**is**

**HEATING**


**crisis.**





# #HeatIsHalf



  
Installed capacity  
in operation:  
**37.5 GW<sub>th</sub>**

  
Annual energy  
generation (estimated):  
**26.7 TWh<sub>th</sub>**

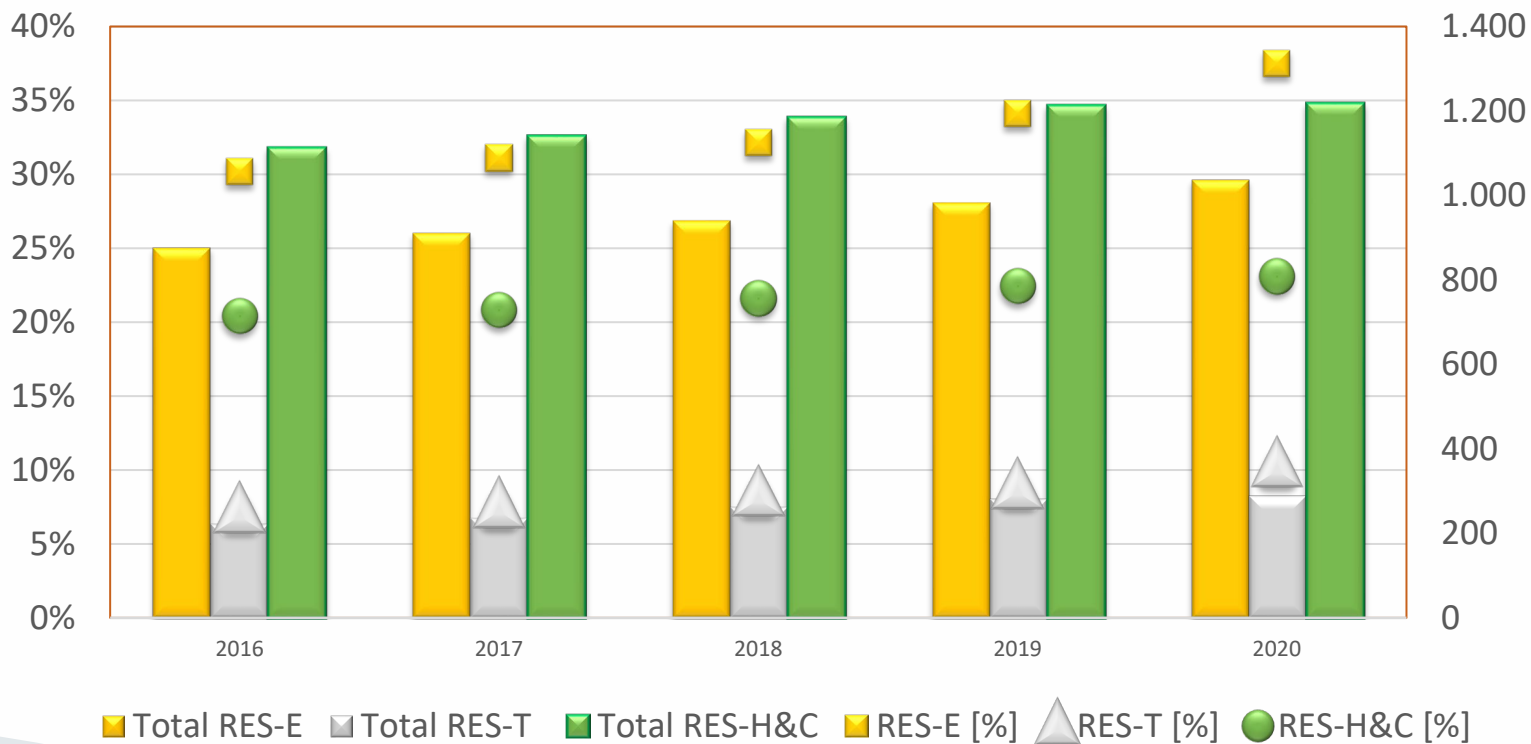
  
Total number of solar thermal  
systems in operation:  
**10.6 million**

  
Estimated energy  
storage capacity:  
**187 GWh**  
(connected with solar heat systems)



# #HeatIsHalf

## Evolution of RES supply in Europe (TWh)



Renewable heat supply in EU is higher than renewable electricity generation.



# Energy Demand: Heat vs. Electricity

Daily average demand (GW)



Daily demand for gas and electricity over the last four years in the UK. Non-daily metered gas demand is shown (excluding power stations and heavy industry), as a proxy for domestic heat demand.

Source: [postimg.cc/Cdq7RXWG](http://postimg.cc/Cdq7RXWG)

# Solar heat technology

What is solar heat?

Market segments

Solar heat collectors/panels





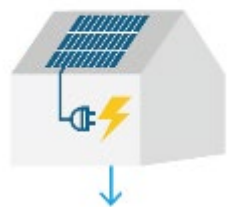
## SOLAR POWER

## SOLAR THERMAL

### CONCENTRATED SOLAR THERMAL

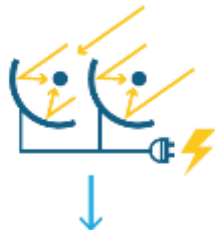
### NON-CONC. SOLAR THERMAL

SOLAR PHOTOVOLTAICS

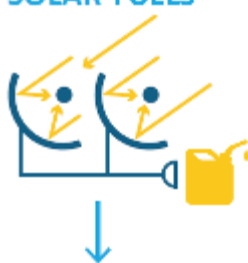


SOLAR ELECTRICITY

CONCENTRATED SOLAR POWER

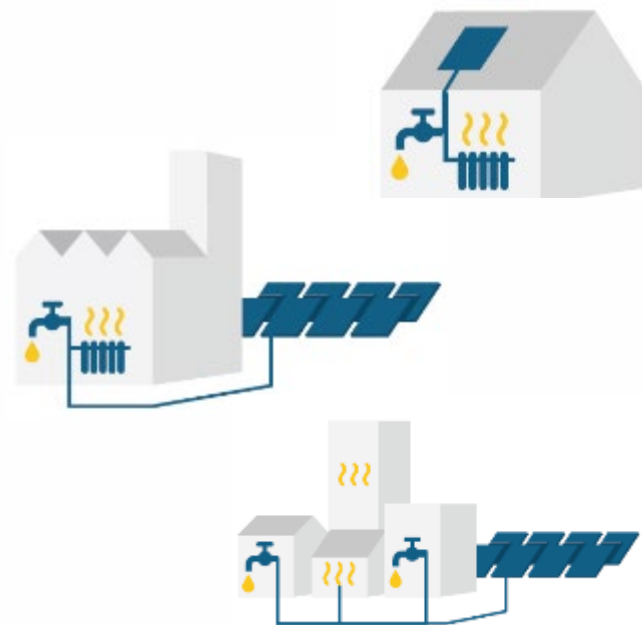


CONCENTRATED SOLAR FUELS



SOLAR FUELS

CONCENTRATED SOLAR HEAT



SOLAR HEAT



# Market segments



**Residential**



**Commercial**



**District**



**Industrial**



# Solar Heat: types of panels/collectors

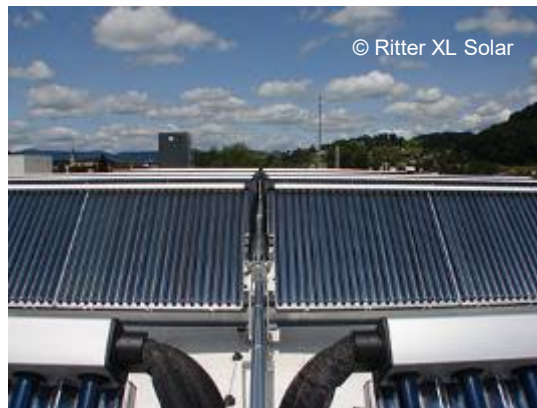
## Non-concentrated Solar Heat



Flat Plate (with single-axis tracker)



High-Vacuum Flat Plate



Evacuated Tube



Hybrid / PVT (Photovoltaic-Thermal)





# Solar Heat: types of panels/collectors

## Concentrated Solar Heat



Parabolic (concentrated solar heat)



Linear fresnel (concentrated solar heat)



Fresnel lenses (concentrated solar heat)



# Established solution looking into the future

**Solar District Heating**  
plant in Vojens, Denmark

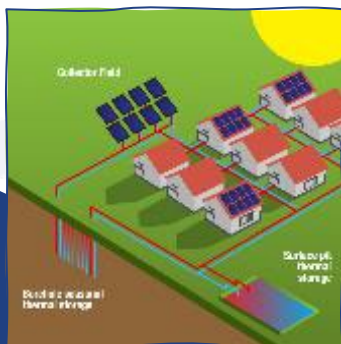
Area collectors: **70 000 m<sup>2</sup>**

Capacity: **37 MW**

Seasonal thermal storage:

