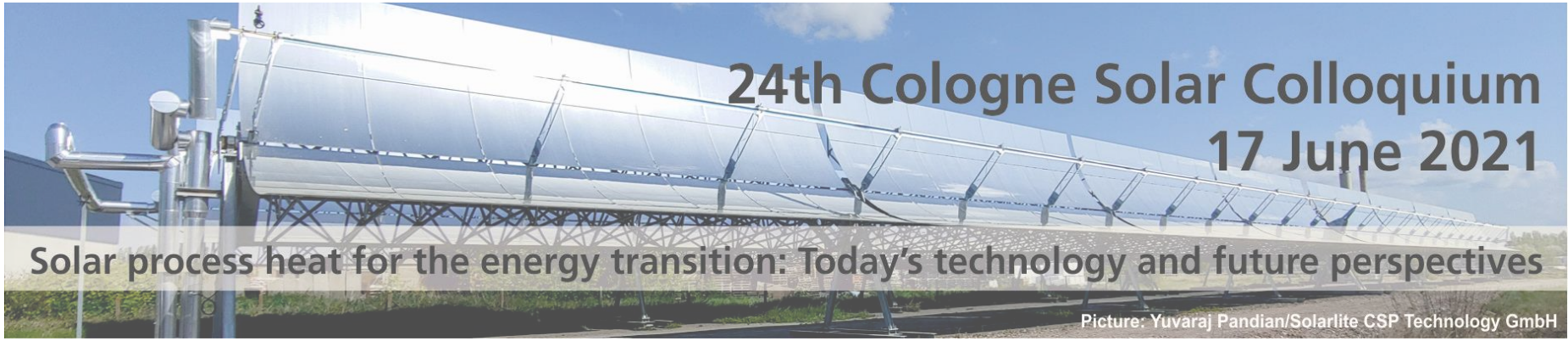
Cost and market trends in solar industrial heat

Bärbel Epp
Managing Director | solrico



DLR

SHIP Supplier World Map on http://www.solar-payback.com/suppliers/

Solar supplier without references	8
