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# Lecture:
# Market Potential for SHIP Applications

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# Outline of the Presentation

- Introduction
- SHIP vs CSP: what make it different
- Industrial Processes (What is it?)
- Current Applications of SHIP
- Market Potential in EU
- Cost of Heat from SHIP
- Conclusions

# Introduction

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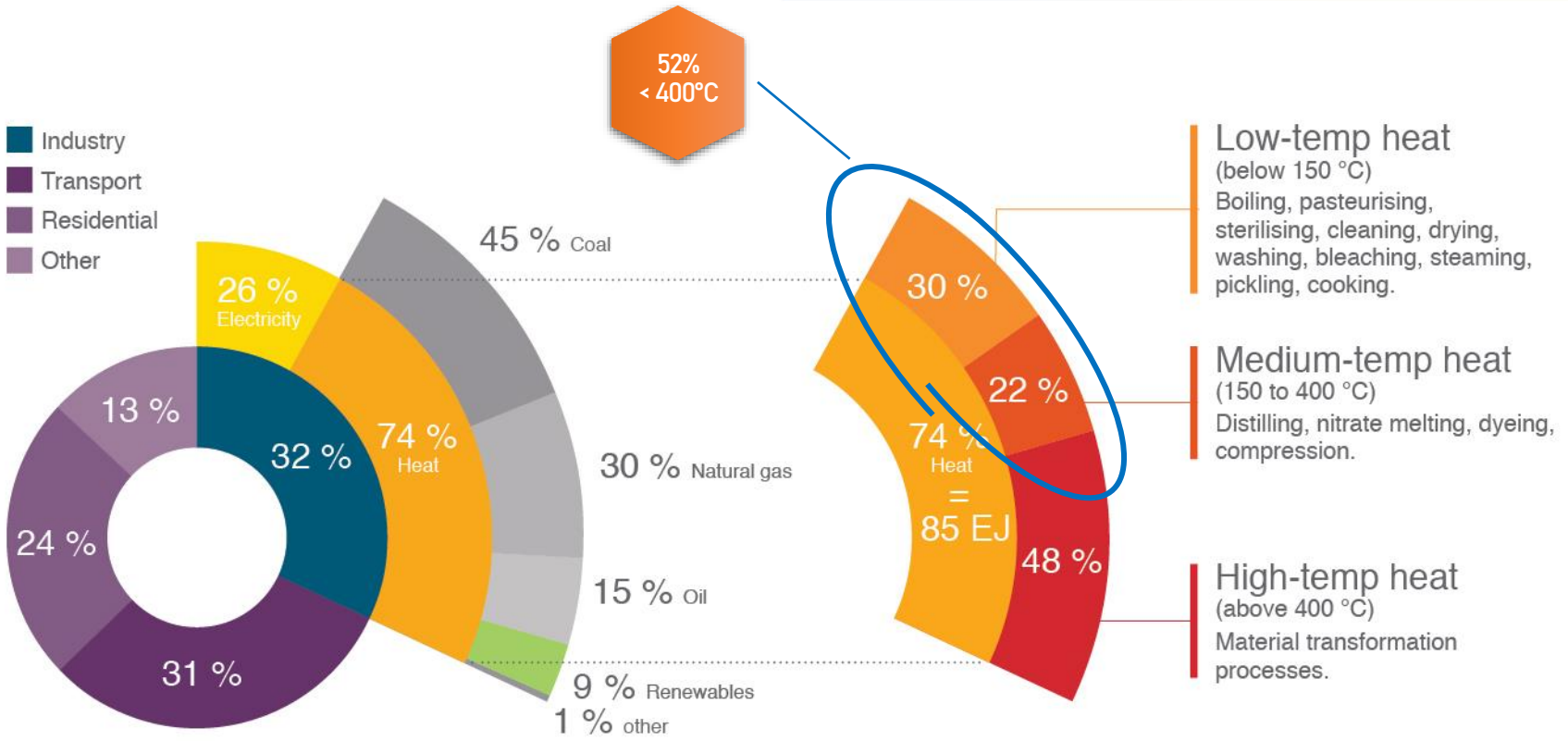
# Introduction - Heat Demand World-Wide



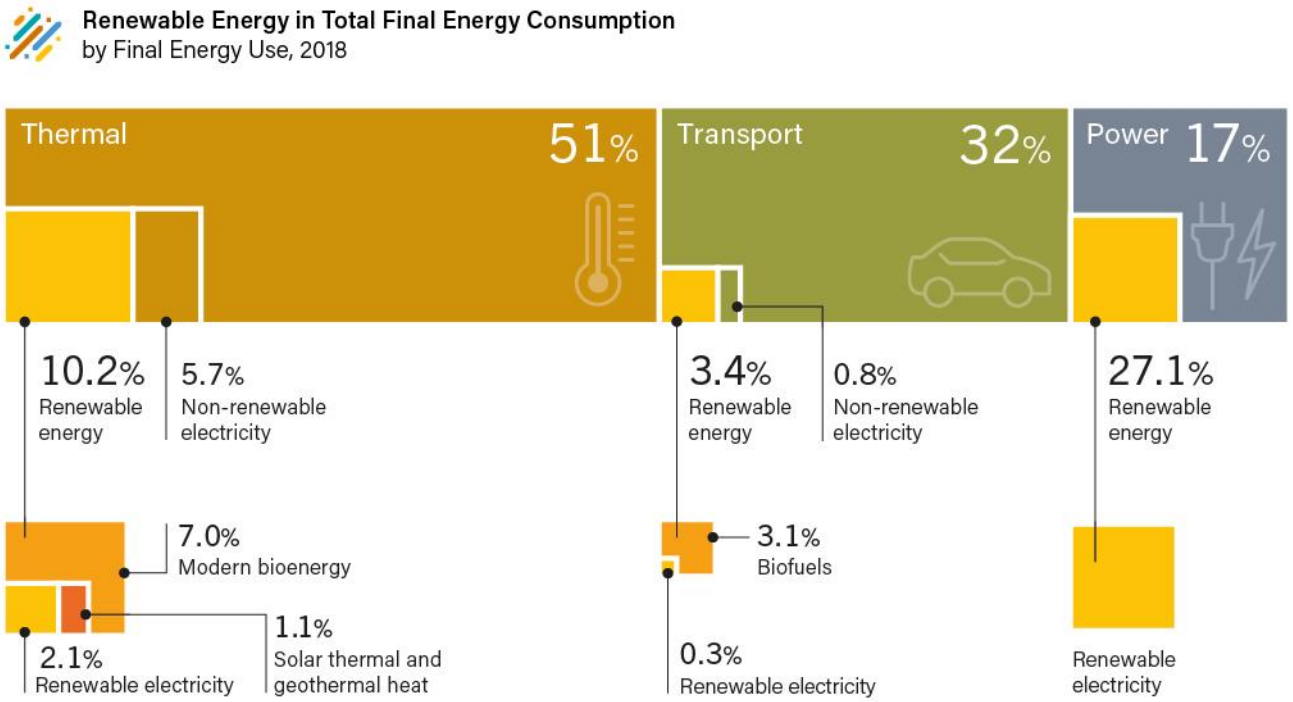

Heat represents three quarters of the total energy demand of industries world-wide

30% of this heat demand is for T<150°C

More than 50% is for T<400°C

SolarPayback (2017) Solar-Heat-for-Industry-Solar-Payback

# Introduction – Solar Thermal in the Total Final Consumption WW

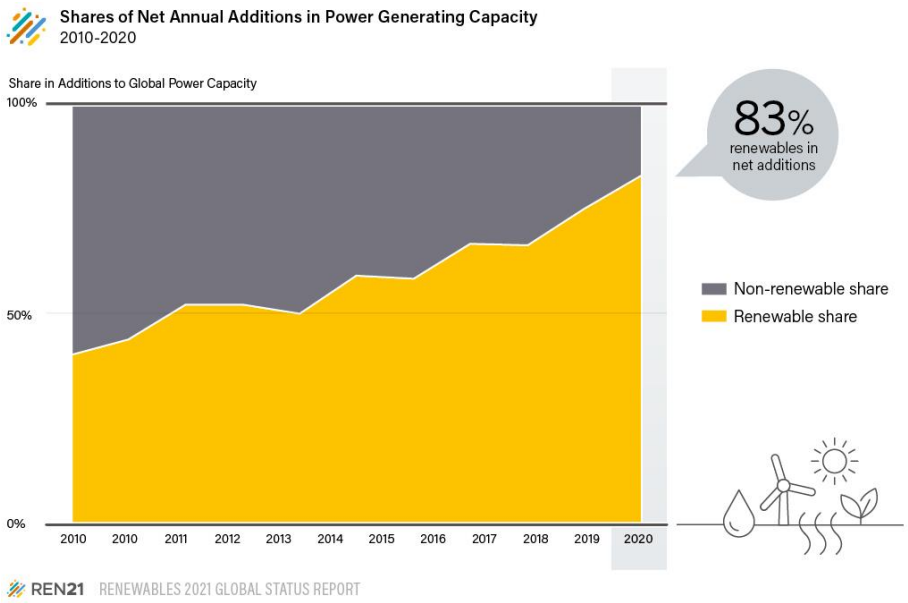



Solar thermal heat represents less than 1% of the total final energy consumption world-wide