**200 k m<sup>3</sup>**

Covering **50%** of heat  
demand

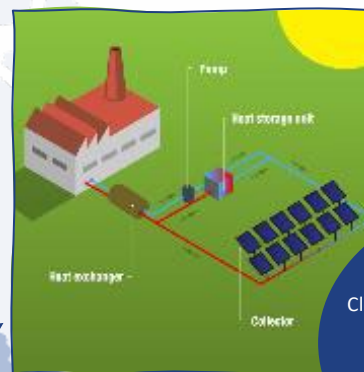


**Solar Heat for Industrial**  
Processes (SHIP) plant in France  
Clean heat for **malt production** factory,  
Boortmalt

Area collectors: **14 252 m<sup>2</sup>**

Capacity: **10 MW**

Thermal storage:  
**3k m<sup>3</sup>**



**Forced circulation solar**  
thermal system for a  
household in Spain

Area collectors: **4 m<sup>2</sup>**

Capacity: **2,8 kW<sub>th</sub>**

Thermal storage:  
**300 l / 22,5 kWh**



**Thermosiphon** for a  
household in Greece

Area collectors: **2 m<sup>2</sup>**

Capacity: **1,4 kW<sub>th</sub>**

Thermal storage:  
**200 l / 15 kWh**



# Solar heat market & projections

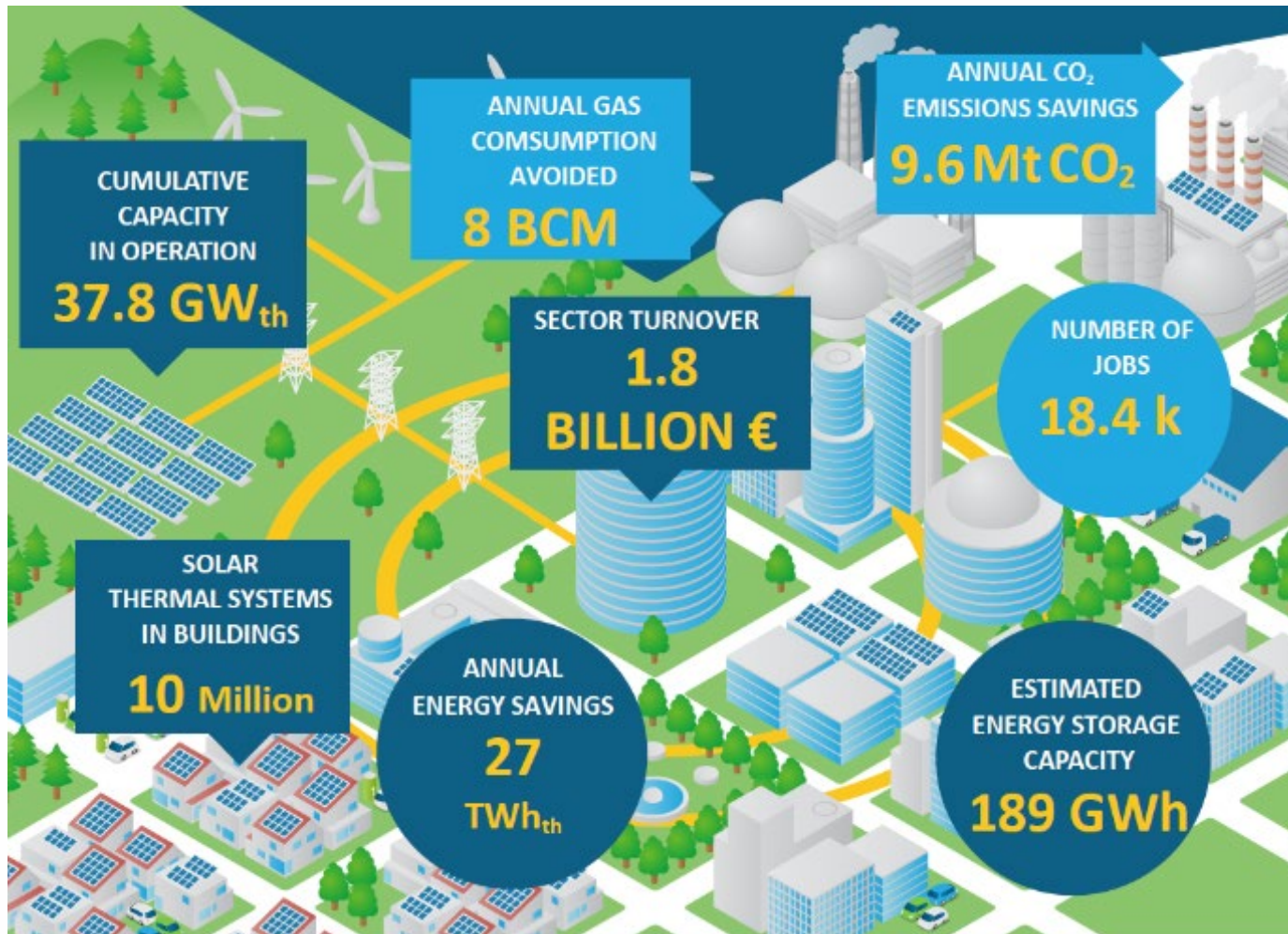
Current status

2030 – 2050

Other projections

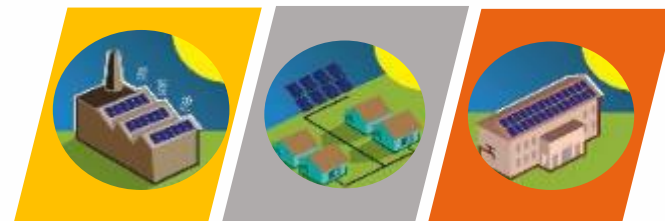
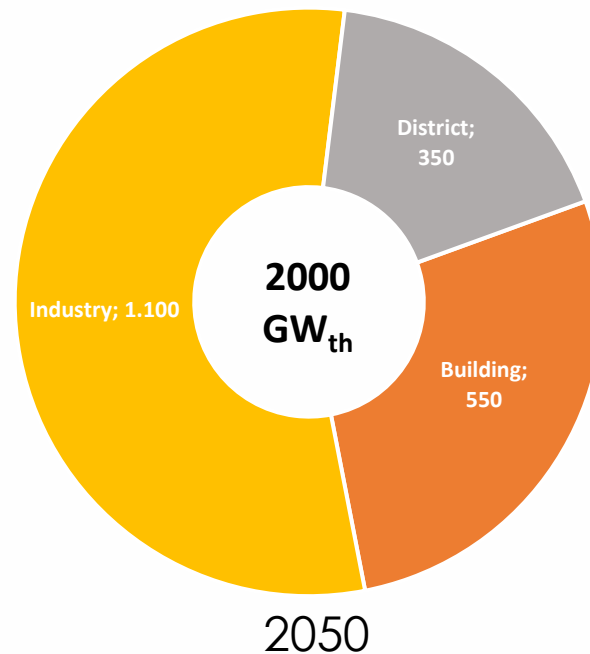
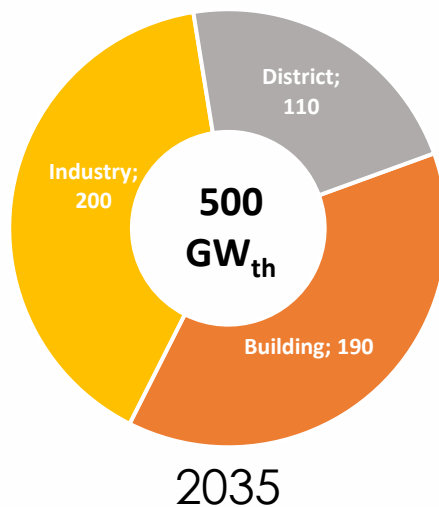
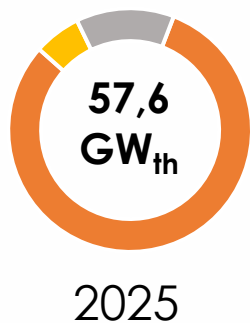


# The solar heat market today





# Solar heating & cooling by 2050







# Solar heat in buildings by 2050

## IEA Net Zero by 2050 Scenario SOLAR IN HOUSEHOLDS BY 2050:

**250**  
Million

2021

**25**  
Million



**1.2**  
Billion

2050

**0.4**  
Billion

households with  
**SOLAR  
THERMAL**



households with  
**SOLAR  
PV**

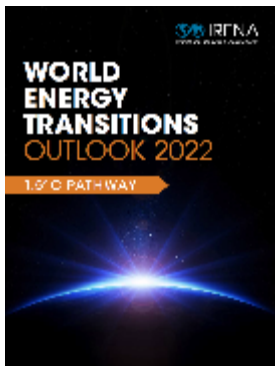




# Solar heat in industry (SHIP)

Key Indicators	Historical	Where we need to be (1.5°C Scenario)	
	2019	2030	2050
Biomass (incl. Feedstocks) (EJ) - Industry	9.2 EJ 	25 EJ 	36 EJ 
Solar thermal consumption (TWh <sub>th</sub> ) - Industry	4 TWh <sub>th</sub> 	890 TWh <sub>th</sub> 	1 291 TWh <sub>th</sub> 
Solar thermal collector area (million m <sup>2</sup> ) - Industry	5 mio m <sup>2</sup> 	1 272 mio m <sup>2</sup> 	1 844 mio m <sup>2</sup> 