Solar supplier with collector production and without references	9
Solar supplier with references	17
Solar supplier with collector production and references	41

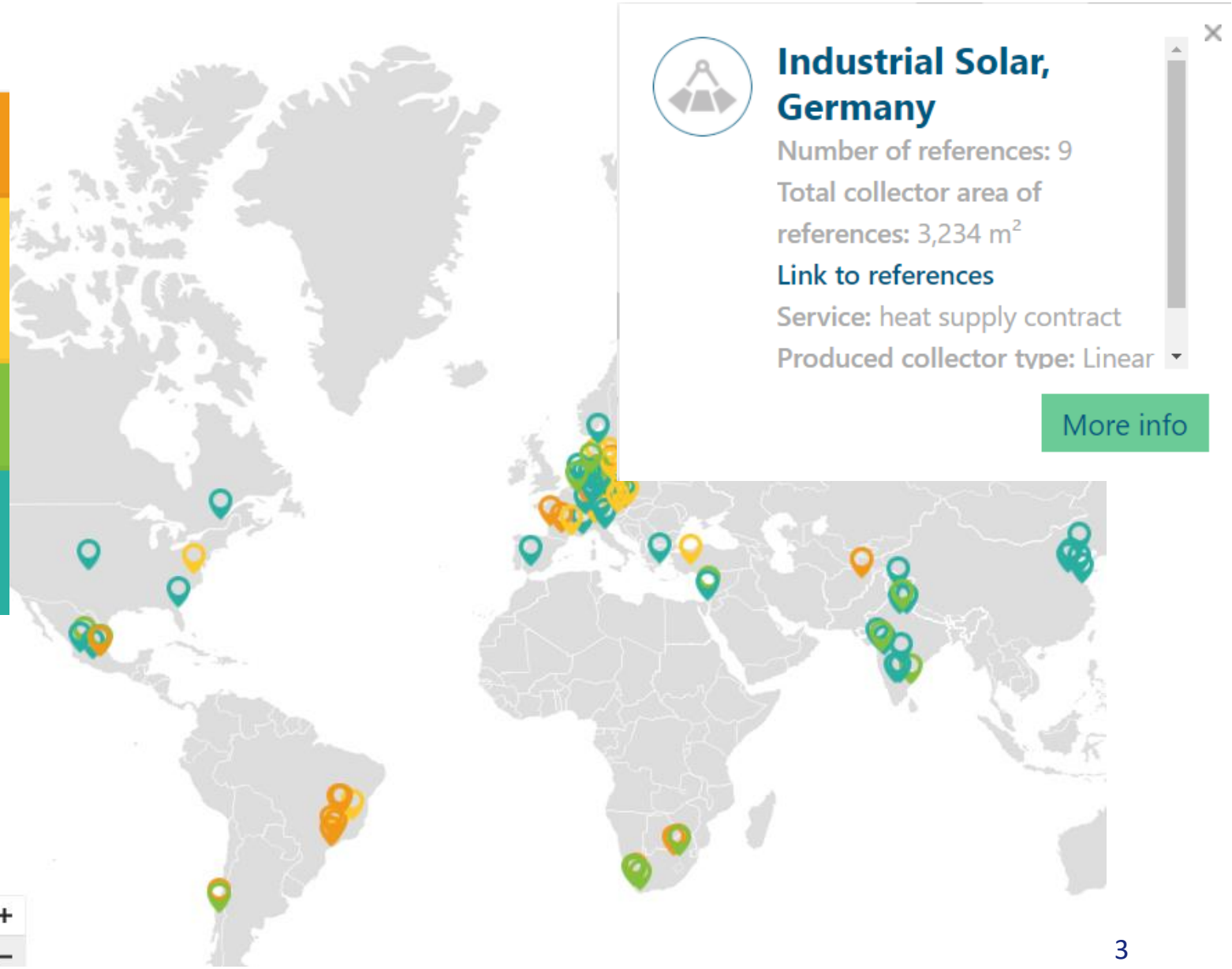
Supported by:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