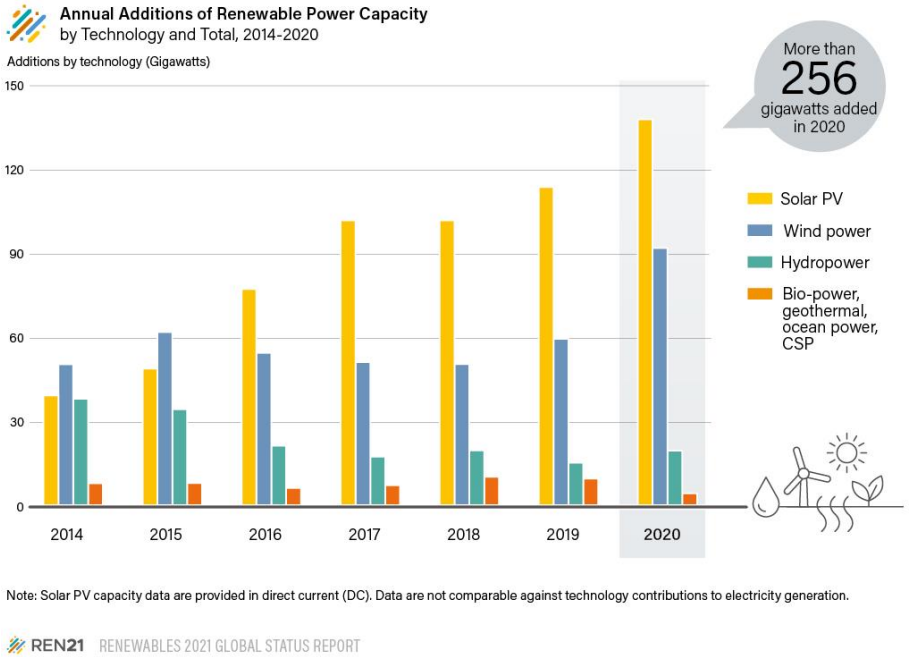
→ We are almost invisible…

REN21 (2021) Renewables 2021 Global Status Report

# Introduction – Annual Additions of REn World-Wide



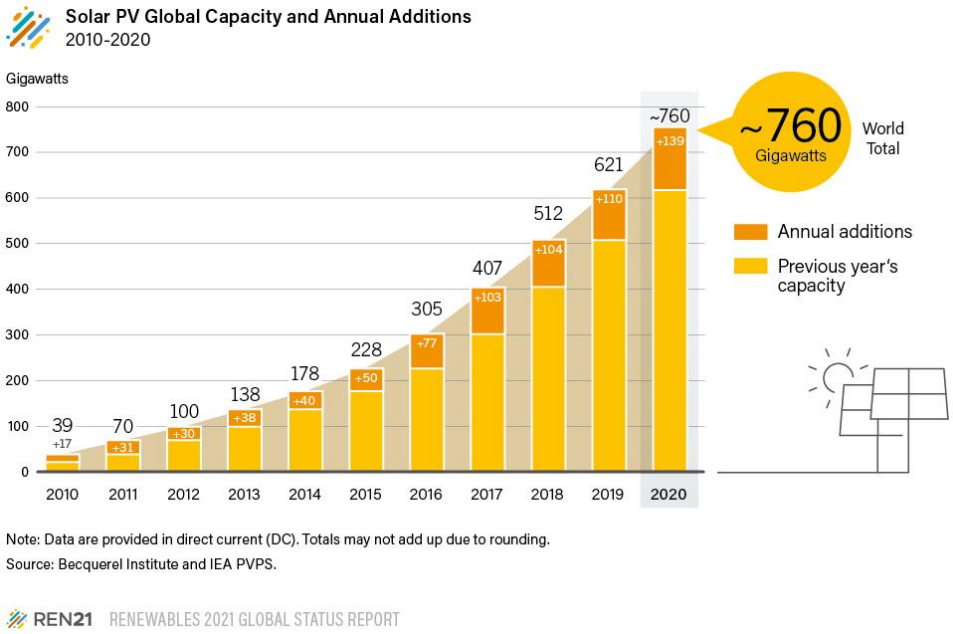

Today, 83% of new addition in power generation is already from REn…

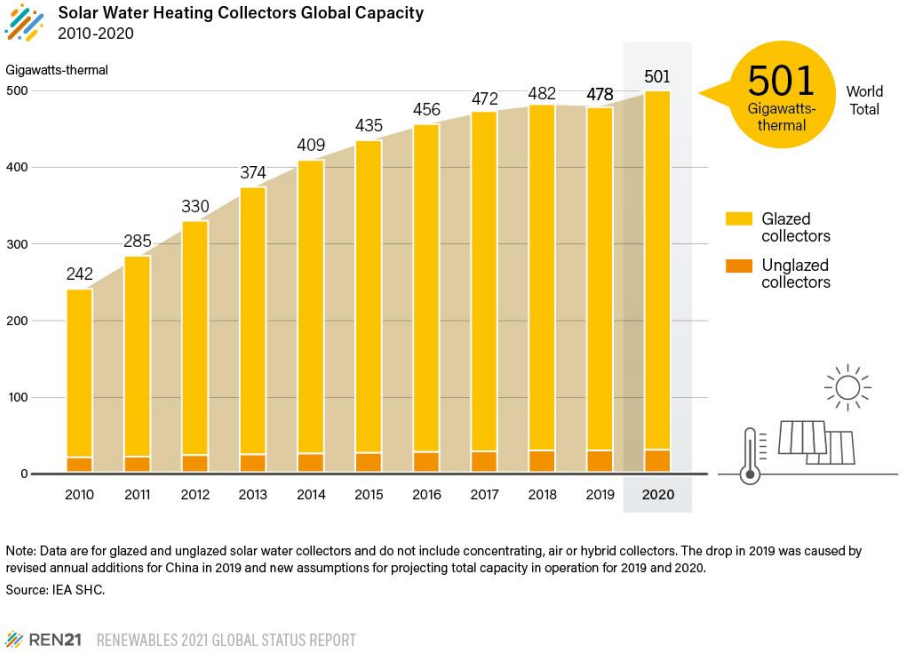



And PV lead the game:
this tends to shadows the Solar Thermal…

REN21 (2021) Renewables 2021 Global Status Report

# Introduction – Evolution of Solar Capacities World-Wide




This is the kind of development we would like to see (also) for the Solar Thermal

And this is what we have…

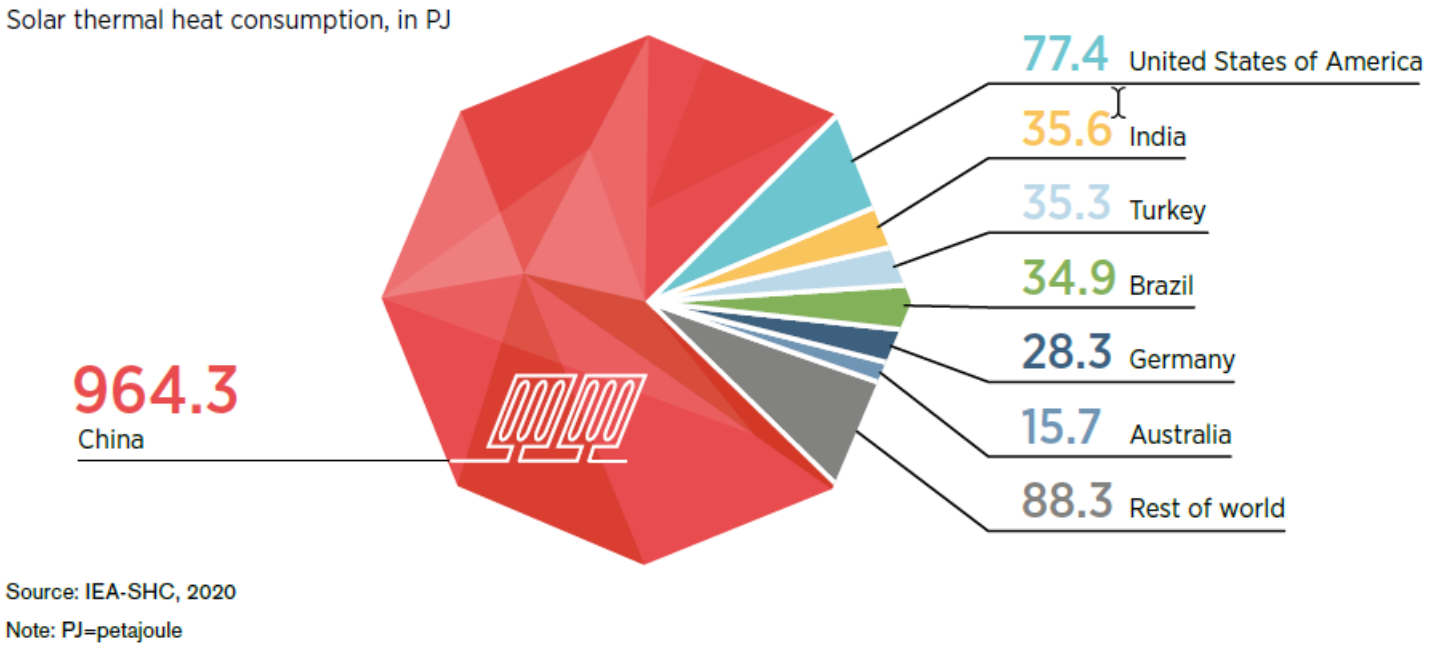
Note that solar water heating is actually the most important market for Solar Thermal…

…where it is about to be beaten by heat pump plus PV systems.

REN21 (2021) Renewables 2021 Global Status Report

# Introduction - SHIP, Everything is Still to be Done

Solar thermal consumption in the largest consumer countries, 2017




Source: IEA-SHC, 2020

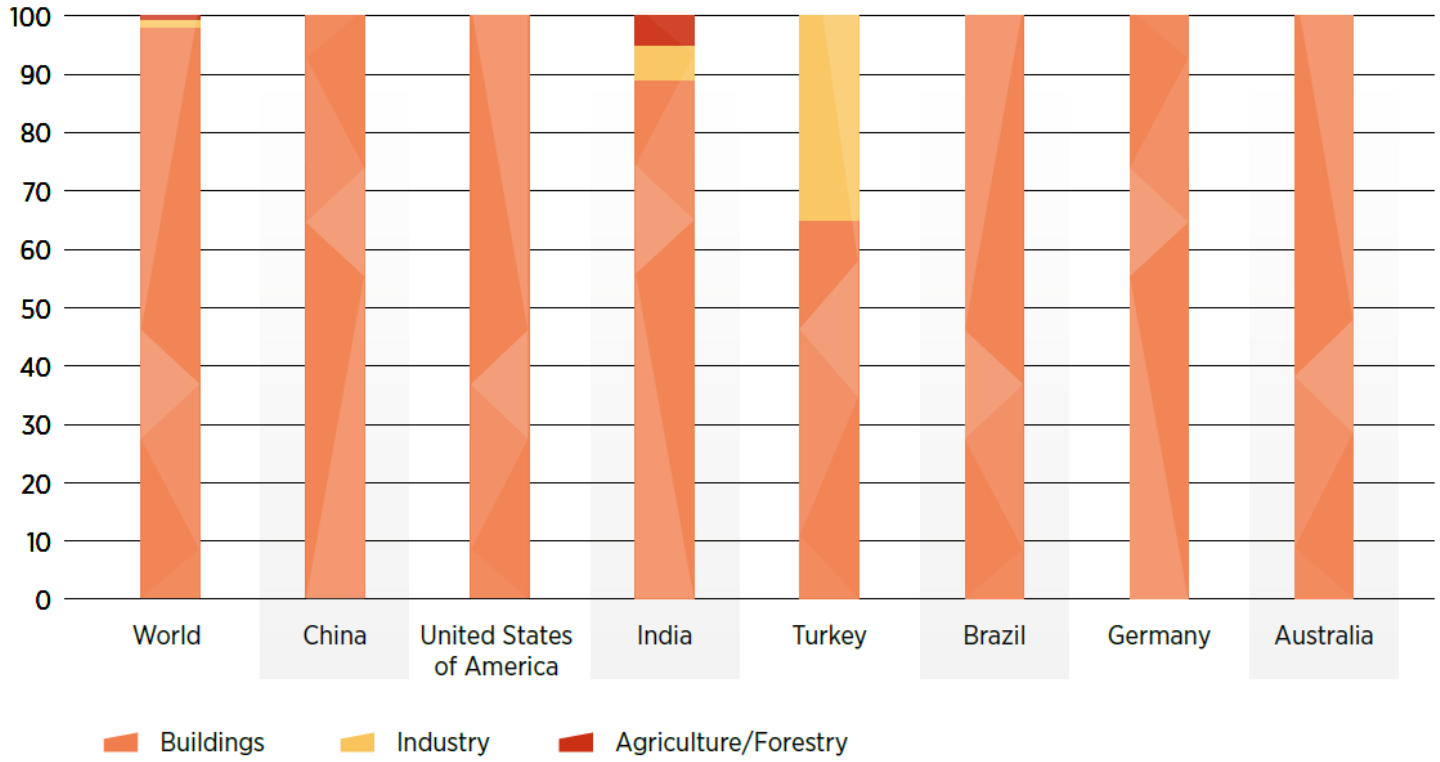
Note: PJ=petajoule

In decreasing order, China, the United States, India, Turkey, Brazil, Germany and Australia had the largest solar thermal heat consumption in 2017

IRENA_IEA_REN21 (2020) Renewable Energy Policies in a Time of Transition - Heating and Cooling

# Introduction - SHIP, Everything is Still to be Done

Distribution of solar thermal heat consumption in the largest consumer countries and worldwide, by sector, 2017




In 2017, 99% of total global solar thermal heat consumption was for buildings…

So, everything is still to be done for Solar SHIP !

IRENA_IEA_REN21 (2020) Renewable Energy Policies in a Time of Transition - Heating and Cooling

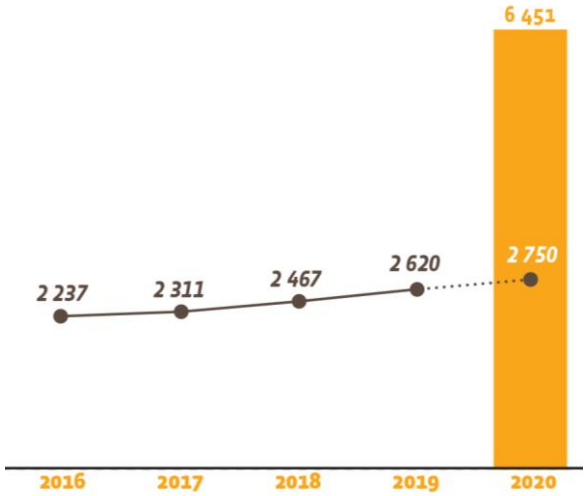
# Estimated solar thermal capacity installed in the EU end 2020 (MWth)

***"Renewable heat is in line for a break"***

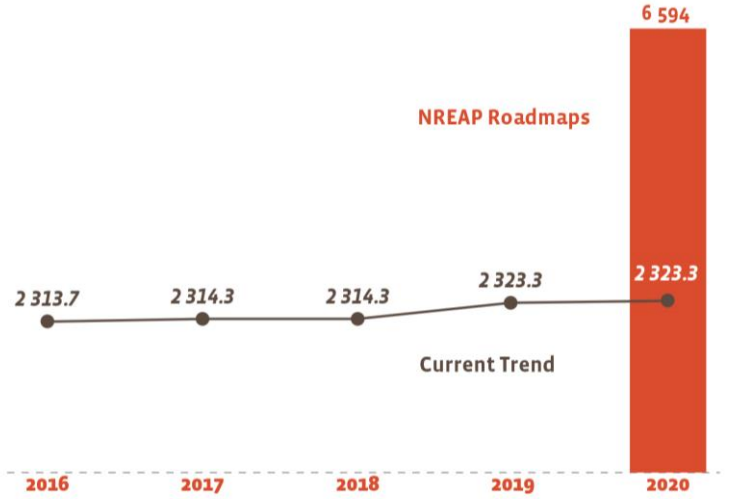
On 14 July 2021 , the **European Commission** revealed the outlines of the **Green Deal for Europe**, the major political mission it set itself at the beginning of its mandate. The stated ambition is nothing less than to build a new economic model by laying down the outlines of this radical change.

**All 27 EU member states have agreed to make the EU the first climate-neutral continent by 2050**.

To achieve this, they have undertaken to **reduce their emissions by at least 55% by 2030**, compared to 1990 levels.