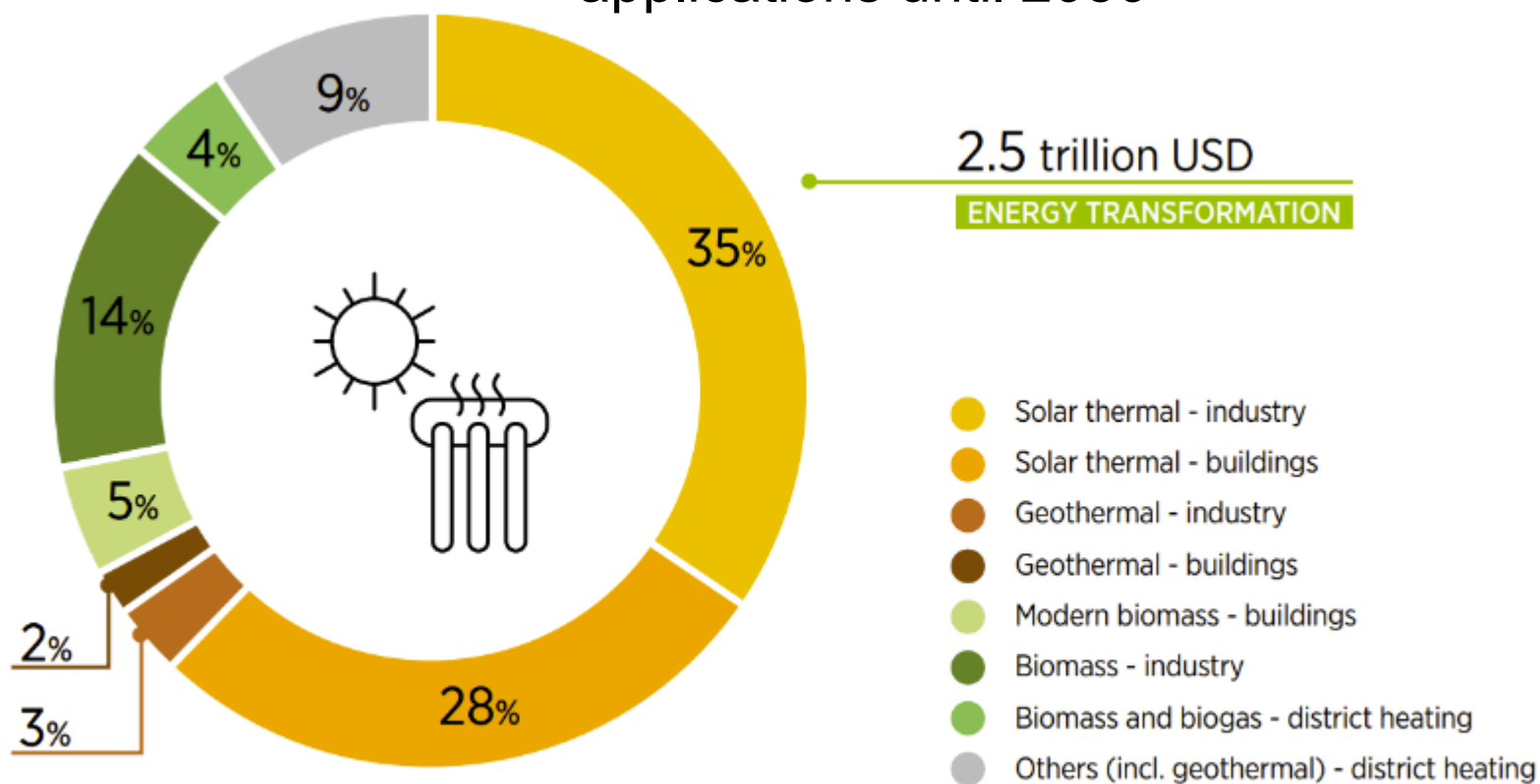
> factor 300





# Solar heat potential by IRENA

Cumulative renewable energy investments needed for direct end-uses and heat applications until 2050



Source: IRENA analysis.