based on a decision of the German Bundestag

SHIP Supplier World Map on http://www.solar-payback.com/suppliers/

Solar supplier without references	8
Solar supplier with collector production and without references	9
Solar supplier with references	17
Solar supplier with collector production and references	41



Solar industrial heat: It´s a tough business

2017
107 SHIP systems with 153 MW_{th}

- 120 MW Miraah in Oman
- No agricultural applications
- 22 systems in India

2018
99 SHIP systems with 39 MW_{th}

- 0 MW Miraah
- 51 SHIP plants in Mexico
- Average project size 551 m^2

2019
86 SHIP systems with 251 MW_{th}

- 180 MW Miraah
- 10 agricultural systems
- Average 1,194 m^2 per project without Miraah

2020
74 SHIP systems with 92 MW_{th}

- Corona delayed installation and contracting
- Increase in China (30 projects with 71 MW)

Source: Solar Payback surveys

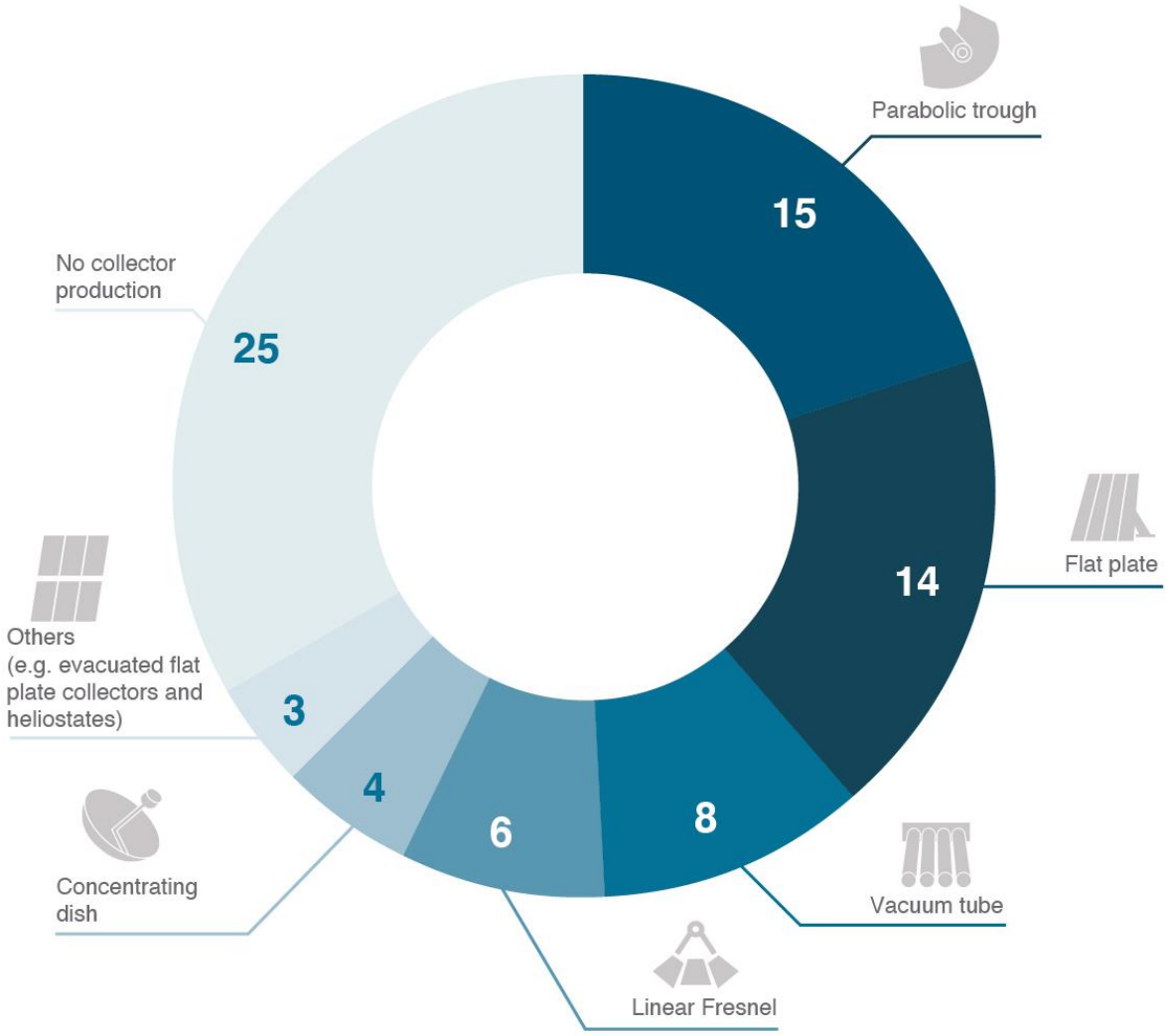
World market of solar concentrating heat

	Application	Newly installed collector area 2018 [m^2 apertur]	Newly installed collector area 2019 [m^2 apertur]	Newly installed collector area 2020 [m^2 apertur]
Parabolic trough	SHIP applications	11,367	7,539	14,030
	NON-SHIP applications	21,220	4,051	218
	Glasspoint (Miraah)	0	257,143	0
	Total	**32,587**	**268,733**	**14,248**
Dish	SHIP applications	1,075	1,962	310
	Commercial cooking	1,576	160	1,140
	Total	**2,651**	**2,122**	**1,450**
Linear Fresnel	SHIP applications	360	636	602
	Total	**360**	**636**	**602**
	Total across all three technologies newly installed	**35,598**	**271,491**	**16,300**
	Total capacity in operation at the end of the year [m2]	**520,556**	**792,046**	**808,346**