*Comparison of the current trend against the NREAP (National Renewable Energy Action Plans) roadmaps of the 27 member states (in ktoe)*




*Comparison of the current trend against the NREAP (National Renewable Energy Action Plans) roadmaps (in MW)*

EurObservER (2021) Solar_thermal_CSP_barometer

# SHIP vs CSP: what make it different

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# SHIP vs CSP - From CSP to cheap SHIP

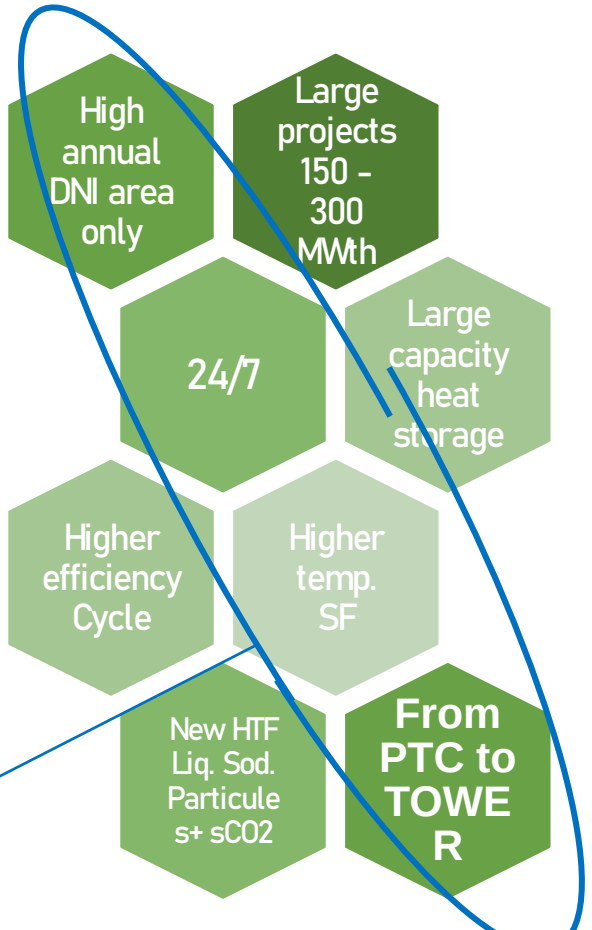
SolarPACES world
Solar Power & Chemical Energy Systems

When talking about CSP, we are generally talking about STE

Competitors: other Ren4E like PV

Main Driver: the cost (LCOE)

This implies the following




This trend also seems appropriate for the development of stand-alone

HT chemical processes lime / cement

Solar Fuels

Must connect to an existing Electricity Grid

# SHIP vs CSP - From CSP to cheap SHIP

SHC world

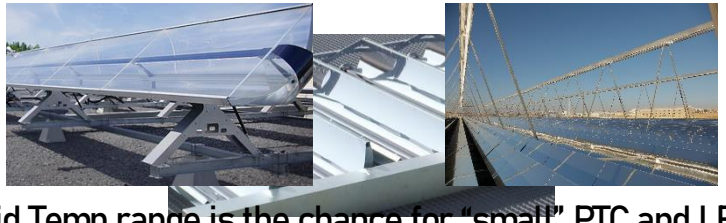
SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

When talking about SHIP, we are talking about Processes from Low to Mid Temp

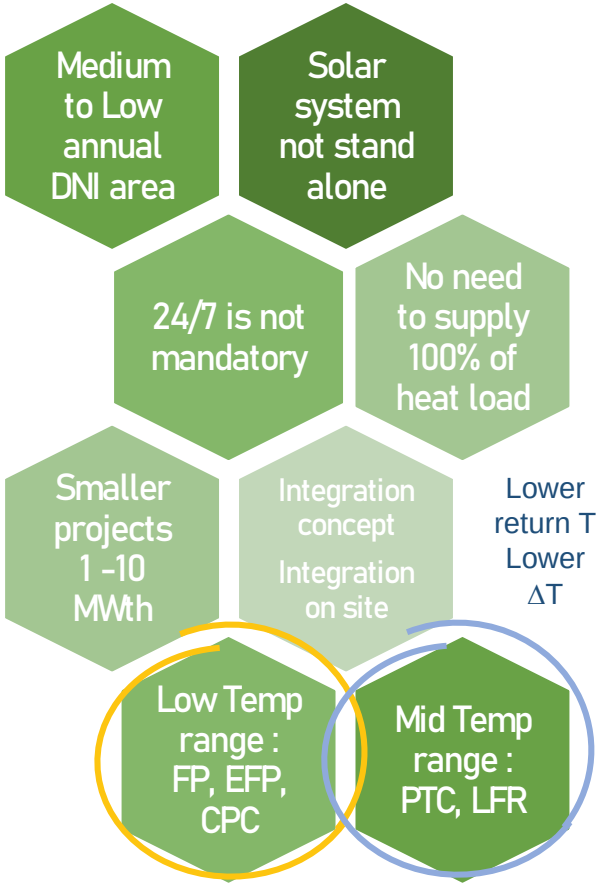
Competitors: other Ren4H like Biomass or PV

Main Driver: LCOH + emissions reduction

This implies the following

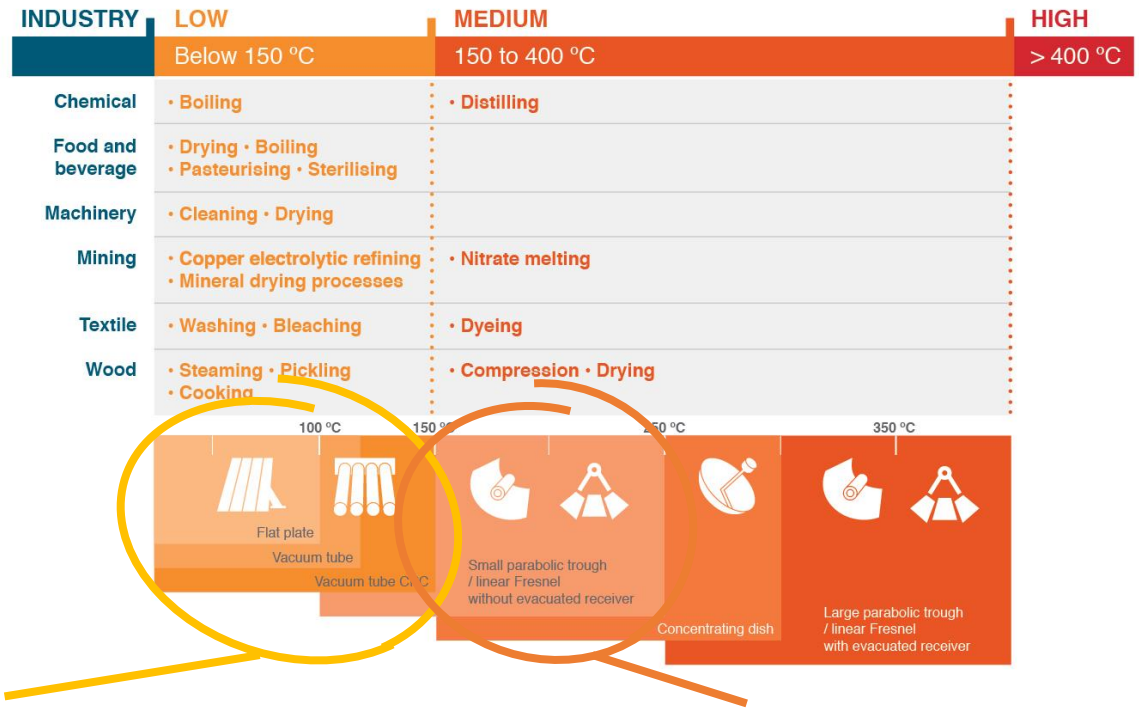


Mid Temp range is the chance for "small" PTC and LFR




Can connect to an existing Heat Network

# SHIP vs CSP– Areas of Overlap Between technologies




Only HVFPs are able to provide cost-effective heat @T > 120°C

Small PTC are able to provide cost-effective heat @T < 150°C

IEA Process Heat Collectors: State of the Art and available medium temperature collectors

# Industrial Processes (What is it?)

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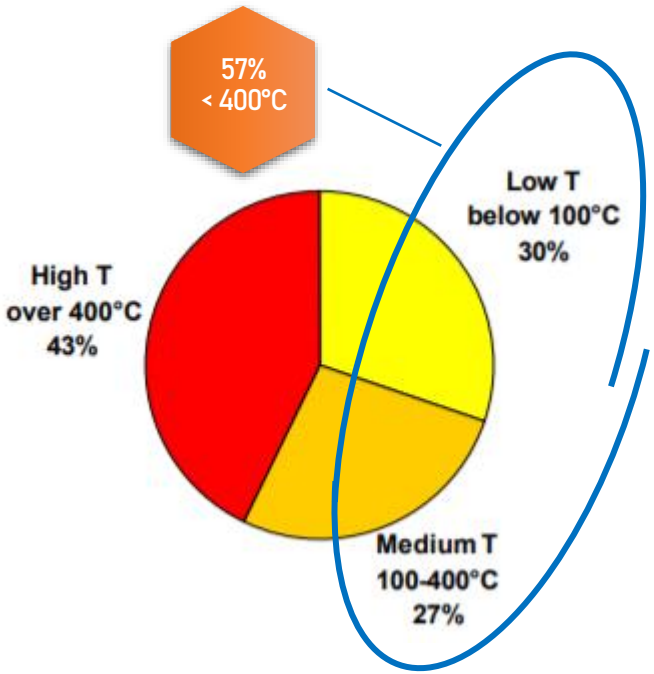
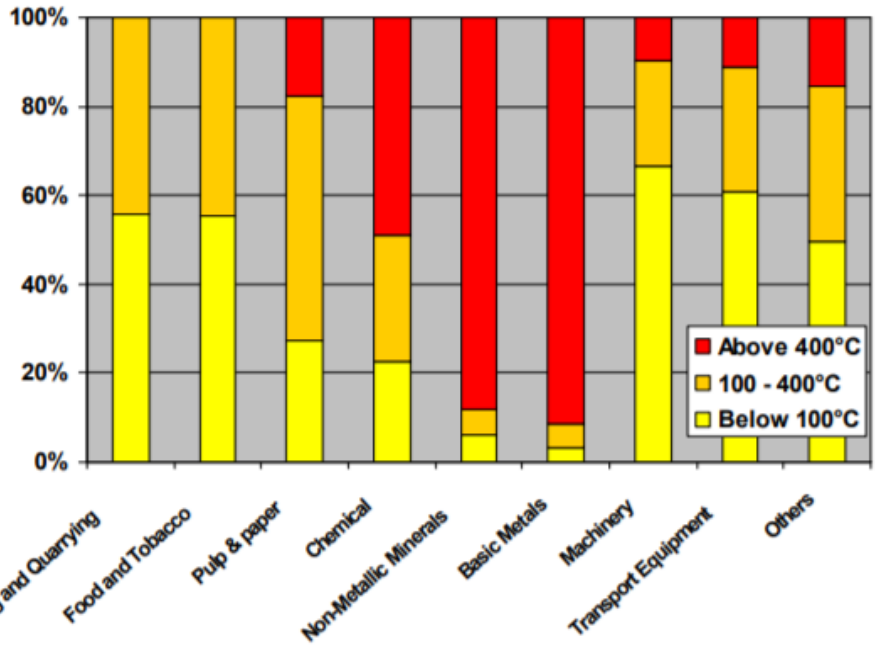
# Industrial Processes -Typology of Industrial Processes in EU (which need heat)



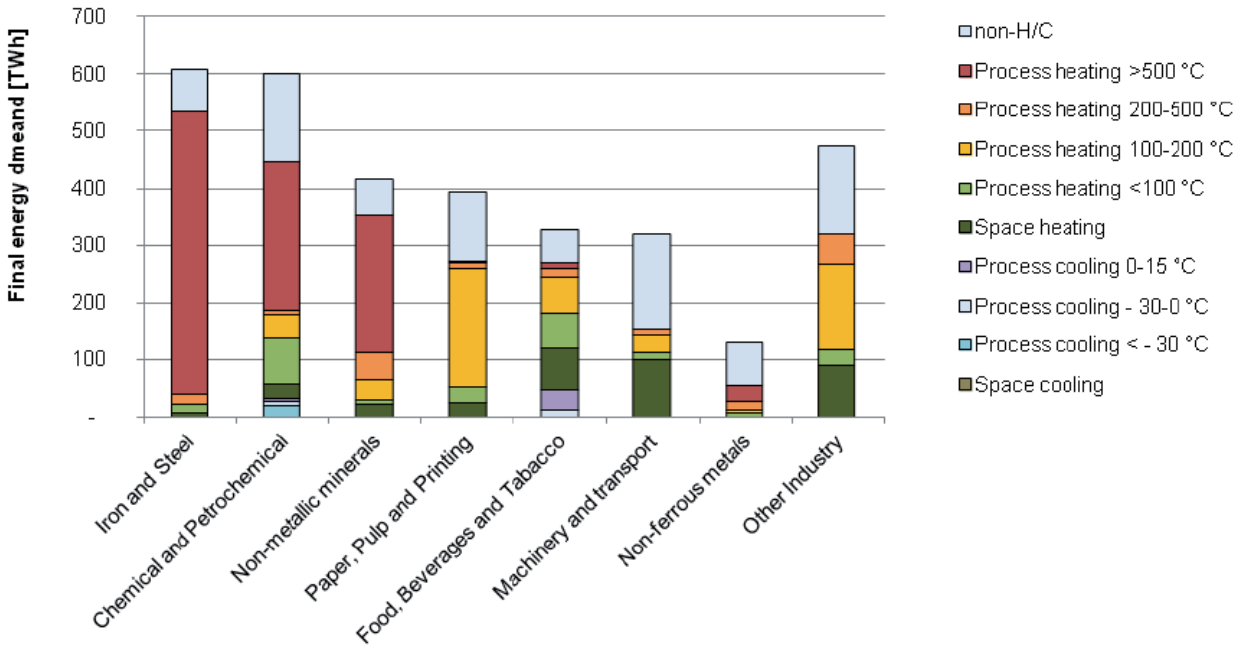

Except in very specific industrial sectors, low and mid temp heat makes up more than 50% of the total consumption

IEA (2008) Potential_for_Solar_Heat_in_Industrial_Processes

# Industrial Processes -Typology of Industrial Processes in EU (which need cold)

With regard to cooling, the sectors with the highest demand are chemical and petrochemical, and food, beverages and tobacco.