# Solar Heat for Industrial Processes

SHIP integration

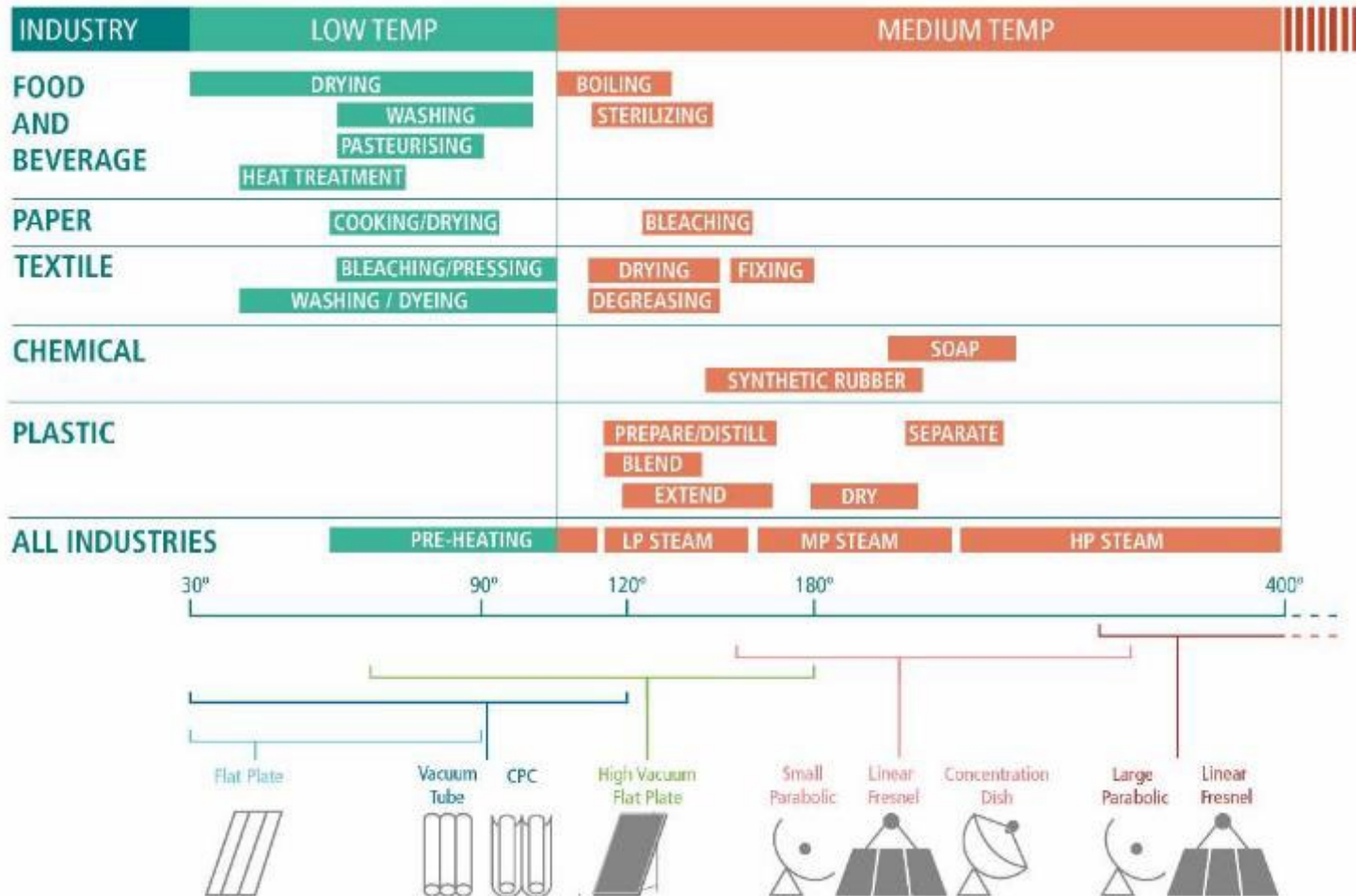
Costs: estimation, evolution

SHIP trends

Examples of medium  
temperature SHIP



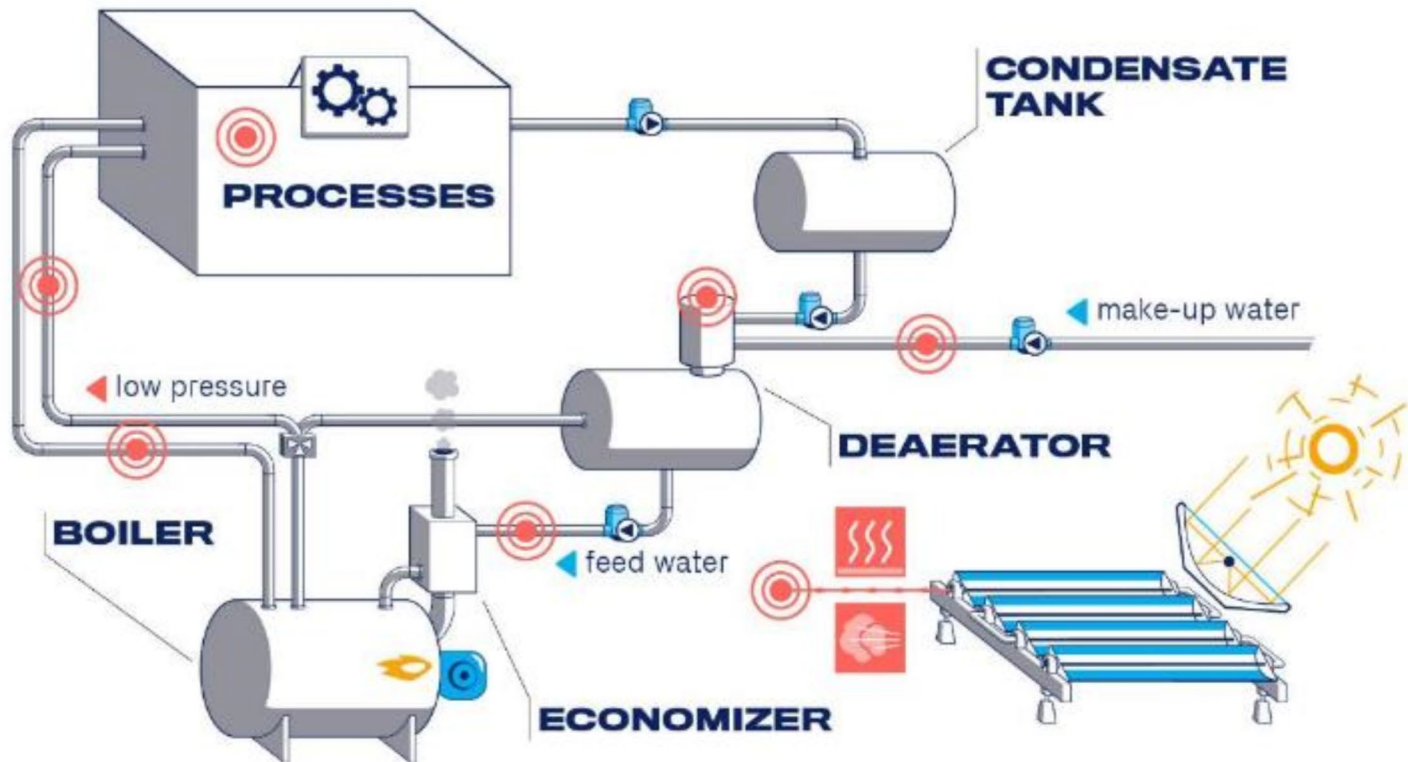
# SHIP integration: temperature ranges





## EASY SOLAR HEAT INTEGRATION

To existing heating systems







# SHIP integration: solar field



## Future cost of heat powered by solar

Your heat cost powered by solar will be **43.36** €/MWh for the next 15 years

Your heat cost powered by solar will be **28.35** €/MWh for the next 25 years

With Absolicon T160 Solar Collectors you can be competitive and lower CO2 emissions at the same time. There are several ways to integrate solar to your industry:

### EASY SOLAR HEAT INTEGRATION To existing heating systems

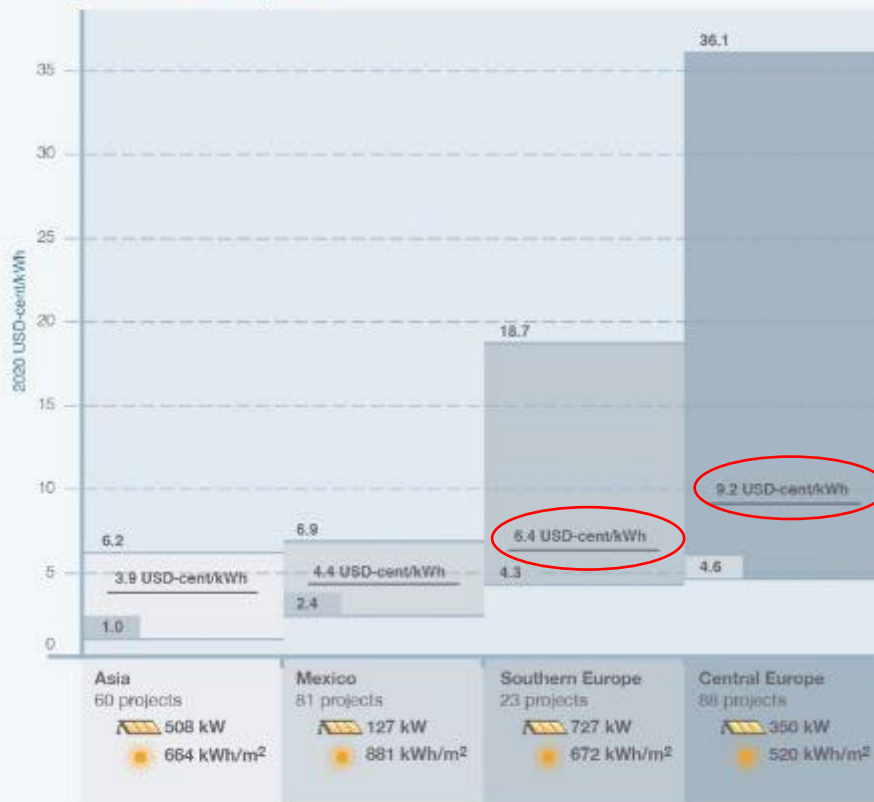


[Field Simulator \(Absolicon\)](#)



# SHIP Cost: LCoH for in Europe

Weighted-average LCOH of SHIP plants in different regions



**How to read this chart:**

The grey bands show the 5<sup>th</sup> and 95<sup>th</sup> percentiles of LCOH by project for a region / country. Projects with various collector technologies are included all commissioned in the period 2010 to 2020. The LCOH is calculated with a standardised WACC of 5 % and 25 years lifetime.

The bold line represents the weighted-average installed costs for that country/region.