Increasing number of concentrating collector manufacturers

75 turnkey SHIP suppliers are currently depicted on the world map

67 % of the listed companies produce collectors in-house or on-site

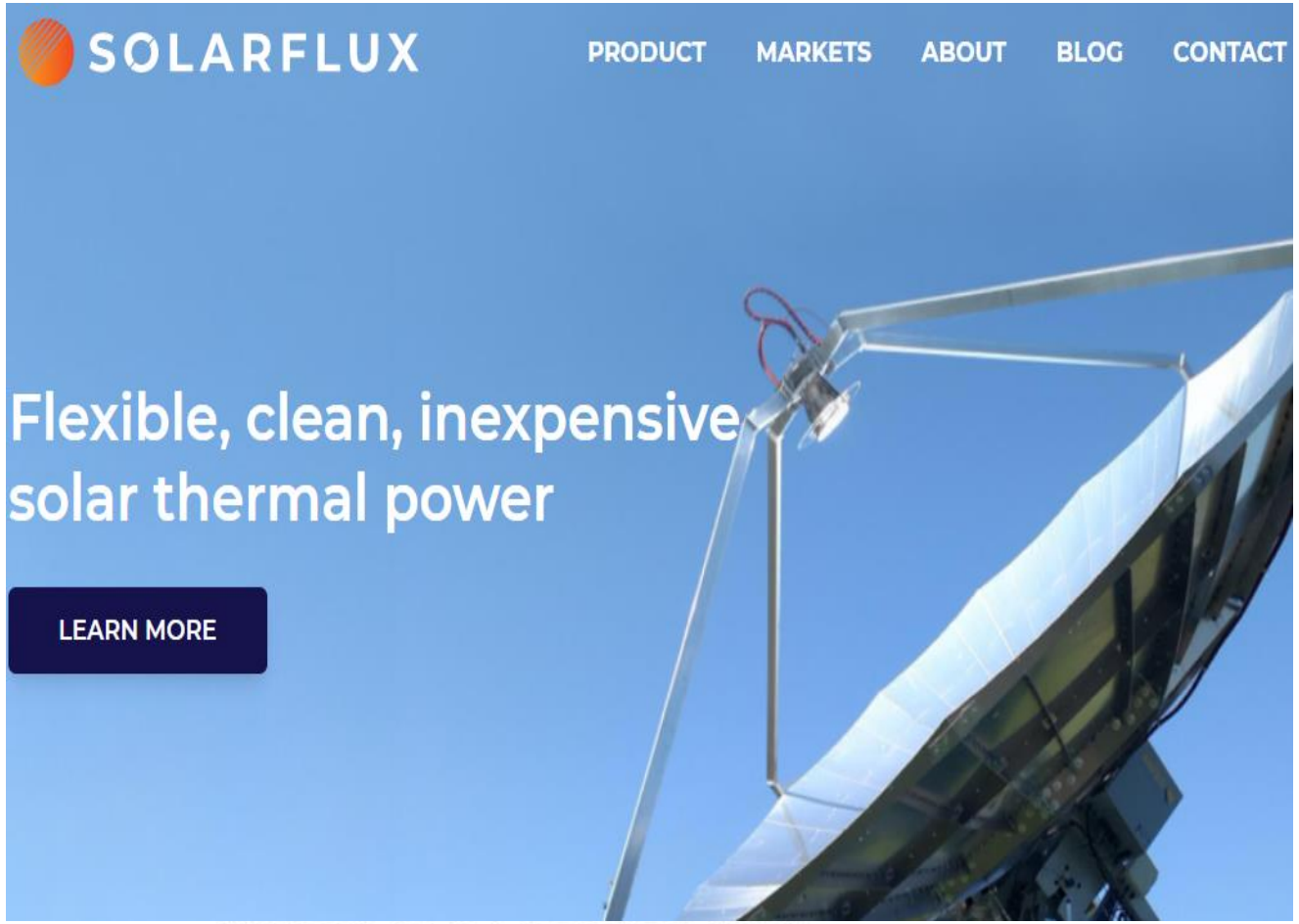


Newly listed US-based concentrating collector manufacturers

https://www.sunvapor.net/index.html

SUNVAPOR
RENEWABLE PROCESS HEAT

Newly listed US-based concentrating collector manufacturers



https://www.sunvapor.net/index.html

https://www.solarflux.co/

Newly listed US-based concentrating collector manufacturers

https://www.sunvapor.net/index.html

https://www.solarflux.co/

https://skyven.co/

Largest SHIP projects commissioned 2020

Installation site	Size of solar field [m2 / kW]	Technology provider	Type of collector	Application
Nibbixwoud, Netherlands	15,000 m^2 10.5 MW_{th}	G2 Energy, Netherlands	Flat plate	Heating Freesia farm greenhouses
Sanya, Hainan, China	6,645 m^2 4.6 MW_{th}	Linuo Paradigma, China	Vacuum tube	Process heat for beverage industry
Ganzhou, Tibet, China	5,500 m^2 3.9 MW_{th}	Vicot, China	Parabolic trough	Preheat for agricultural drying
Lhasa, Tibet, China	5,000 m^2 3.5 MW_{th}	Sunrain, China	Vacuum tube	Heating agricultural greenhouses
Izmir, Turkey	5,000 m2 3 MW_{th}	Soliterm, Germany	Parabolic trough	Process heat for packaging company