The temperature for cooling can range from 15 °C to below -30 °C




Rehfeldt (2018) A bottom-up estimation of the heating and cooling demand in European industry. Energy Efficiency

# Industrial Processes – Low to Mid Temp Heat (< 400°C)

A lot of unitary process with heat demand in différent temperature ranges

| Industrial Sector | Unit operation | Temperature range (°C) |
|---|---|---|
| Food | Drying | 30-90 |
| | Washing | 60-90 |
| | Pasteurising | 60-80 |
| | Boiling | 95-105 |
| | Sterilising | 110-120 |
| | Heat Treatment | 40-60 |
| Beverages | Washing | 60-80 |
| | Sterilising | 60-90 |
| | Pasteurising | 60-70 |
| Paper Industry | Cooking and Drying | 60-80 |
| | Boiler feed water | 60-90 |
| | Bleaching | 130-150 |
| Metal Surface Treatment | Treatment, electro-plating, etc. | 30-80 |
| Bricks and Blocks | Curing | 60-140 |
| Textile Industry | Bleaching | 60-100 |
| | Dyeing | 70-90 |
| | Drying, De-greasing | 100-130 |
| | Washing | 40-80 |
| | Fixing | 160-180 |
| | Pressing | 80-100 |
| Chemical Industry | Soaps | 200-260 |
| | Synthetic rubber | 150-200 |
| | Processing heat | 120-180 |
| | Pre-heating water | 60-90 |
| Plastic Industry | Preparation | 120-140 |
| | Distillation | 140-150 |
| | Separation | 200-220 |
| | Extension | 140-160 |
| | Drying | 180-200 |
| | Blending | 120-140 |
| Flour By-products | Sterilising | 60-90 |
| All Industrial Sectors | Pre-heating of boiler feed water | 30-100 |
| | Industrial solar cooling | 55-180 |
| | Heating of factory buildings | 30-80 |

+ some more general heat demand →

Cooling can be considered as a heat consumer

Can alos be added: DHn, Desalination, H2…

IEA Process Heat Collectors: State of the Art and available medium temperature collectors

Low Temp Range

*Stuck in the Middle*

Mid Temp Range

## Actual Heat Sources of Industrial Processes

The transfer of heat to a material within a production process is realized by convection, conduction, or radiation.

Heating technologies are typically categorized by fuel type:

- **fuel-based technologies**: **combustion** of solid, liquid, or gaseous fuels;
- **electric technologies**: use **electric currents** or **electromagnetic radiation** to generate heat either directly within, or indirectly transferred to the material being processed;
- **steam-based technologies**: **steam** is generated by **combustion** or trough **electric** resistance elements;
- **hybrid technologies** use more than one fuel type

DOE 2015a. "Improving Process Heating System Performance: A Sourcebook for Industry." Washington, D.C.
DOE 2016a. "Quadrennial Technology Review: Process Heating Technology Assessment." Washington, D.C.: U.S. Department of Energy.
Chindris, Mircea, and Andreas Sumper. 2012. "Industrial Heating Processes." In Electrical Energy Efficiency, edited by Andreas Sumper and Angelo Baggini, 295–334. John Wiley & Sons, Ltd.

# Industrial Processes – Actual Heating and Cooling Supply

## Process Heating and Cooling Supply

Access to heating and cooling is accomplished in industries in two ways:

- the plant operate as a **standalone facility** where all utilities are self-generated,
- the plant is located in an **industrial park** where a 3rd party (**ESCO**) provides utilities.

**For heating applications, the preferred medium of heat transfer is saturated steam, which is typically generated using a boiler.**

However, pressurised hot water, hot flue gasses, air, thermal oil, and superheated steam are also used in certain applications.

Boiler design, capacity and firing fuel are all parameters that vary with plant functionality, location and size.

**For cooling applications, chillers, and cooling towers are typically employed, and water or water/glycol mixtures are the preferred heat transfer media.**

In suitable locations, river water or well water can also be used to meet cooling loads.

FRIENDSHIP Project, WP1, contribution from ABSOLICON & INDSUTRIAL SOLAR

## The case of Industrial Parks

- The steam supply network in an **industrial plant** typically uses **saturated steam** and has **operating pressures** that can go as high as **20 bar** (**212°C**).

Beyond this pressure, the required pipe thickness would inhibit heat transfer and increase costs, thereby making it an unappealing option.

- **When temperatures required are high** enough such that the pressure of saturated steam surpasses 20 bar, **alternate heat transfer media like thermal oil is utilised** (allowing for a pressure-less or low-pressure system).
- **Despite this variance in temperature for processes**, for heating, **typically one steam network running at one fixed temperature and pressure will provide heat to various processes running at various temperatures**.

The steam network temperature is selected based on the highest process temperature required, and operating capabilities of the 3rd party supplier in the case of an industrial park.

FRIENDSHIP Project, WP1, contribution from ABSOLICON & INDSUTRIAL SOLAR

## The case of Industrial Parks

- **For cooling, the demand is much lower in comparison**. Hence, **cooling is typically provided to specific processes**. The cooling supply using components such as a cooling tower is typically localised to a specific process or area of the plant. However, though it is not always the case, **a cold distribution network is also sometimes used**. For example, in an industrial park, a 3rd party supplier may provide cooling water to any plant in need through a cooling water network (e.g. with cooling towers).

FRIENDSHIP Project, WP1, contribution from ABSOLICON & INDSUTRIAL SOLAR

# Current Applications of SHIP

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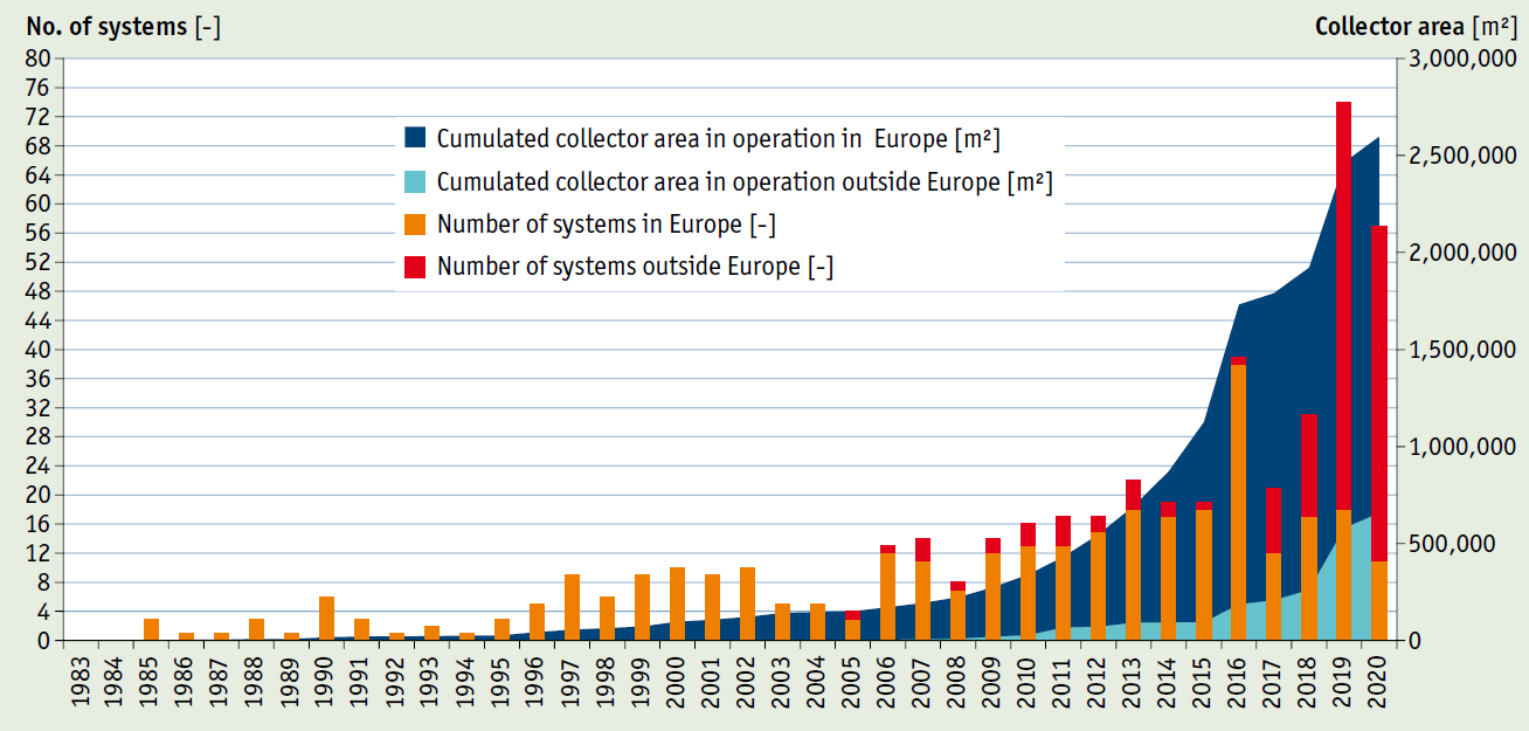
# Current Applications of SHIP - Large-scale systems (DHn + Buildings)

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY



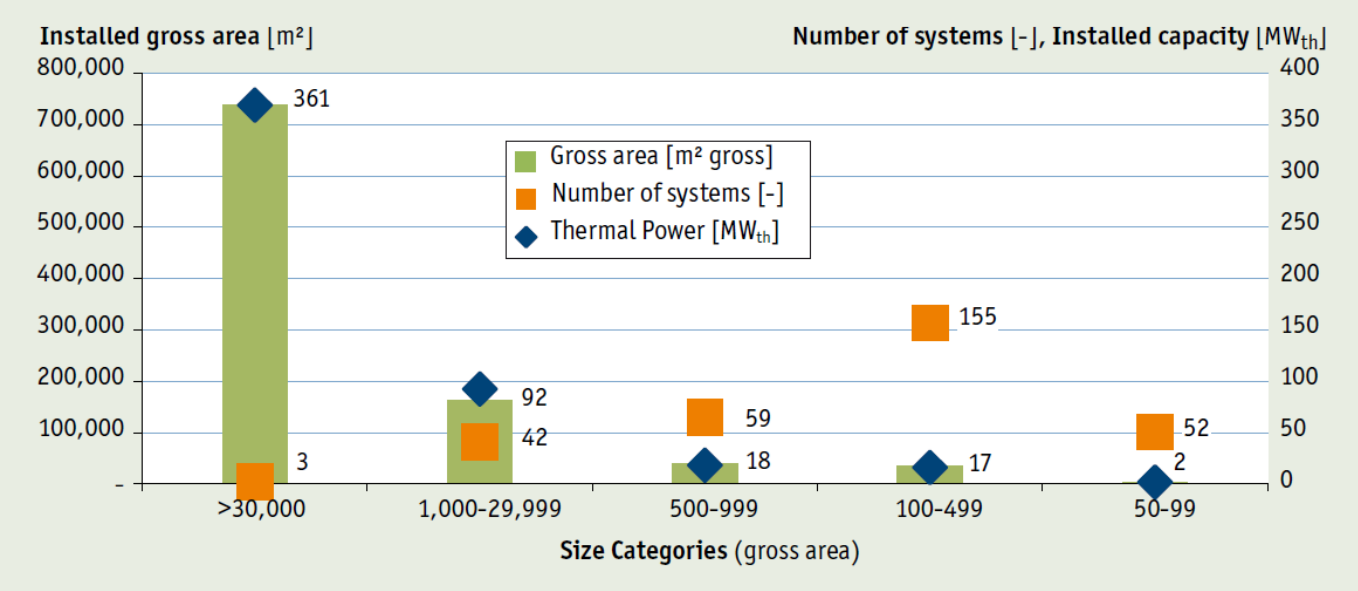

- End of 2020, **470 large-scale solar thermal systems** (> 350 kWth, 500 m²) were in operation.
- The **total installed capacity of** these systems equaled **1,710 MWth** (2.4 million m²).