Average collector field size

Average annual solar yield



COST ANALYSIS: IRENA



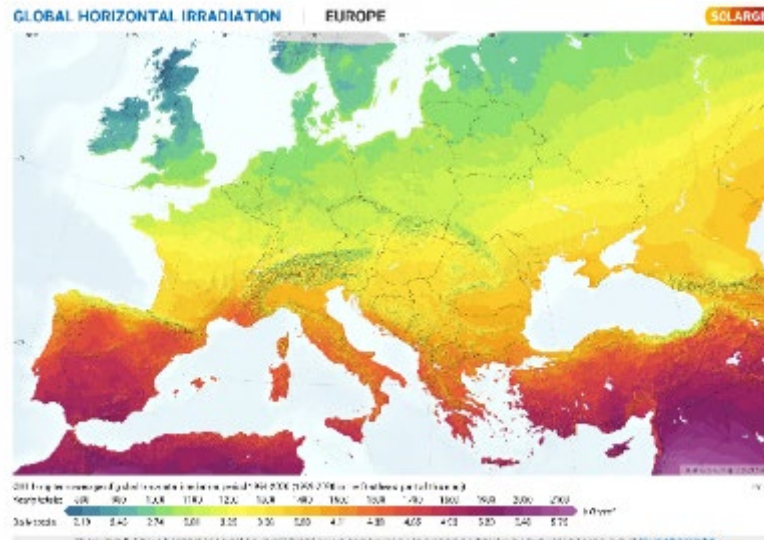


# SHIP costs: Irradiance/temperature



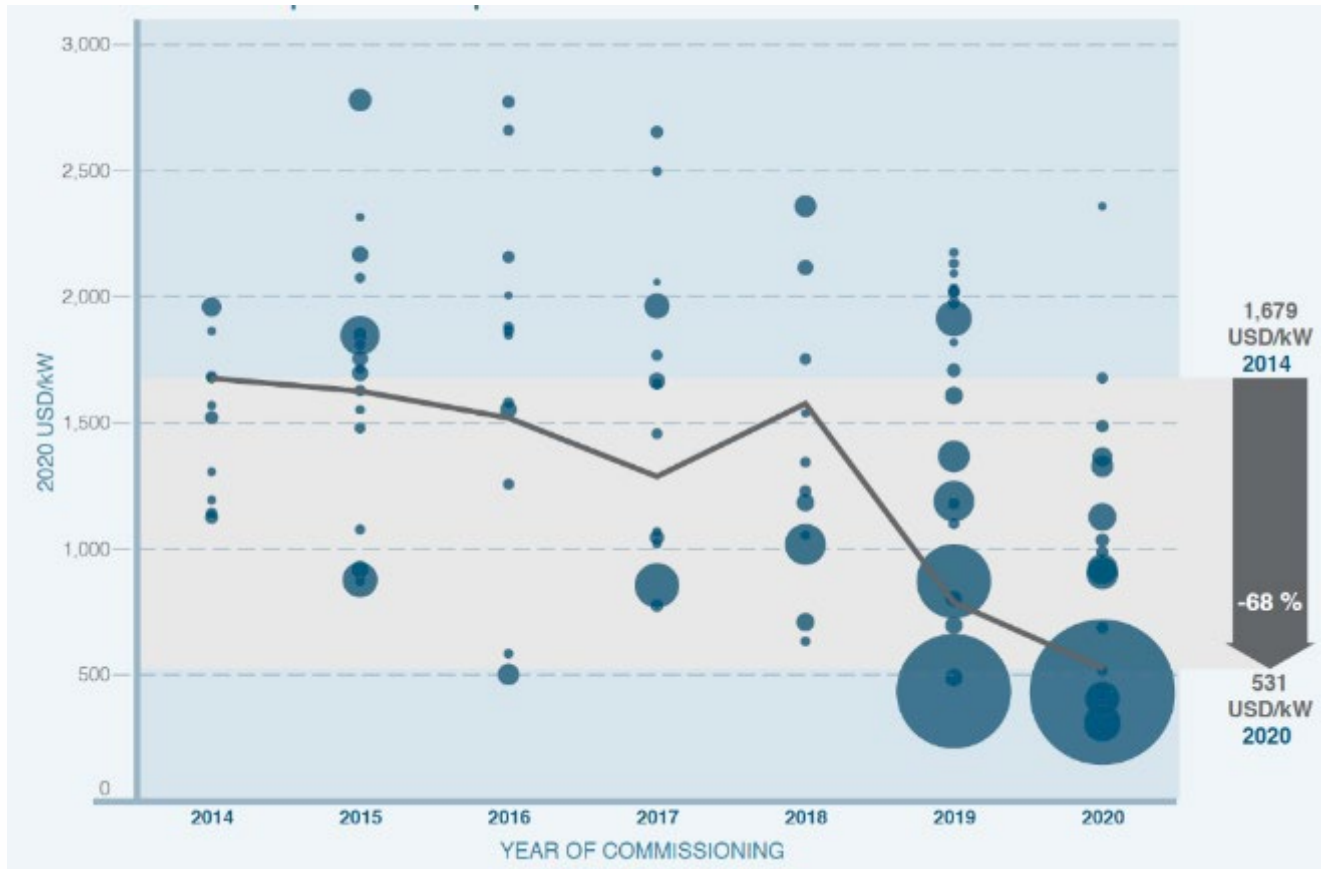
Source: TVP Solar

IRRADIANCE		1100	1300	1500	1700	1900	2100	2200	kWh/m <sup>2</sup> /year
Tm	@80°	3.9	3.1	2.7	2.3	2.1	1.8	1.8	c€/kWh
Tm	@100°	5.1	3.7	3.1	2.6	2.4	2.0	1.9	c€/kWh
Tm	@120°	6.4	4.3	3.4	2.9	2.6	2.1	2.1	c€/kWh
Tm	@150°	8.6	5.7	4.5	3.7	3.2	2.6	2.5	c€/kWh





# SHIP Cost evolution



In **2014**, the weighted-average installed costs of 11 **Solar Heat for Industrial Processes** (SHIP) projects were 1 679 USD/kW, while the average of 15 plants commissioned in **2020** dropped to 531 USD/kW, a **decrease of 68%**.

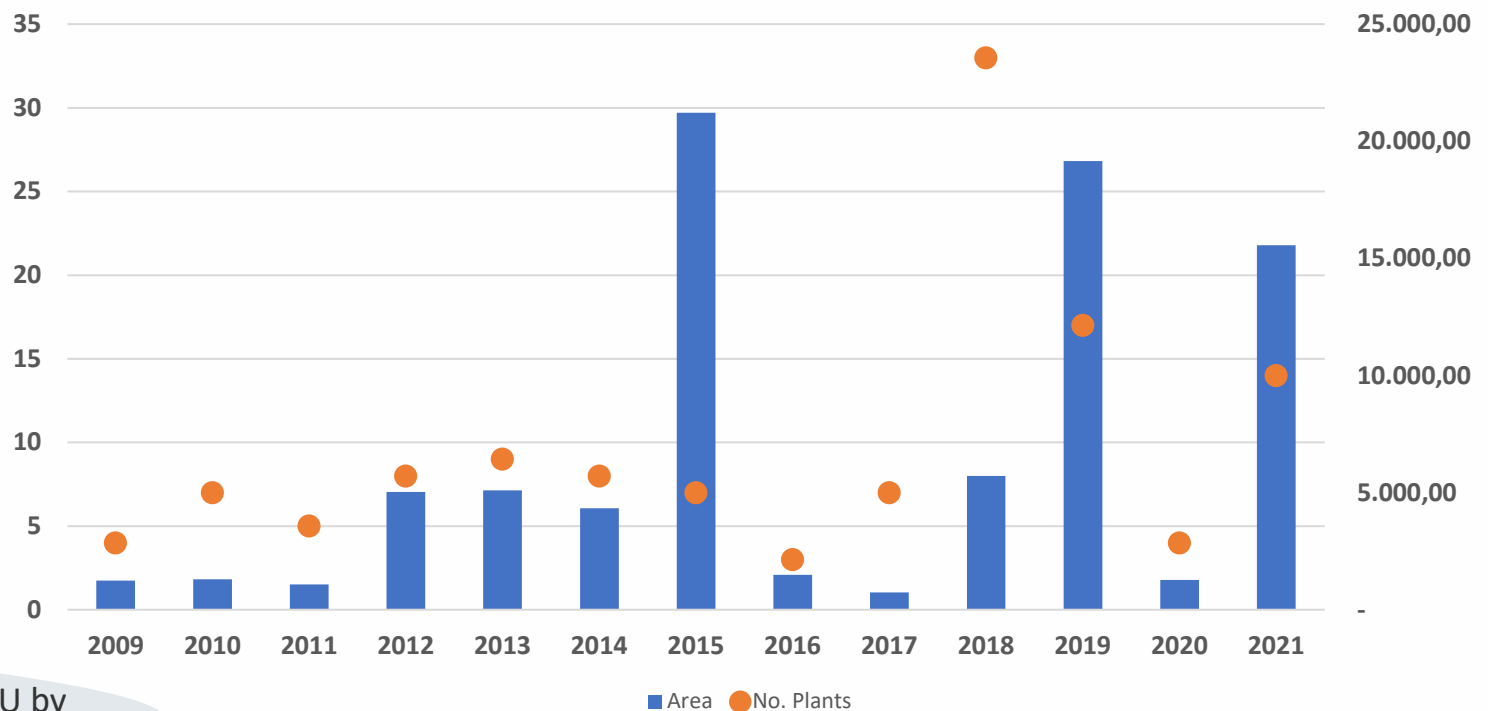


Source: *Cost Trends of Solar Energy for Heat in Industry, Solar Payback 2021*



# Trends: new SHIP systems in EU

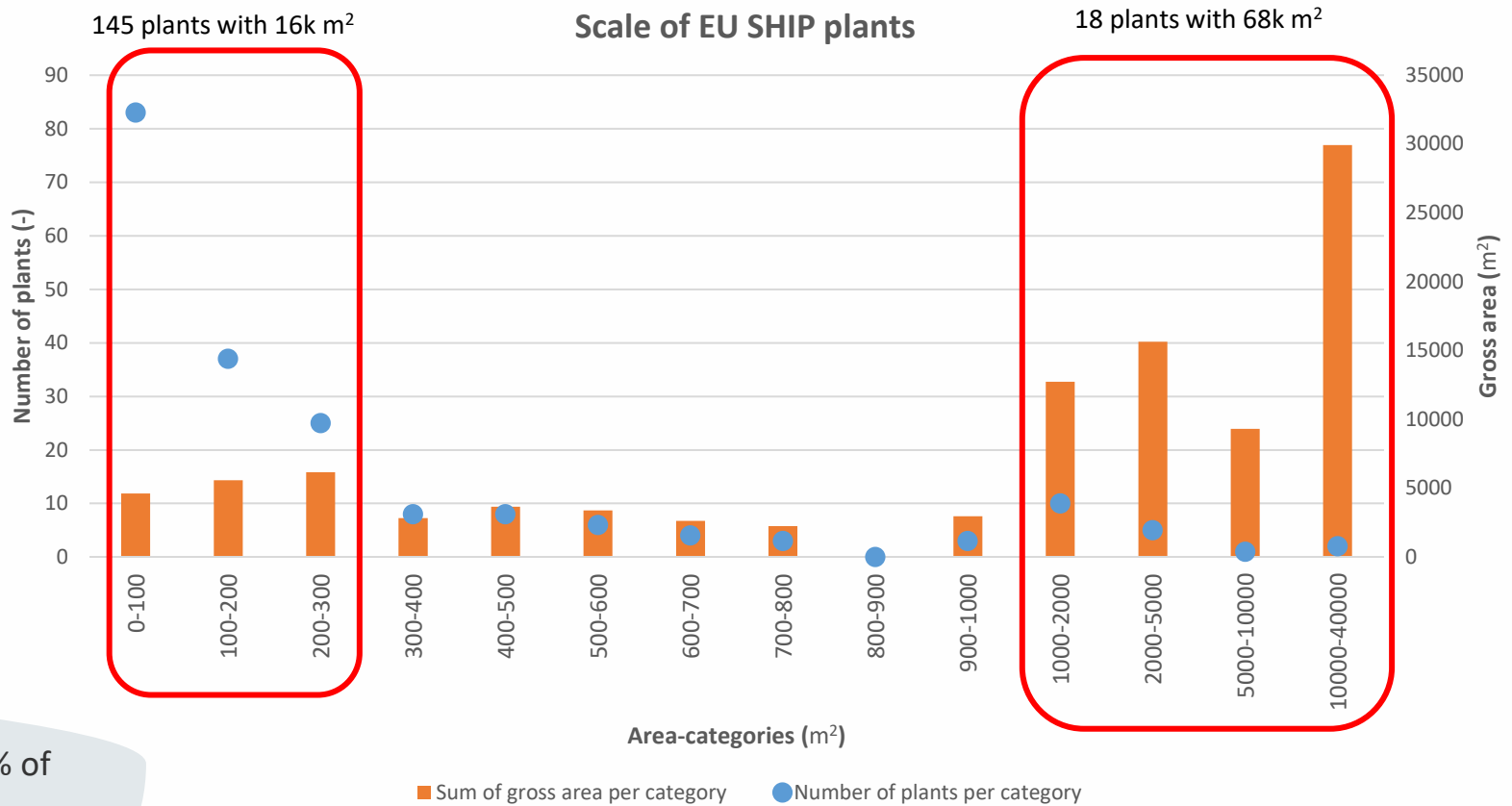
## Evolution of new SHIP plants in EU



Total installed capacity in EU by the end of 2022 estimated to be above 100 MW<sub>th</sub>



# Trends: Scale of SHIP plants in EU

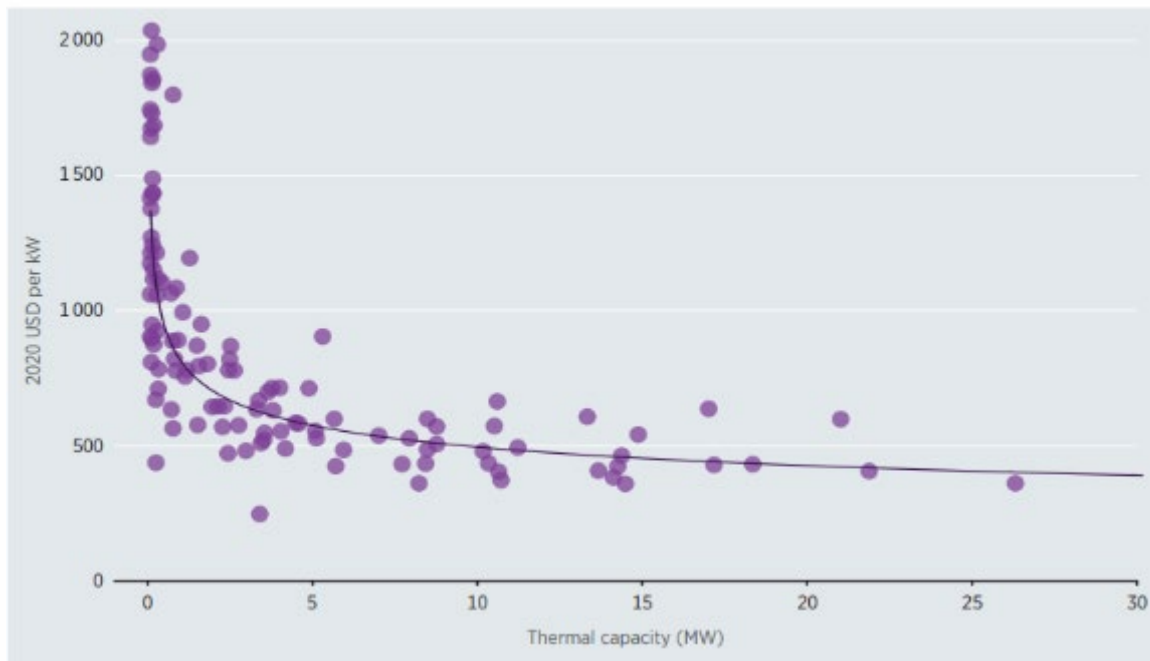


9% of the plants represent 66% of the total SHIP capacity

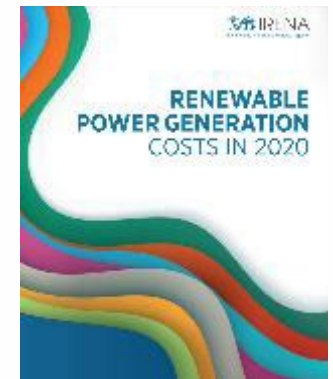


# Trends: larger systems

**Figure 9.3** Total installed costs for district heating projects by installed capacity in Europe, 2010-2020



Larger solar heat plants provide clear economies of scale, with clear results above 3 MW<sub>th</sub>.  
*Note: example from SDH.*





## Trends: Larger SHIP Plants

New Heat



**June 2019, France:** Condat paper mill, 4 200 m<sup>2</sup> (3.4 MW<sub>th</sub>)  
tracked flat plate collectors

**April 2020, the Netherlands:** 15 000 m<sup>2</sup> (10 MW<sub>th</sub>) flat plate collectors supply heat to freesias greenhouse farm







## Trends: Larger SHIP Plants



**September 2021, France:**  
Malting Plant, 14 200 m<sup>2</sup>  
(10 MW<sub>th</sub>), flat plate  
collectors



**Croatia:** 29 000 m<sup>2</sup> (20 MW<sub>th</sub>) flat plate  
collectors for malting plant (under  
development)

**Spain:** 43 400 m<sup>2</sup> (30 MW<sub>th</sub>), parabolic  
trough collectors for brewery (HPA  
contract signed)



## Trends: CSH pants globally (cumulative)



The cumulated CSH capacity is expected to reach 700 MW<sub>th</sub> globally in 2023.





# Greece

<b>In operation since</b>	<b>1999</b>
<b>Process Temperature</b>	<b>7-45 °C</b>
<b>Power</b>	<b>1,89 MWth</b>
<b>Collector area</b>	<b>2 700 m<sup>2</sup></b>
<b>Purpose</b>	<b>Warehouse cooling</b>
<b>Collector type</b>	<b>Flat Plate</b>
<b>Heat Storage Size</b>	<b>66 m<sup>3</sup></b>
<b>CO<sub>2</sub> savings</b>	<b>5 125 t/a</b>
<b>Solar plant operator</b>	<b>Sarantis S.A.</b>
<b>Specific investment costs per m<sup>2</sup> of collector area</b>	<b>484 €/m<sup>2</sup></b>
<b>Other emissions saved</b>	<b>SO<sub>2</sub>, CO, Nox, HC, Particles</b>



Source: S.O.L.E.



# Limassol, Cyprus

Solar circuit temperature	250 °C
Pressure	6 bar (Silicat oil)
Power	1 MWth
Aperture area	1 500 m <sup>2</sup>
Collector type	Parabolic trough
Payback time	3,3 years
CO2 savings	700 t/a
Gas savings	€ 165 000
Conventional steam cost	50 €/t
Solar steam cost	10 €/t
Solar plant operator	KEAN Juice Co.