*Note that these numbers exclude concentrating solar thermal systems and PVT collectors connected to district heating, which would add an additional 162,784 m².*

IEA-SHC (2021) Solar-Heat-Worldwide

# Current Applications of SHIP – SHIP Status by size

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

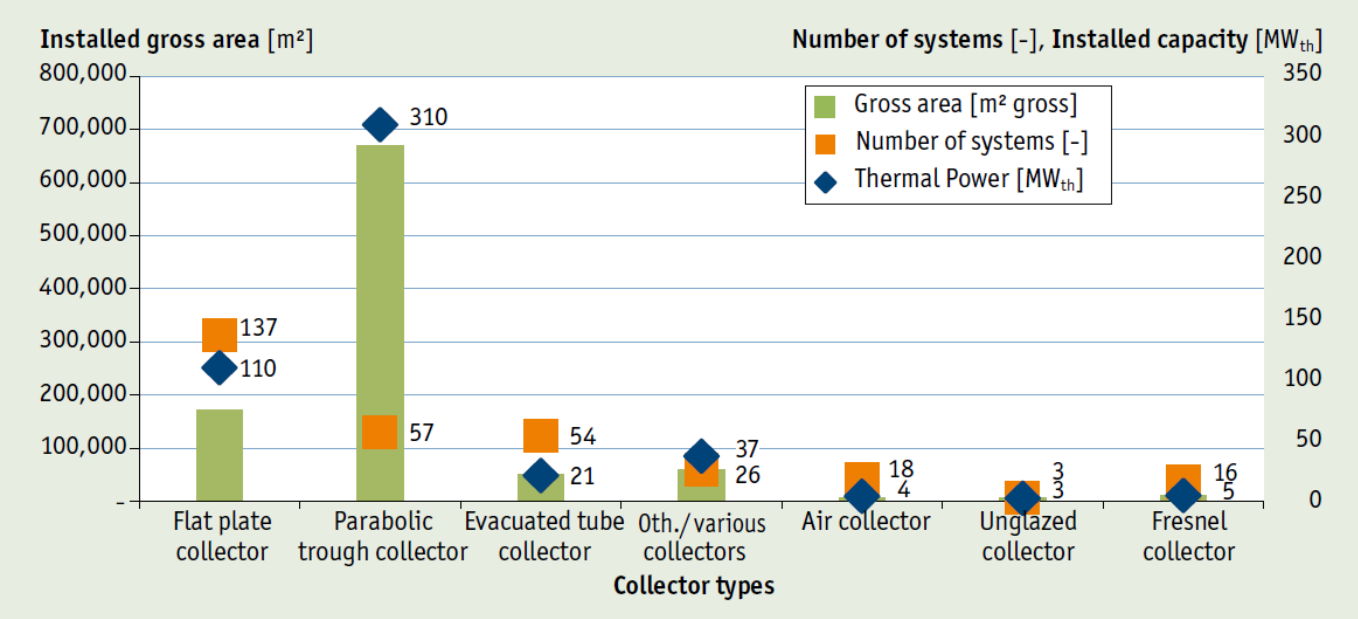



- The world's largest SHIP plant, the **Miraah** in **Oman** (**300 MWth**), produce steam for the **extraction of heavy oil** from the ground.
- The second largest SHIP application is for a **green house** in **Australia** (**36.6 MWth**).
- The third largest system is installed in **Chile** (**27.5 MWth**) for a **copper mining process**.

Together, those three plants represent **74 % of the total installed SHIP thermal capacity**.

IEA-SHC (2021) Solar-Heat-Worldwide

# Current Applications of SHIP – SHIP Status by type



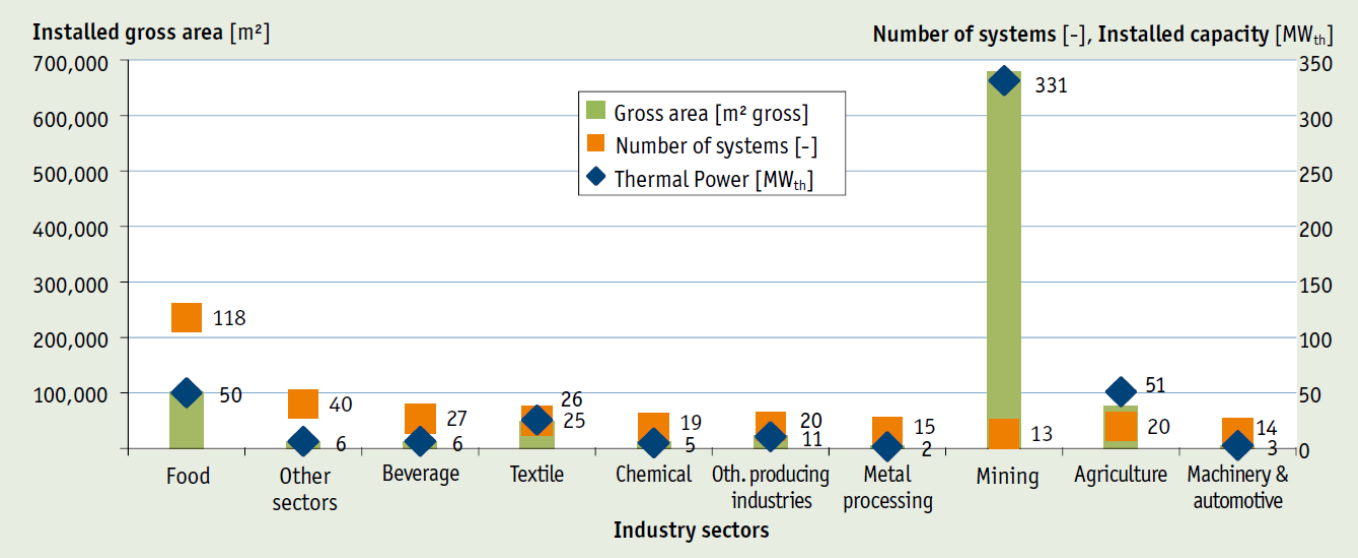

The majority of the systems use **flat-plate collectors** to produce solar process heat, followed by **parabolic trough collectors** and **evacuated tube collectors**.

*Note that parabolic trough collectors have the highest installed gross area, however, without the **Miraah** plant, it would rank third.*

IEA-SHC (2021) Solar-Heat-Worldwide

# Current Applications of SHIP – SHIP Status by sector

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY




- The combined **food and beverage sector accounts for 47 % of all installed systems**, however, they tend to be small to medium-sized systems (only 10 % of the installed thermal capacity).
- **Another promising sector is the textile industry**, with 25 installations and 26 MWth (5 %) installed thermal capacity.
- The **mining industry**, which includes two of the three largest systems, is the dominant sector in terms of installed thermal capacity.

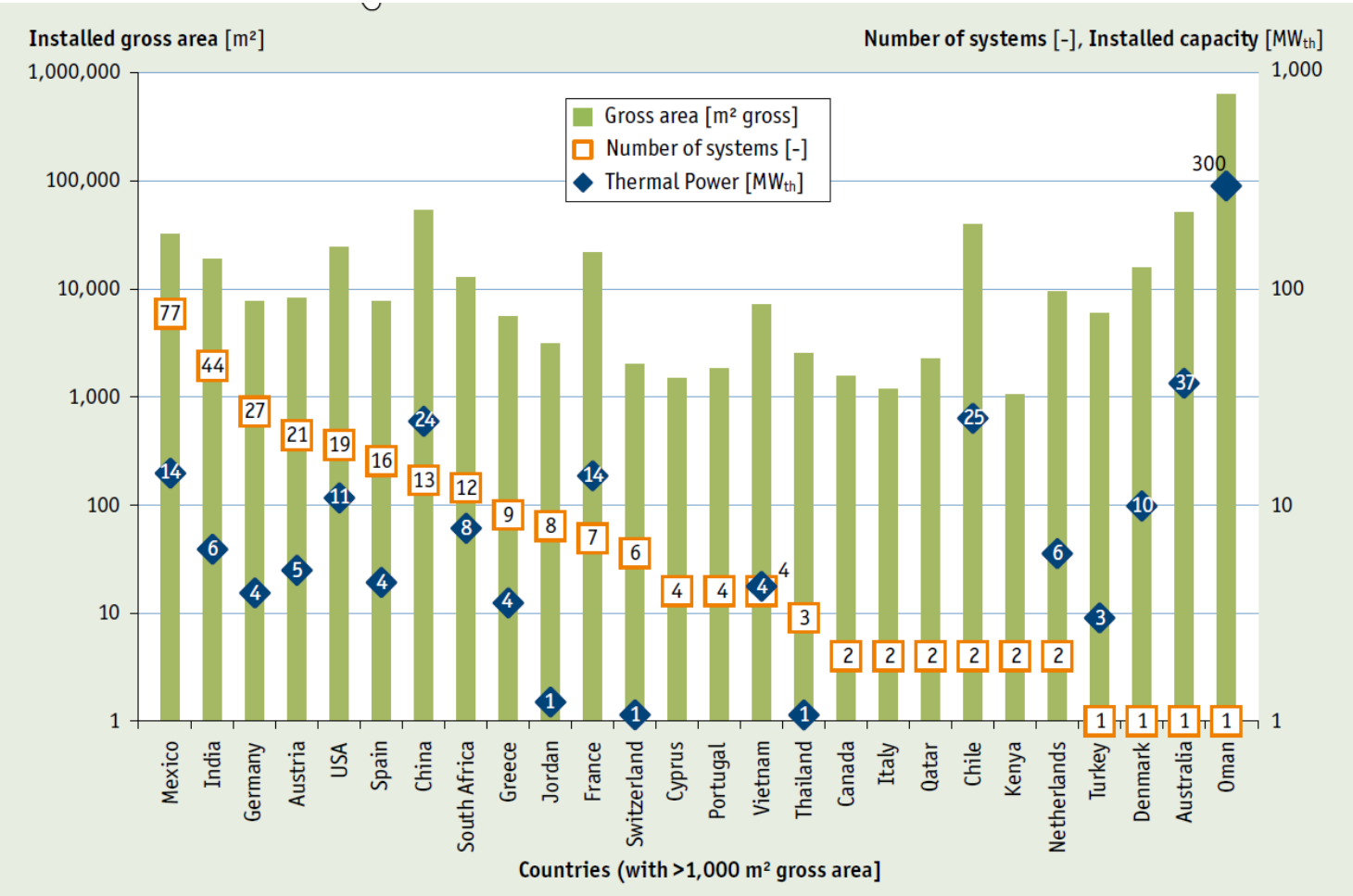
IEA-SHC (2021) Solar-Heat-Worldwide

# Current Applications of SHIP – SHIP Status by country

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

**Mexico** and **India** have the highest number of systems, followed by **Germany**, **Austria**, the **USA** and **Spain**.

**Oman** and **Chile** leads (with **China**) in terms of capacity with respectively only one and two installed systems. country…




IEA-SHC (2021) Solar-Heat-Worldwide

# Current Applications of SHIP – What's going wrong?

**The market for solar thermal** is still at an early stage of development, but at least 120 large-scale heat projects were added in 2020 in the commercial and industrial sectors. These feed renewable heat into **district heating networks**, or supply heat to **processes in the manufacturing sector**. **Compared to what is needed to achieve the Paris Agreement goals, deployment rates remain woefully inadequate**.

**IRENA's 1.5°C pathway requires global solar thermal capacity to increase** from around **4 GWth** in 2018 to **890 GWth in 2030** and **1 290 GWth in 2050**.

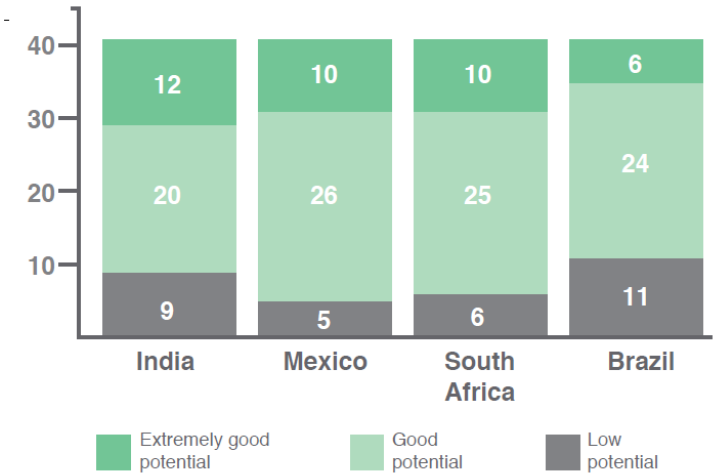
**Total solar thermal heat capacity in Europe grew by only 3% in 2020** (Solar Heat Europe/ESTIF, 2021) – **is therefore insufficient**. Like many of the technologies necessary for decarbonising the building and industrial sectors, solar thermal is typically held back by the **absence of coordinated and sustained policy support to decarbonize heat**.

IRENA (2021)_Renewable_heat_generation_costs_2010_to_2020

# Current Applications of SHIP – In SHIP we Trust!

Solar Payback

SHIP suppliers acknowledged the good market potential in 4 sunny countries




Germany is also ranked 3rd in new SHIP addition in 2020!

| Top Three Markets | | 1 | 2 | 3 |
|---|---|---|---|---|
| **Solar district heating** new additions in **2020** |  | Germany | Denmark | China |
| **Solar industrial heat** new additions in **2020** |  | China | Mexico | Germany |
| **Swimming pool heating** new additions in **2019** |  | USA | Brazil | Australia |
| **Solar air heating systems** total in operation at end of **2019** |  | Canada | Australia | Japan |
| **Hybrid systems for heat and electricity (PVT)** total in operation at the end of **2020** |  | France | South Korea | China |

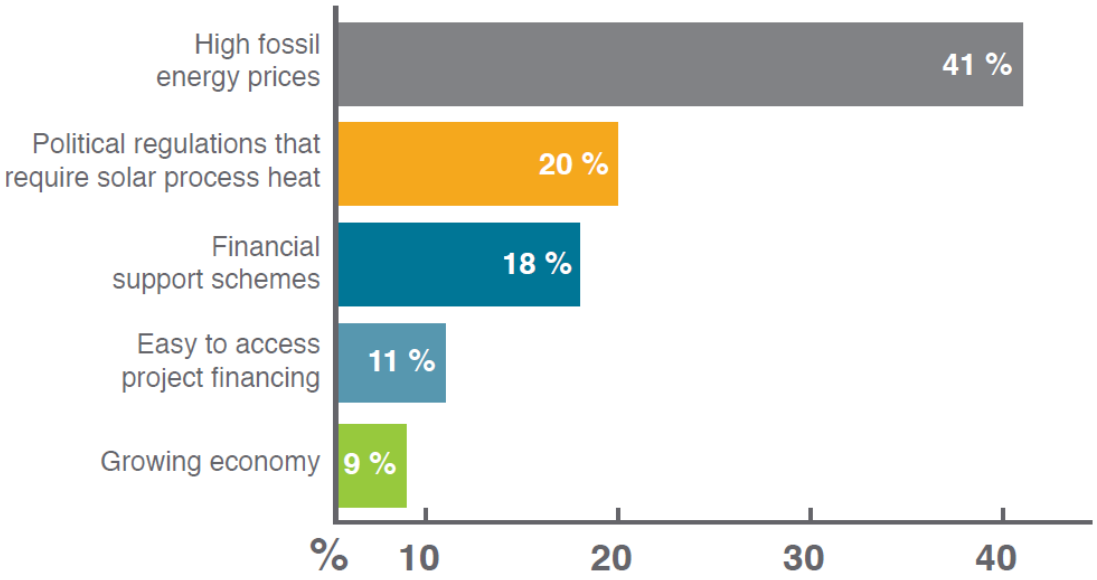
Photos: SOLID Solar Energy Systems, Solareast Holding Company, SolarWall, PA-ID Process, Sunbather

SolarPayback (2017) Solar-Heat-for-Industry-Solar-Payback
https://www.iea-shc.org/Data/Sites/1/media/images/solarheatworldwide/2021/top-three-markets-table-large.jpg

# Current Applications of SHIP – Need Help?

Solar Payback

Most relevant criteria for a good market development (Answers from 71 SHIP suppliers)




Energy price cap: Millions of households face higher gas and electricity bills

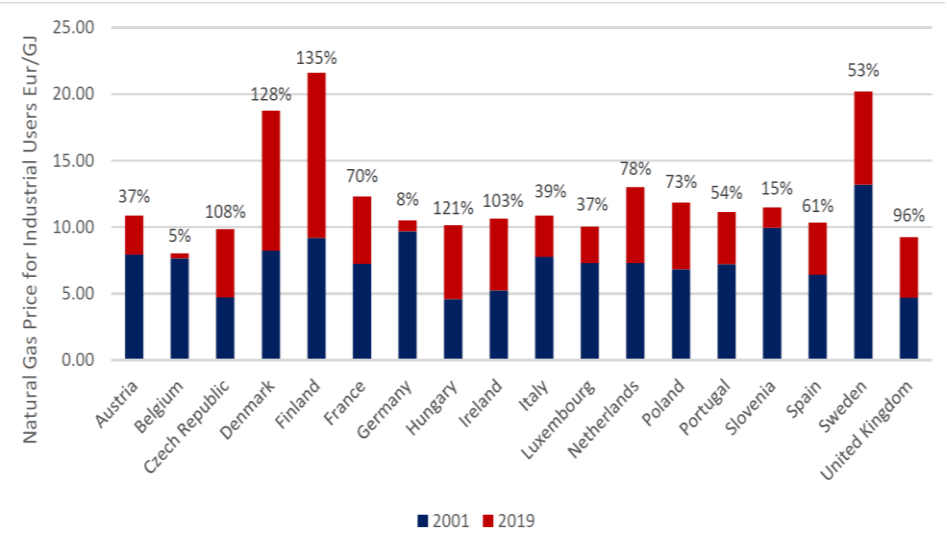
By Kevin Peachey
Personal finance correspondent, BBC News

3 days ago | Comments

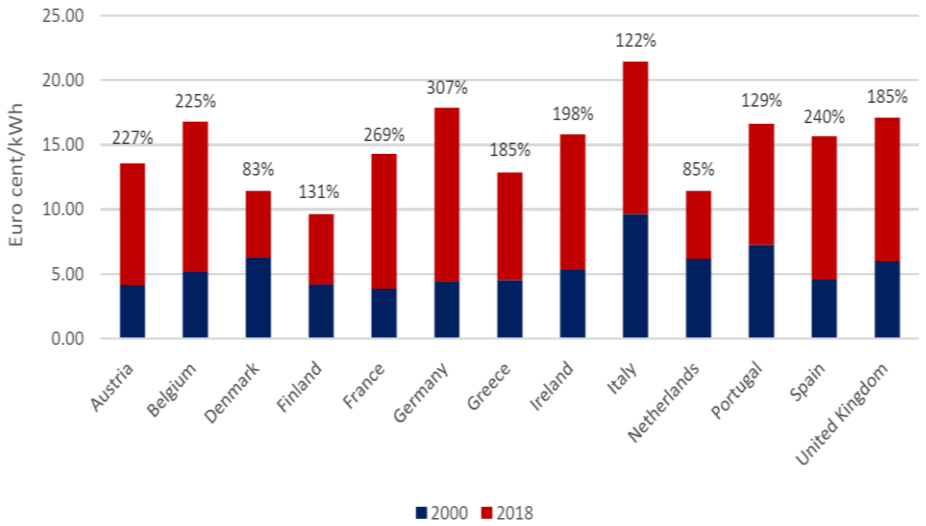
GETTY IMAGES

SolarPayback (2017) Solar-Heat-for-Industry-Solar-Payback

# Current Applications of SHIP – Need Help?




Natural gas Price evolution




Electricity Price evolution

FRIENDSHIP Project, WP1, contribution from ABSOLICON & INDSUTRIAL SOLAR

# Current Applications of SHIP – The French Case (good news!)

An Independent Producer of Solar Heat - newheat fournisseur de chaleur renouvelable

+

National Fund (Heat Fund) - FONDS CHALEUR EXPERTISE ET FINANCEMENT

→ Generates 4 projects

Which generates new projects:

3 new projects without Heat Fund help !

*After the First of a Kind, one project leads to another*

https://fondschaleur.ademe.fr/
https://newheat.com/en/

# Current Applications of SHIP – The French Case (good news!)

| |  |  |  |  |
|---|---|---|---|---|
| year | 2019 | 2021 | 2021 | 2021 |
| Type | Condat Paper Mill | Malteries Franco-Suisses | City of Pons DHn | City of Narbonne DHn |
| Integration | Preheating of the steam boiler make-up water | Preheating of air for malt drying | Heating of the network return | Network heating |
| Coll. Area | 4 212 m² | 14 252 m² | 1 800 m² | 3 200 m² |
| Annul. Prod. | 3 900 MWh | ~8 000 MWh | ~1 000 MWh | 2 200 MWh |
| $CO_2$ saved | 1 078 Tons | 2 200 Tons | 275 Tons | 600 Tons |

https://newheat.com/en/

# Market Potential in EU

- Introduction
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# Market Potential in EU – Wine Fermentation

**Wine fermentation & stabilization**
**La Rioja, Spain**

BODEGAS RODA
Haro . Rioja Alta . España

SHIP2FAIR

## NEEDS

### Heating

- Radiant floor heating for malolactic fermentation
- Heat for adsorption process
- Pipe cleaning & desinfecting
- High-pressure cleaning

### Cooling (Absorption chiller)

- Fermentation process
- Ageing

100 m² FPs (VIESSMANN), rooftop
**Supply Hot Water @70°C**
**Supply Cold Air @15°C**

# Market Potential in EU – Sugar Boiling

Sugar boiling
Porto, Portugal

RAR
DOCE DE PORTUGUESA

SHIP2FAIR

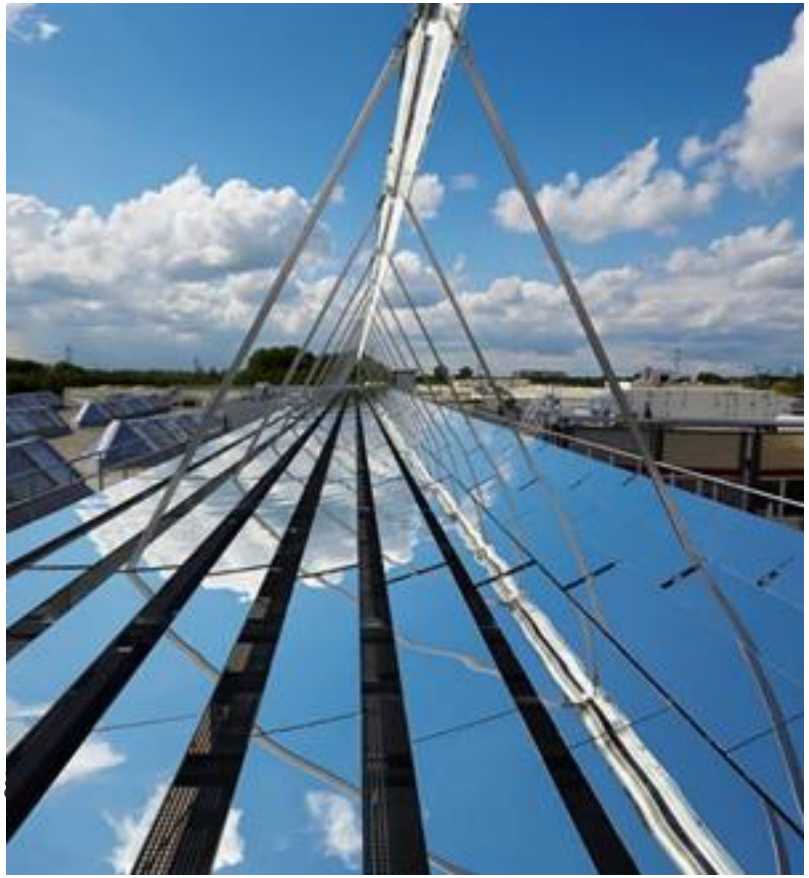
## NEEDS

### Heating

- Sugar crystallization process: 125°C

Solar steam operation modes:

- Main use: 2 bara stream for all major processes plus the deaerator
- Optional: 6 bara stream used for cleanin (in continuous process)



660 m² LFRs (INDUSTRIAL SOLAR), rooftop
**Supply Steam @10 bara** (+ Storage 60mn)

# Market Potential in EU – Spirits Distillation

Spirits distillitation
Pessione, Italy

MARTINI

SHIP2FAIR

## NEEDS

### Heating

- Bottling process
- Distillation

Dual use of solar heat :

- Summer → Steam for major processes
- Winter → Space heating

596 m² HVFPs (TVP Solar), rooftop
**Supply Steam @4,7 bara** (summer)
**Supply Hot Water @90°C** (winter)

# Market Potential in EU – “Foie-Gras” Production

Foie-gras production
Castelnaudary, France

LARNAUDIE

SHIP2FAIR

## NEEDS

### Heating

- Boiler feed water pre-heating
- Water tank heating


1600 m² HVFPs (TVP Solar), ground
**Supply Hot Water @140°C**

# Market Potential in EU – Speciality Chemicals

CLARIANT

Speciality Chemicals
Gendorf, Germany

FRIEND SHIP

## NEEDS

### Heating

- Various chemical processes
- Two networks:
  - 3.9 bar, 170 °C
  - ~~20 bar, 240 °C~~

### Cooling (GAX Absorption Chiller)

- Various chemical processes

1600 m² PTCs (ABSOLICON) + HTHP, ground
**Supply SH Steam @4,9 bara-170°C**
**Supply Cold @-15°C**

# Market Potential in EU – Wood-based Panels Production

SONAE MC

Wood-based Panels Production

Nettgau, Germany

FRIEND SHIP

NEEDS

## Heating

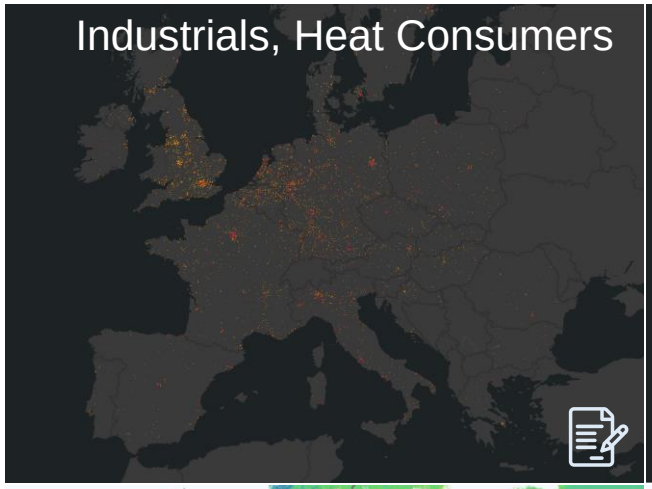
- Boiler feed water pre-heating
- Water tank heating

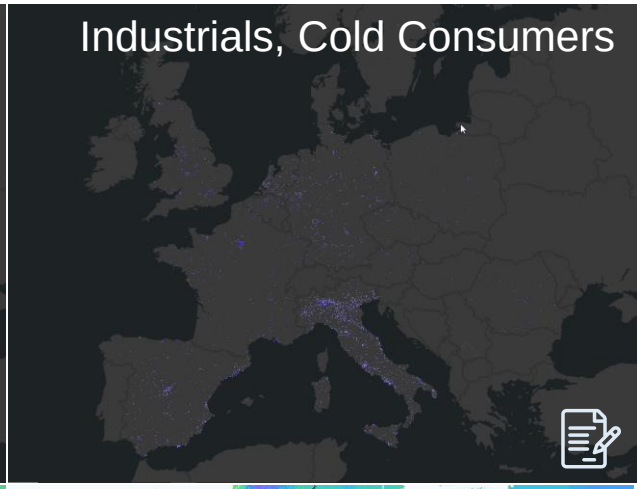
23 480 m² LFRs (INDUSTRIAL SOLAR), ground

**Supply Hot Themal Oil @300°C**

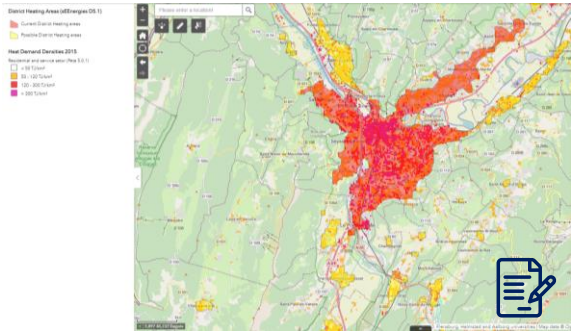
# Market Potential in EU – Cartography of the Market?