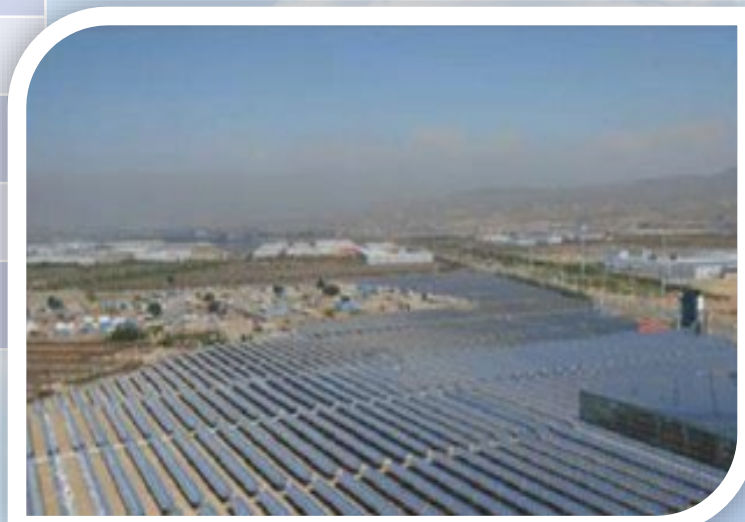


Source: ProTarget



# Baotou, Inner Mongolia, China

<b>Solar circuit temperature</b>	<b>220 °C</b>
<b>Aperture area (ground-mounted)</b>	<b>71 000 m<sup>2</sup></b>
<b>Aperture area (rooftop)</b>	<b>22 000 m<sup>2</sup></b>
<b>In operation since</b>	<b>October 2016 and June 2017</b>
<b>Heat transfer medium</b>	<b>Thermal oil</b>
<b>Total tank volume for both solar fields</b>	<b>66 000 m<sup>3</sup></b>
<b>Type of storage</b>	<b>14 steel tanks</b>
<b>Maximum tank water temperature</b>	<b>95 °C</b>



Source: Solarthermalworld.org; XuChen,2020



# Baotou, Inner Mongolia, China



<b>Estimated annual solar yield</b>	<b>83 GWh</b>
<b>Specific solar yield</b>	<b>887 kWh/m<sup>2</sup> (aperture area)</b>
<b>Backup system</b>	<b>Gas and electric boilers</b>
<b>Solar plant operator</b>	<b>XuChen Energy</b>
<b>Total amount invested</b> <i>(including storage, installation and heat network)</i>	<b>RMB 0.55 billion (USD 81.05 million)</b>
<b>Specific investment costs per m2 of aperture area</b> <i>(including heat network)</i>	<b>872 USD/m<sup>2</sup></b>

Source: Solarthermalworld.org; XuChen,2020





# Ras Al Khaimah, United Arab Emirates

<b>Solar circuit temperature</b>	<b>180 °C</b>
<b>Pressure</b>	<b>6 bar</b>
<b>Medium</b>	<b>Silicat oil</b>
<b>Power</b>	<b>1 MW<sub>th</sub></b>
<b>Aperture area</b>	<b>1 500 m<sup>2</sup></b>
<b>Land area</b>	<b>500 m<sup>2</sup></b>
<b>Collector type</b>	<b>High-vacuum flat plate</b>
<b>Specific solar yield</b>	<b>668 kWh/m<sup>2</sup> (aperture area)</b>
<b>Solar steam cost (average)</b>	<b>35 USD/MW<sub>th</sub></b>
<b>Solar steam cost (range winter/summer)</b>	<b>29- 40 USD/MW<sub>th</sub></b>
<b>Solar plant operator</b>	<b>Ocean Rubber Factory</b>



Source: TVP Solar



# Maputo, Mozambique

Solar circuit temperature	160°C
Pressure	8 bar
Power	1 MWth
Aperture area	7 920 m <sup>2</sup>
Collector type	Parabolic trough
Estimated annual solar yield	6,3 GWh
Process temperature	120 °C
Heat Storage Size	1 660 m <sup>3</sup>
Heat Storage Pressure	1 bar
Solar plant operator	AB InBev



Source: Absolicon



# Izmir, Turkey

Solar circuit temperature	180 °C
Pressure	10 bar
Power	3,5 MWth
Aperture area	4 500 m <sup>2</sup>
Collector type	Parabolic trough
Solar plant operator	Mayr-Melnhof Graphia



Source: Solar Thermal World



# Rooftop Concentrated Solar Heat

<b>In operation since</b>	<b>2021</b>
<b>Process Temperature</b>	<b>107 °C</b>
<b>Power</b>	<b>184 kWth</b>
<b>Collector area</b>	<b>264 m<sup>2</sup></b>
<b>Energy Generation</b>	<b>163 MWh</b>
<b>Collector type</b>	<b>Parabolic Trough</b>
<b>Purpose</b>	<b>Fabric Softener reactor</b>
<b>Solar plant operator</b>	<b>Colgate-Palmolive</b>
<b>Location</b>	<b>Athens, Greece</b>



Source: Colgate-Palmolive



# Strategic net-zero industrial sector

Made in Europe

Competitive & sustainable

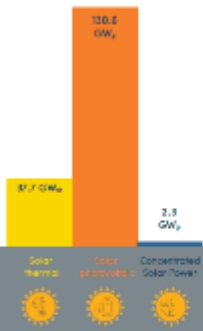
Policy and regulatory needs



# Made in Europe



Installed capacity in Europe<sup>1</sup>



Trade balance<sup>1</sup>

**Net exporter sector**





# Solar heat costs

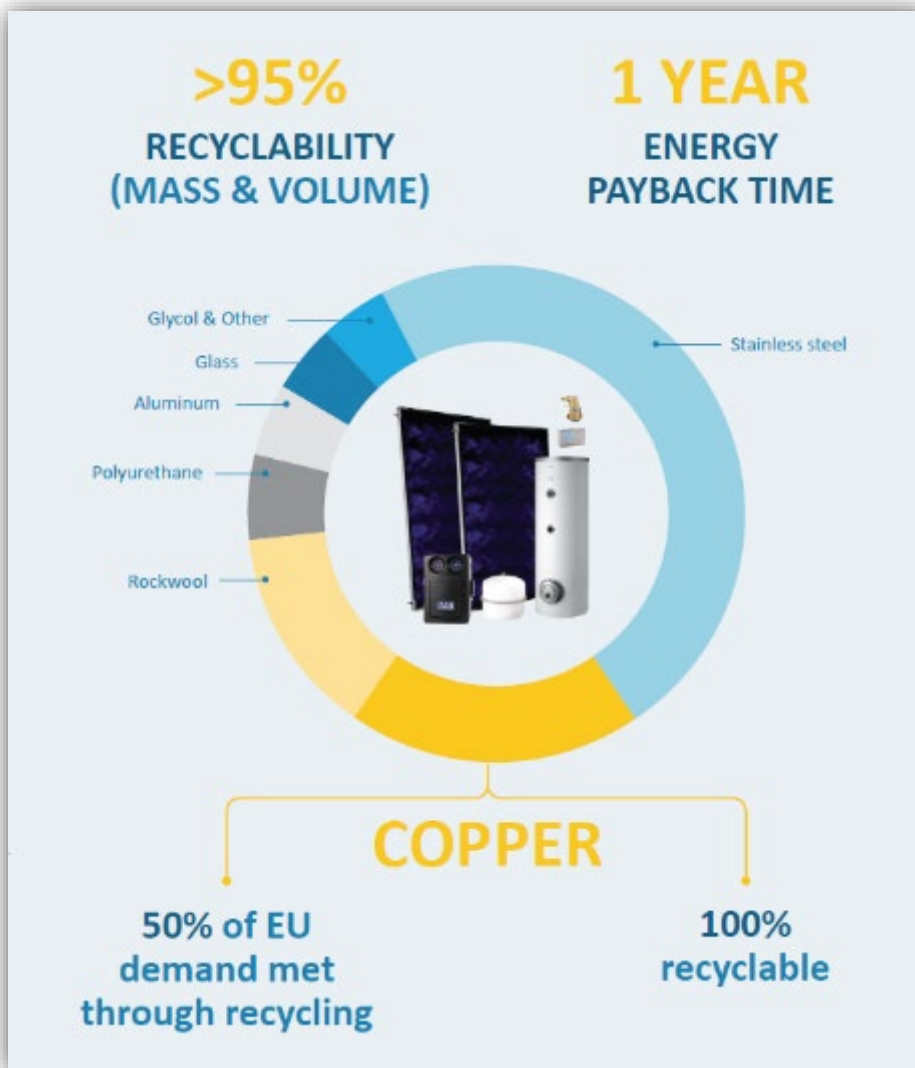
Solar thermal requires a higher up-front investment cost, which is followed by a low maintenance cost

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



With solar heat, grid and storage costs are avoided

Sources: Eurostat; Trinomics Report for the European Commission; IEA-SHC: IEA-SHC task 52, Classification and Benchmarking; Solar Heat Worldwide 2018; Energy Visualisation Portal (europa.eu)



**Solar heat is sustainable, promoting circularity and EU based supply**



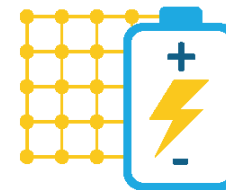
# Thermal Storage

## SOLAR THERMAL STORAGE



**180**  
GWh/a

## POWER (ELECTRICITY) STORAGE



**5**  
GWh/a



ENERGY STORAGE CAPACITY BY

**2020**

More than **20 million** EU citizens already benefit from **energy storage**, a **default element** of their **solar heat installation**.