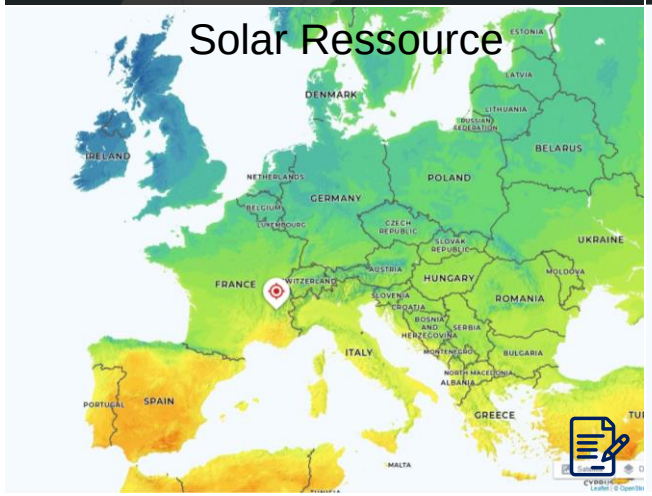
To identify the Market, you probably have you have to cross-reference information:

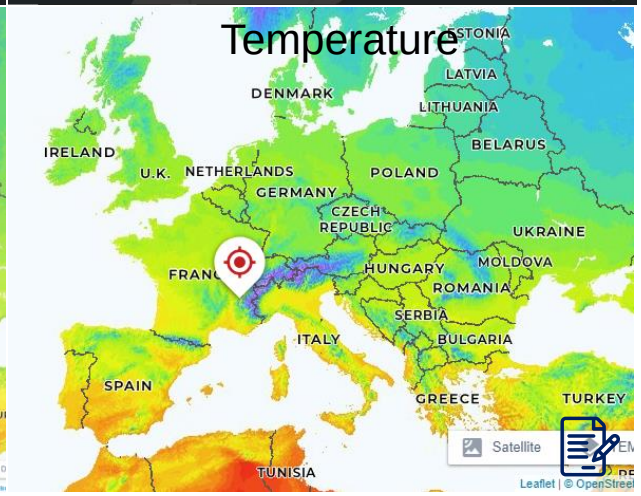


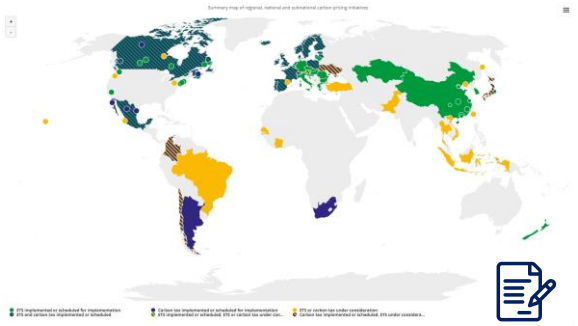

DHn nearby?





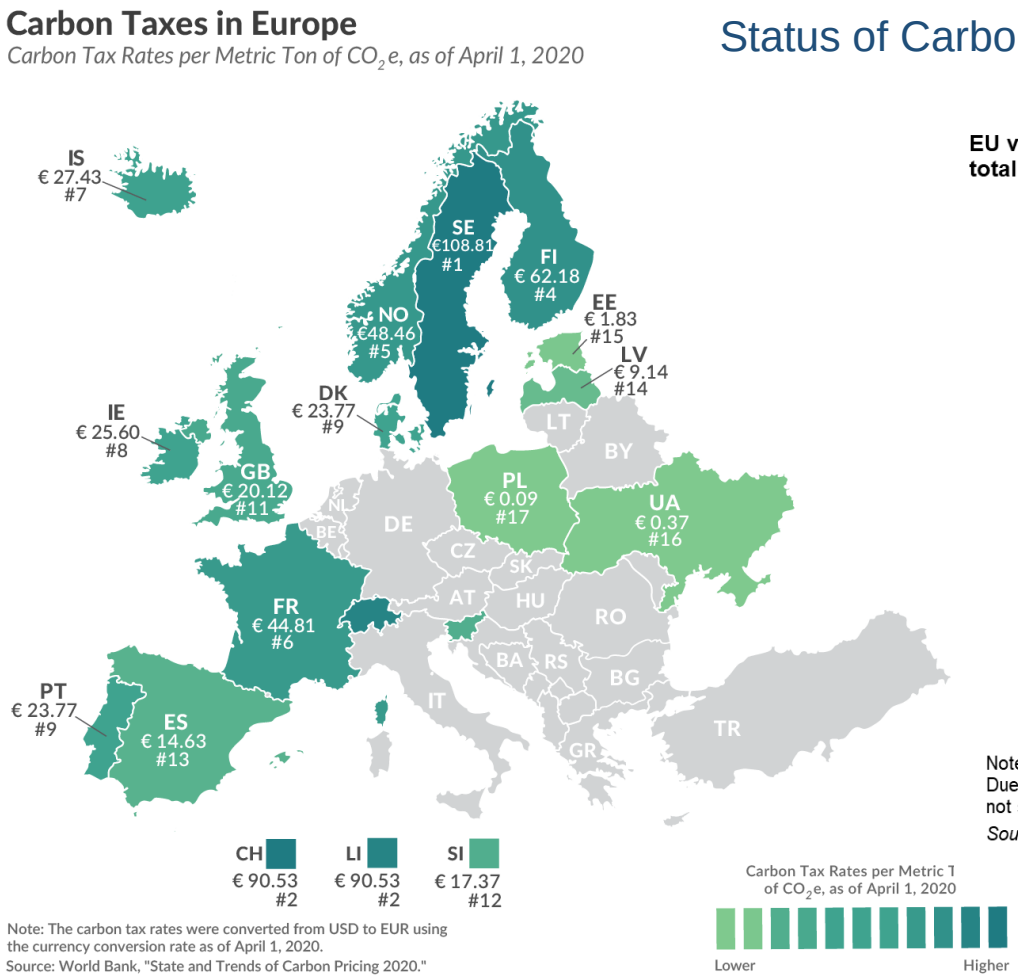




$CO_2$ Tax Policy or National/Local Incentives?

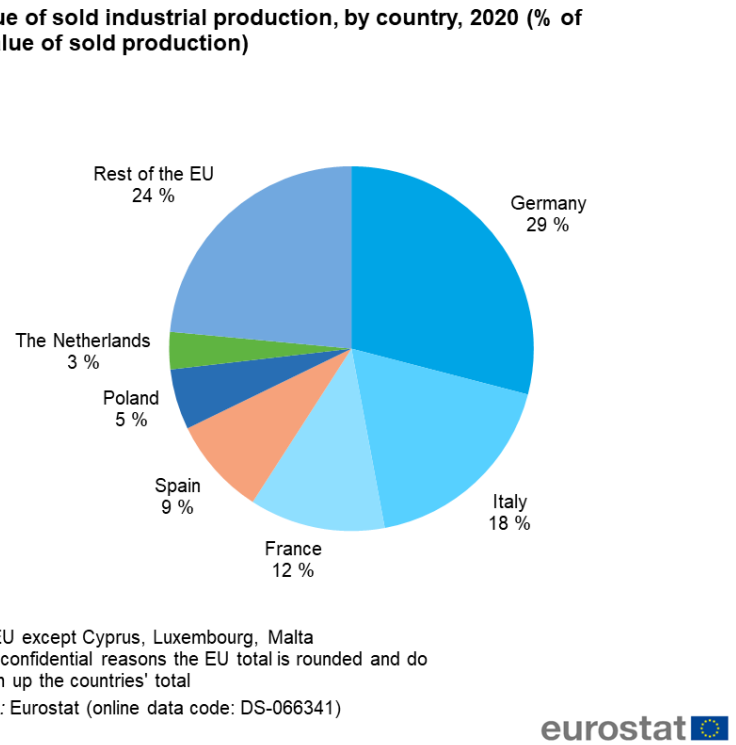


https://carbonpricingdashboard.worldbank.org/map_data

# Market Potential in EU – Status of CO2 Tax Policy in EU




## Status of Carbon Tax in Industrial European Countries




https://ec.europa.eu/eurostat/statistics-explained

# Cost of Heat from SHIP

- Introduction
- SHIP vs CSP: what make it different
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# Cost of Heat from SHIP – Production Costs for SHIP

IRENA circulated interesting information on the European market in March 2021 about a **downward trend in production costs for Solar Heat for Industrial Process (SHIP) plants** observed in two particularly mature markets, those of **Germany** and **Austria**.

They have fallen by **51%** (from 2014-2020) **in Germany** and by **42%** (from 2012-2018) in **Austria**, to **715** and **504 €/m²** respectively.

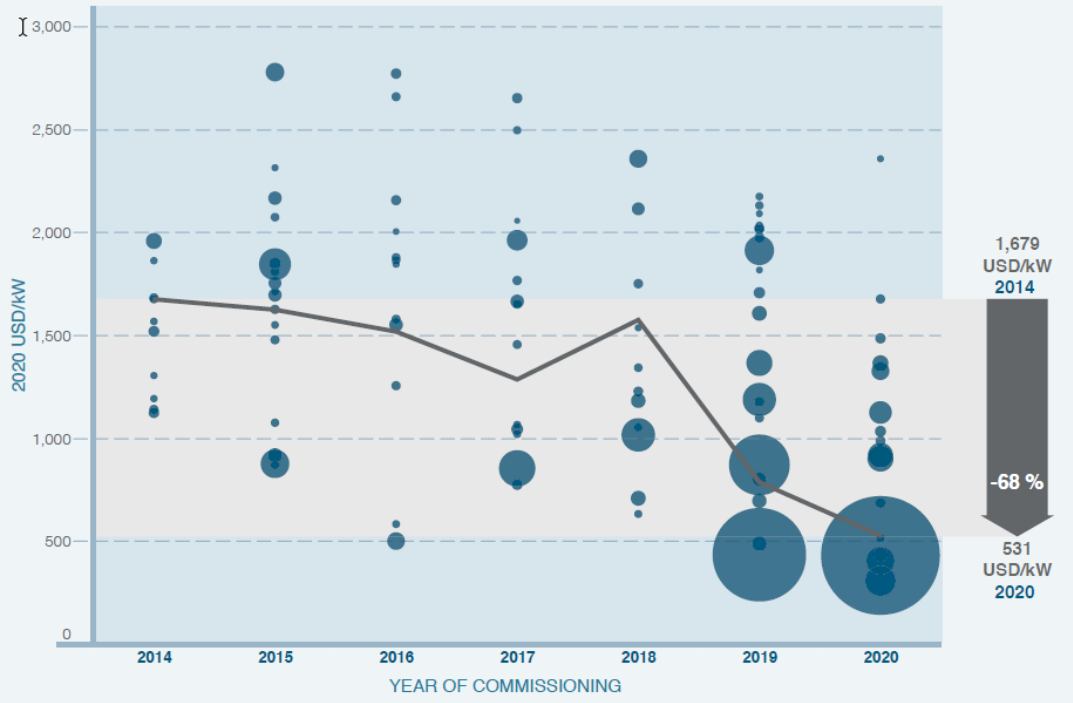
**The main reason for this cost reduction is that the market is turning away from individual installations**, whose production costs are comparatively higher per m², **towards large operations** (especially in industry) **where economies of scale come into play**.


Total installed costs and LCOHEAT for commercial and industrial-scale solar thermal plants in Austria and Germany, 2010-2020

EurObservER (2021) Solar_thermal_CSP_barometer
IRENA (2021)_Renewable_heat_generation_costs_2010_to_2020

# Cost of Heat from SHIP – Economies of Scale

Weighted-average, total installed costs of 101 SHIP plants in Europe




Drivers of these **economies of scale** are:

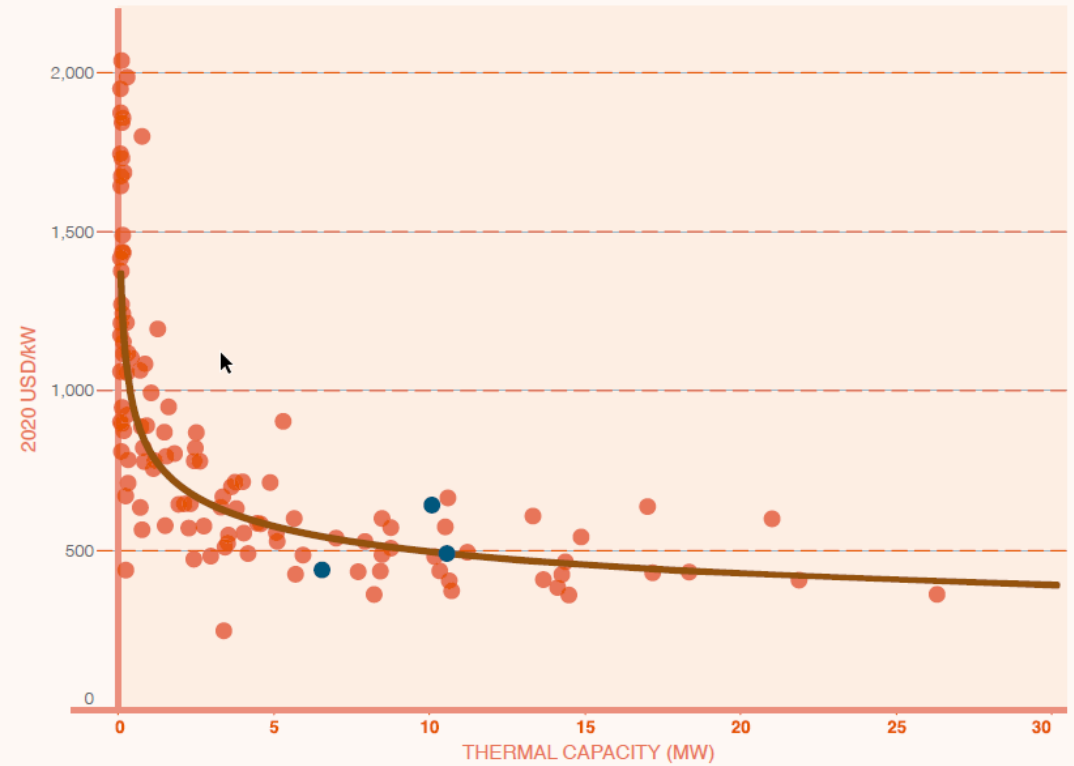
- ✓ Lower bill-of-materials for larger quantities
- ✓ Improved efficiency in manufacturing
- ✓ Lower fixed costs per kW for permissions, design and logistics
- ✓ Faster and more efficient installation

*The projects in this chart include stationary and concentrating collector technologies and are commissioned in Austria, Belgium, Cyprus, France, Germany, Greece, Italy, Netherlands and Spain. Total installed costs shown as real USD values in 2020 (taking inflation into account).*

SolarPayback (2021) Flyer SHIP Cost Trends

# Cost of Heat from SHIP – Economies of Scale (the SDH example)

Weighted-average, total installed costs of large SDH European plants




The trend curve suggests that for every **doubling of the size** of the plant, total installed **costs** will **decline by 14 %**.

The curve results in costs of **253 €/kW** for a **110 MW** plant.

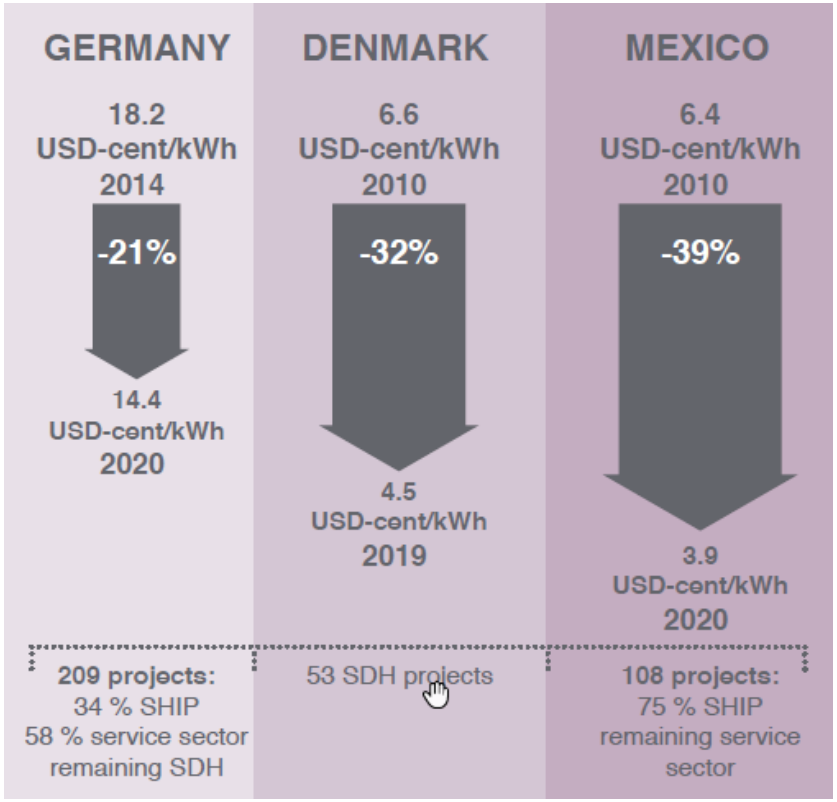
The REX on the **CSP** indicates that the **economy of scale** is not enough and that it is necessary to develop **modular** and **scalable** concepts.

*Each orange circle shows one SDH project and each blue circle shows one of the large multi-MW SHIP plants commissioned between 2010 and 2021 in Europe. 97 % of the SDH projects have been installed in three countries Austria, Germany and Denmark.*

SolarPayback (2021) Flyer SHIP Cost Trends

# Cost of Heat from SHIP – Cost Reductions in Mature Markets

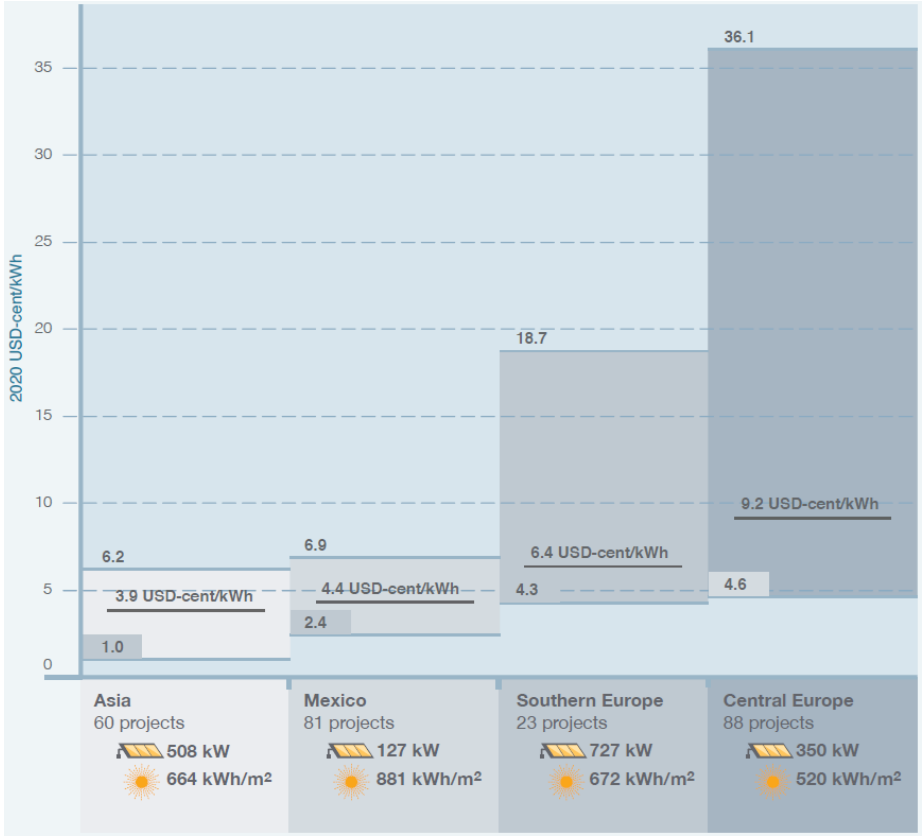
## Cost Reductions in Mature Markets




- In **Mexico**, the costs of large solar heat plants have come down 17 % in the last decade due to **production output optimisations**, **more efficient logistics** and **high competition between well-established project developers**.
- **Improved system efficiencies** have driven down the LCOH by more (-39 %) than the decrease in **installed costs**.
  *The low LCOH in 2020 of 3.9 USD-cent/kWh is also the result of superior solar resources compared with other major solar heat markets.*
- It is notable that **these cost reductions have been achieved without the benefit of economies of scale**, as the average plant size of the 108 projects illustrated in the charts is relatively small (139 kW).

SolarPayback (2021) Flyer SHIP Cost Trends

# Cost of Heat from SHIP – Costs Structure & Irradiation Levels Impact




- The regional average **LCOH for SHIP plants** ranges from a low **3.9 USD-cent/kWh in Asia** to a high **9.2 USD-cent/kWh in Western Europe**. Besides economies of scale, variations in **cost structure** and **irradiation levels** impact the LCOH.

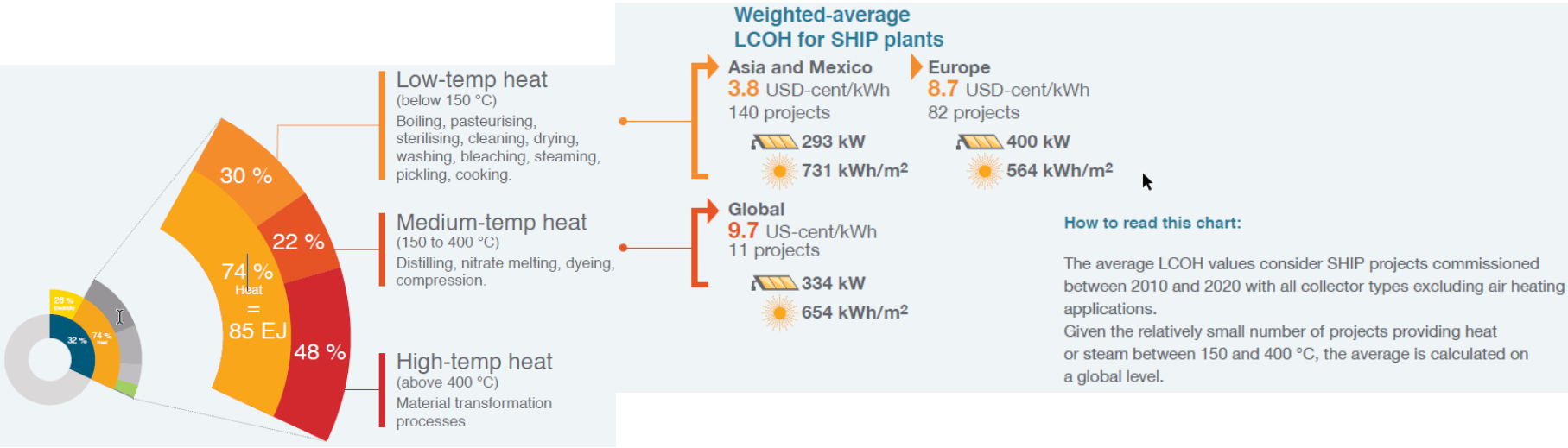
✓ Costs structure: the **level of material costs together** with the **labour costs** for **acquisition**, **planning**, **design**, **installation** and **commissioning** explain most of the large differences in installed costs at regional / country level.
*Ex: total installed costs in Southern Europe are 84% higher than in Asia.*

✓ Irradiation levels: more sunshine on the collector area **increases the solar heat harvested from the same area**.
*Ex: Mexican plants achieve on average a 70% higher yield than those in Central Europe.*

SolarPayback (2021) Flyer SHIP Cost Trends

# Cost of Heat from SHIP – Actual LCOH Estimates

- The **most popular applications for SHIP plants globally are processes that need heat up to 150 °C**. This segment makes up **30 % of the global industrial heat demand** and **solar heat costs are generally lower in this segment**.
- **The lowest weighted-average LCOH values of 3.8 USD-cent/kWh** for solar heat up to 150 °C **are achieved** in the service of factories in **Asia** and **Mexico**.




SolarPayback (2021) Flyer SHIP Cost Trends

# Conclusions

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# Conclusions

- ✓ Nowaday SHIP, as ST, is almost invisible
- ✓ But it is on its way, and necessary to fight against climate change
- ✓ Things can change fast after some successful examples of SHIP installations
- ✓ There is a lot of different markets for SHIP
- ✓ Lessons learned and economy of scale make SHIP cheaper and cost-competitive
- ✓ Success is linked to the commitment of the states in the form of incentives or effective carbon tax
- ✓ The actual and future projection of cost for gas and electricity may give a push to SHIP solutions

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# End of Presentation

- Thank you for your attention
- Questions ? But first, I have one:

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