## Green Deal Industrial Plan



- Solar thermal recognised as a Strategic Net Zero Technology
- Priority to preserve and enlarge the existing manufacturing capacity
- Strengthen the competitiveness of the EU solar heat industry

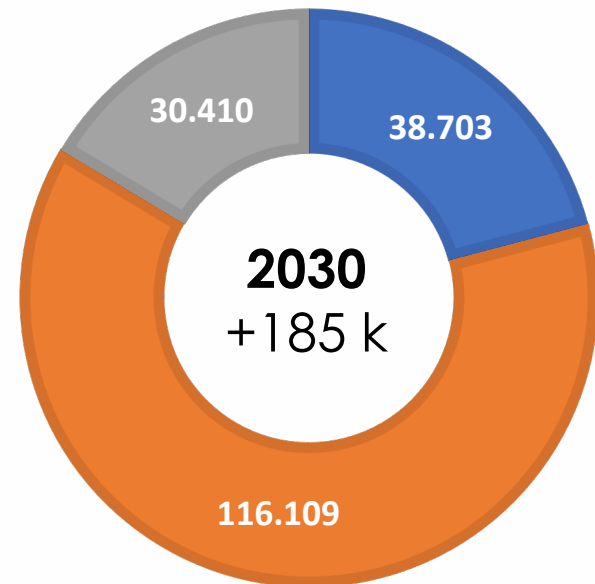




## Skilled Workforce

- Training, qualification and certification based on a modular approach
- Installers' portfolio with several decentralised RES
- Cooperation between industry and public authorities
- Start **immediately training experts** for local authorities and technical offices

■ Manufacturing ■ Instalation ■ Maintenance & other





## Innovative technologies



Fresnel lenses by Heliac, Denmark



High-vacuum flat plate by TVP Solar, Switzerland

- Inclusion of **renewable heating & cooling** in the **SET plan**
- Stronger **investment in R&I** at different **TRL levels**
- Re-purposing of the Implementation **Working Group** on CST to cover also **non-concentrating solar thermal**



Glazed hybrid PVT collectors by Abora Solar, Spain



Full project implementation:  
Solar Heat for Industrial Processes (20 MW<sub>th</sub>):  
28 months



Permitting: 24 months



## Go-to Areas in urban spaces

... artificial and **built surfaces**, such as **rooftops**, transport infrastructure areas, parking areas, waste sites, **industrial sites**, mines, artificial inland water bodies, lakes or reservoirs, and, where appropriate, urban waste water treatment sites, as well as **degraded land** not usable for agriculture ...







## National implementation of FitFor55

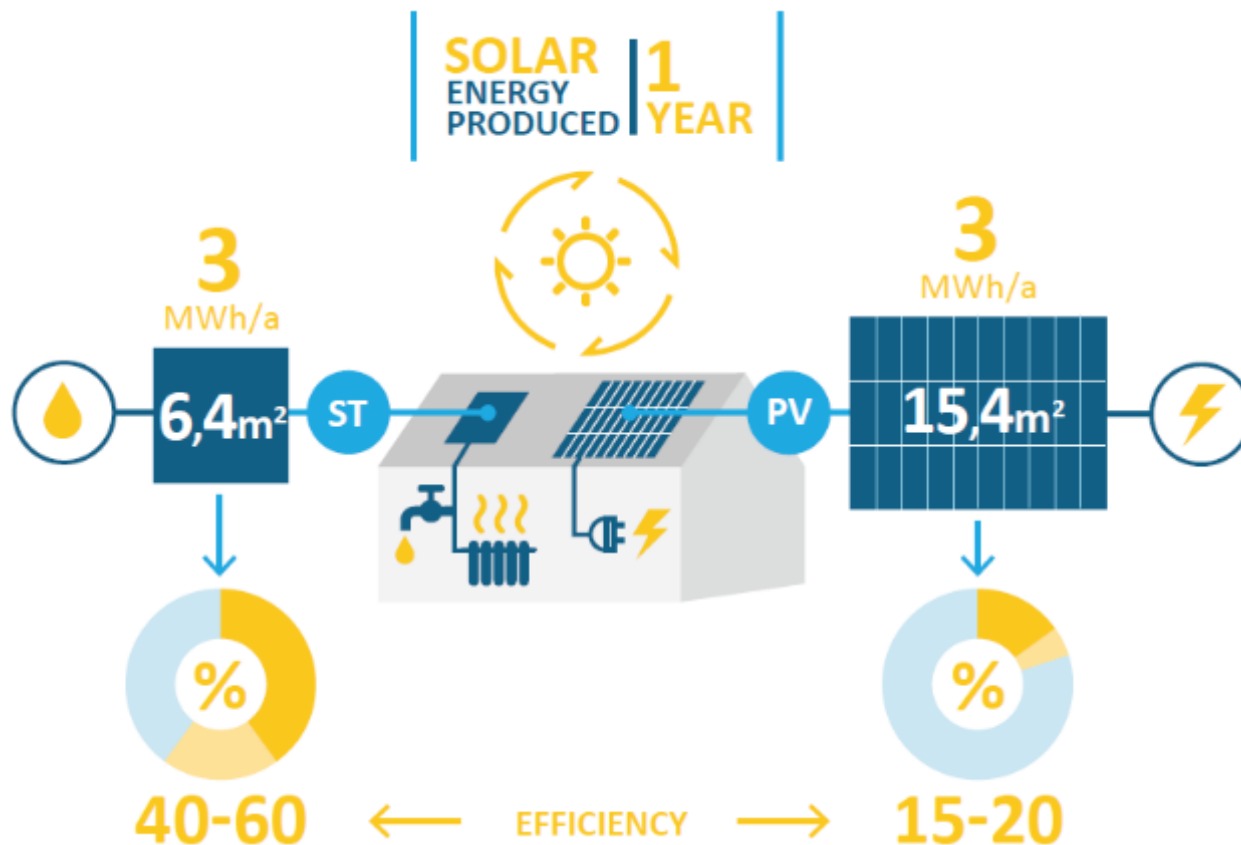
- Target for renewables in industry
- NECPs fit for purpose
- Capacity building and skills
- Demonstration projects



*SHIP2FAIR, SHIP plant, demonstration project for Martini & Rossi by TVP Solar*



# Solar Mandate



- Monitor implementation at Member State level to ensure a level playing field among solar technologies






## Heat is **half**, let's **solarise** heat!



- Clean & direct renewable heat generation
- European-based industry, locally based, net exporter
- Reduces carbon emissions
- Increases energy security and independence
- Over 100 MWth of SHIP Plants in EU
- Exceptional thermal energy storage provided
- Can be combined with any other technology
- Competitive solution for the decarbonization of industrial processes



# Energising Europe with Solar Heat

 **Solar Heat Europe**  
ESTIF

## Energising Europe with Solar Heat

### A Solar Thermal Roadmap for Europe

Achieving decarbonisation with an exceptional solution that...

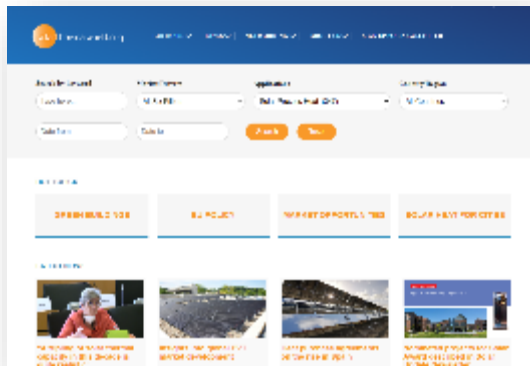
- is cheaper than electrification
- has a positive trade balance for Europe
- has an exceptional contribution to the climate and energy security
- is sustainable, promoting circularity and EU based supply
- provides the largest energy storage capacity from all RES
- provides the best energy density from 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!

#SolariseHeat | [solariseheat.eu](http://solariseheat.eu)

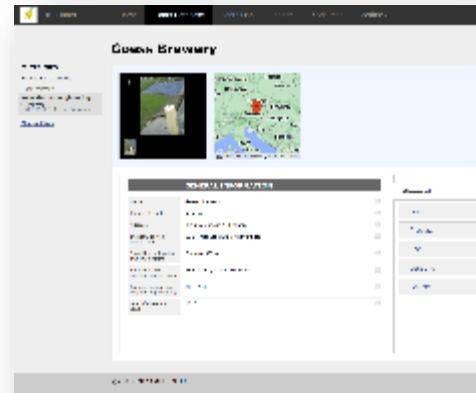




# SHIP resources



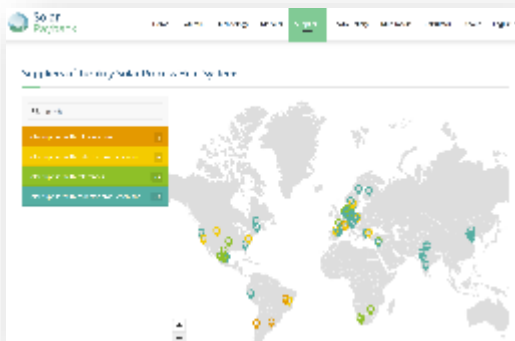
[Solarthermalworld.org](http://Solarthermalworld.org)



[Ship-Plants.info](http://Ship-Plants.info)



[IDAE.es](http://IDAE.es)



[Solar-Payback.com](http://Solar-Payback.com)



[Task64.IEA-SHC.org](http://Task64.IEA-SHC.org)



[ren21.net/gsr-2023](http://ren21.net/gsr-2023)



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