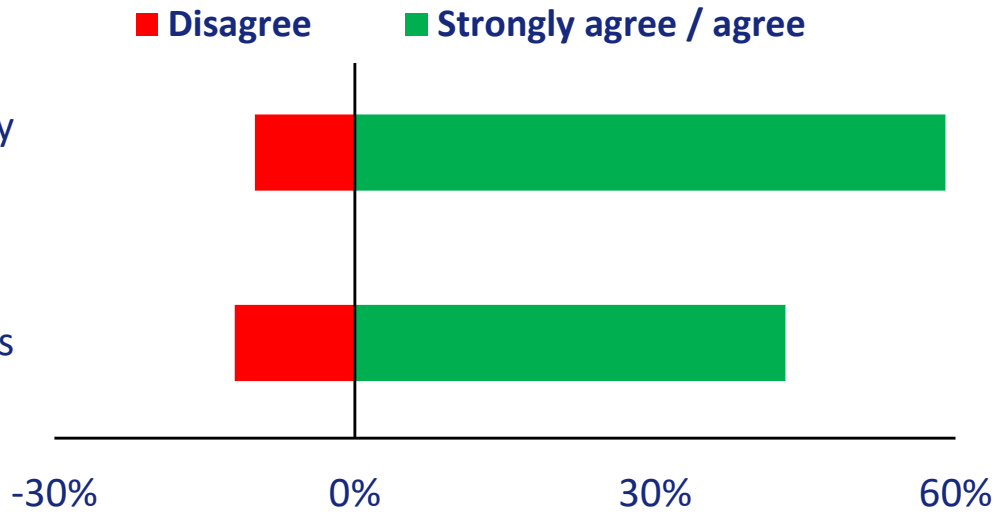
Photo: Vicot

Photo: Solimpeks

Growing demand from multinational cooperations

The interest in green heating solutions by multinational cooperations is growing.

Environmentally conscious customers increase the pressure on consumer goods manufacturers to reduce their carbon footprint



51 answers from SHIP technology suppliers worldwide listed on **www.solar-payback.com/suppliers**

Transparent yields are added value

"We see real added value from this approach, as our data is going to help inform policy makers and will assist modelers trying to incorporate different solar heat technologies into their scenarios."

Michael Taylor, Senior Analyst, Renewable Cost Status and Outlook at IRENA

162 countries are member at IRENA

All charts in this presentation are preliminary, and subject to change.

Supported by:

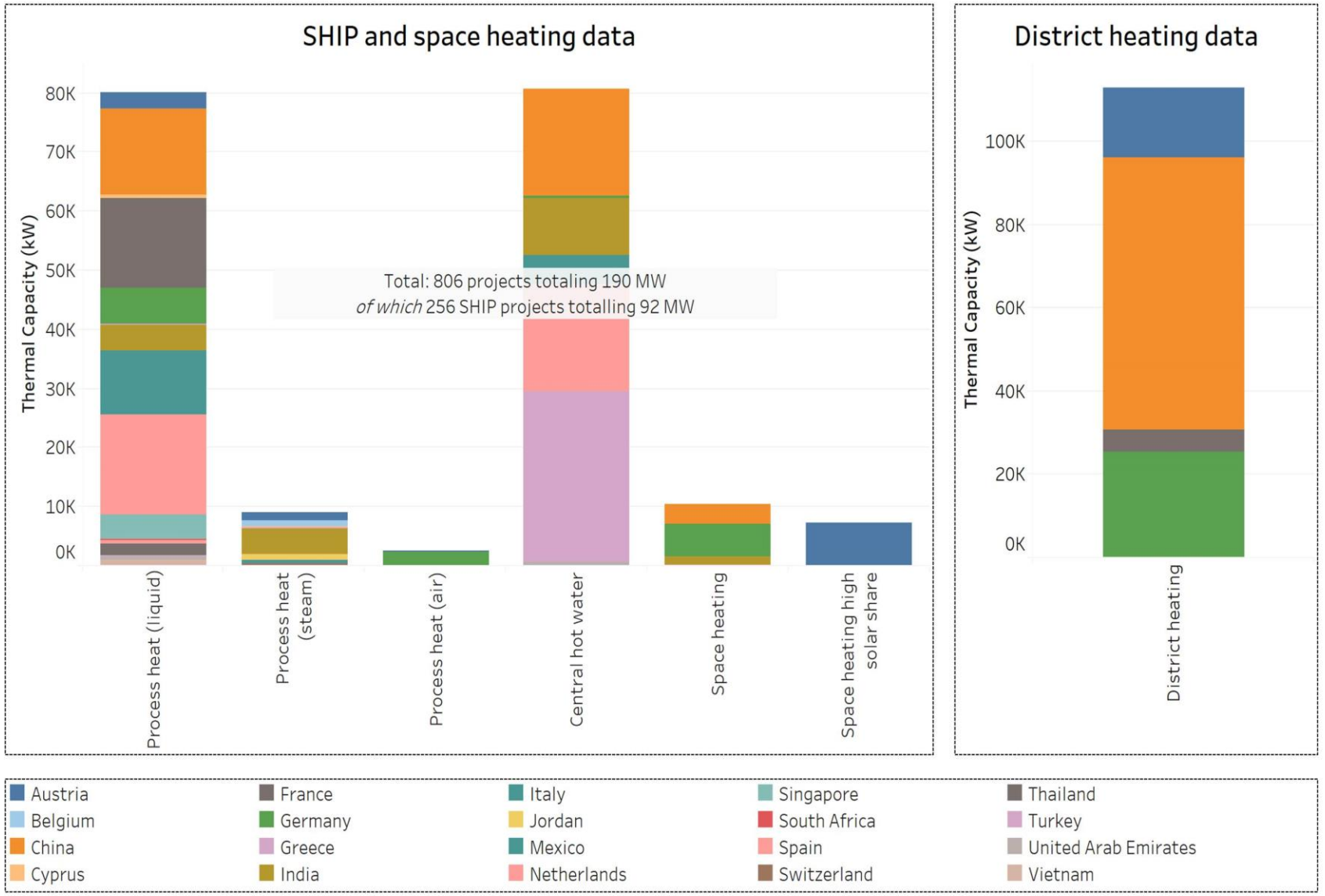
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

based on a decision of the German Bundestag

Template for data gathering

	Data of Project 1
Year of commissioning	
Country of installation	
Collector field technology	
Type of mounting system	
Aperture area (m^2) of concentrating collector field	
Solar thermal capacity (MW) of concentrating collector field	
Type of solar storage tank	
Application	
Average supplied temperature level over the year	
Currency of total costs	
Total costs in local currency including: - Collector field and circuit - Solar storage tank - Planning and installation costs Please exclude equipment for integration into client's network, financing costs, subsidies and VAT.	
Annual useful solar yield (MWh/a) based on simulations during the planning or monitoring. "useful" stands for the thermal energy delivered to the customer.	
Remarks to any special feature of the project (this field is not mandatory)	

Database



926 data points (including multiple systems)

Flatplate collectors dominate

District heating largest capacity

70 plants with concentrating collectors (100 MW)

Data conversion = IRENA Methodology

Calculation of Levelised Cost of Heat (LCOH) – adaptation to the formular for Levelised Cost of Electricity (LCOE) used by IRENA so far (see right hand side)

$$LCOH = \frac{I_o + \sum_{t=1}^{n} \frac{M_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{Y_t}{(1+r)^t}}$$

Where

LCOH = the average levelised cost of heat generation in lifetime

n = lifetime of the system: 25 years (same as PV)

I_0 = investment expenditure in year zero

M_t = operation and maintenance expenditure estimated by IEA SHC Task 64 experts

- 1% of total installed costs (net) per year (≤ 1000m² aperture area of field)
- 0.5% of total installed costs (net) per year (>1,000m² aperture area of field)

Y = project-specific annual heat generation [MWh/a]

r = discount rate (WACC) = 5 % (real)

$$\mathrm{LCOE} = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:

LCOE = the average lifetime levelised cost of electricity generation

I_t = investment expenditures in the year t

M_t = operations and maintenance expenditures in the year t

F_t = fuel expenditures in the year t

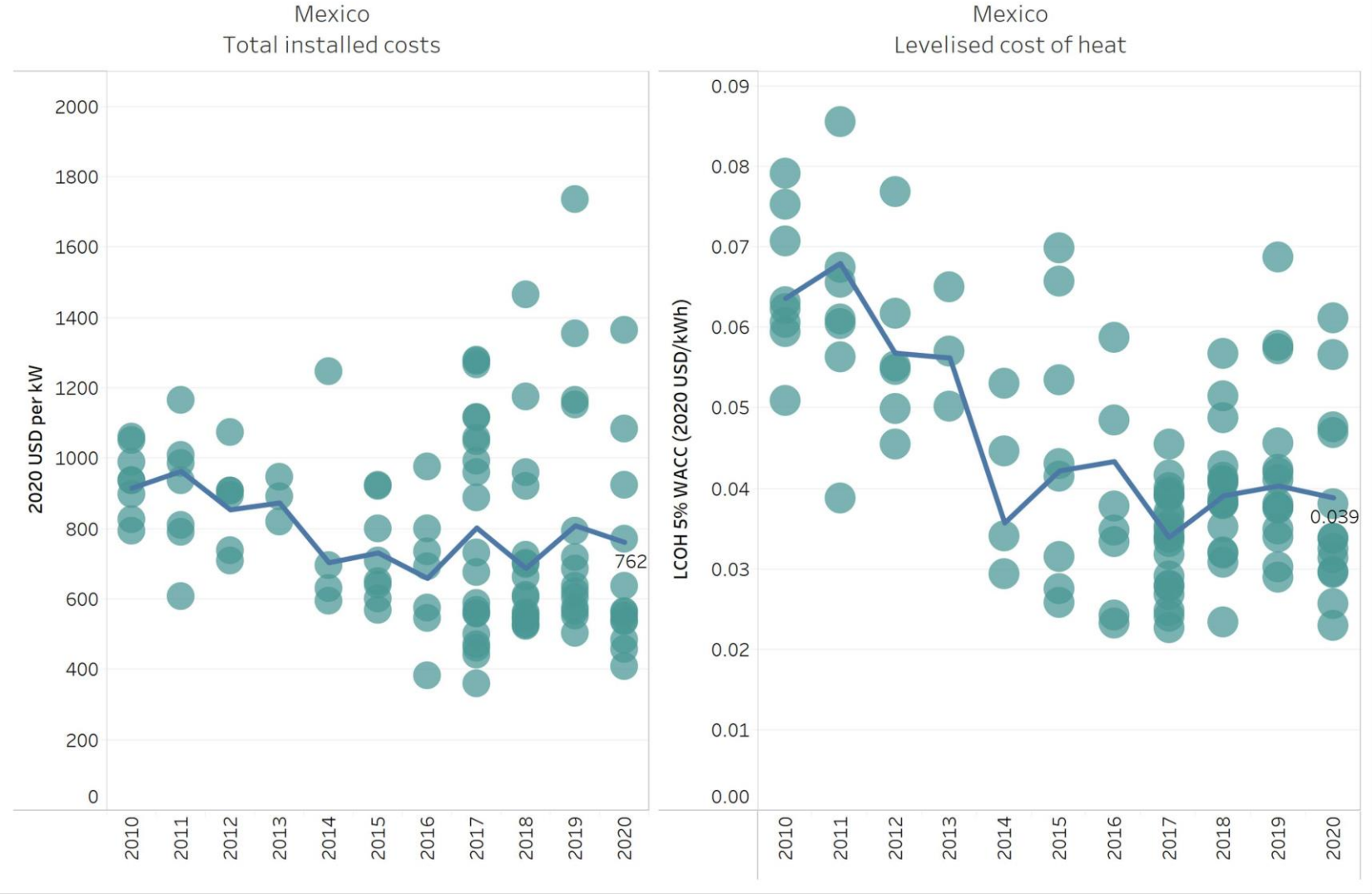
E_t = electricity generation in the year t

r = discount rate

n = life of the system. 25 years for PV

WACC is lowered linearly from 7.5% to 5% for the OECD and China between 2010 and 2020 and from 10% to 7.5% elsewhere.

Cost curves in Mexico



Four suppliers with 106 projects (central hot water and SHIP together) both concentrating and stationary collectors

Improved yields results in even faster reduction of LCOH (-40%)

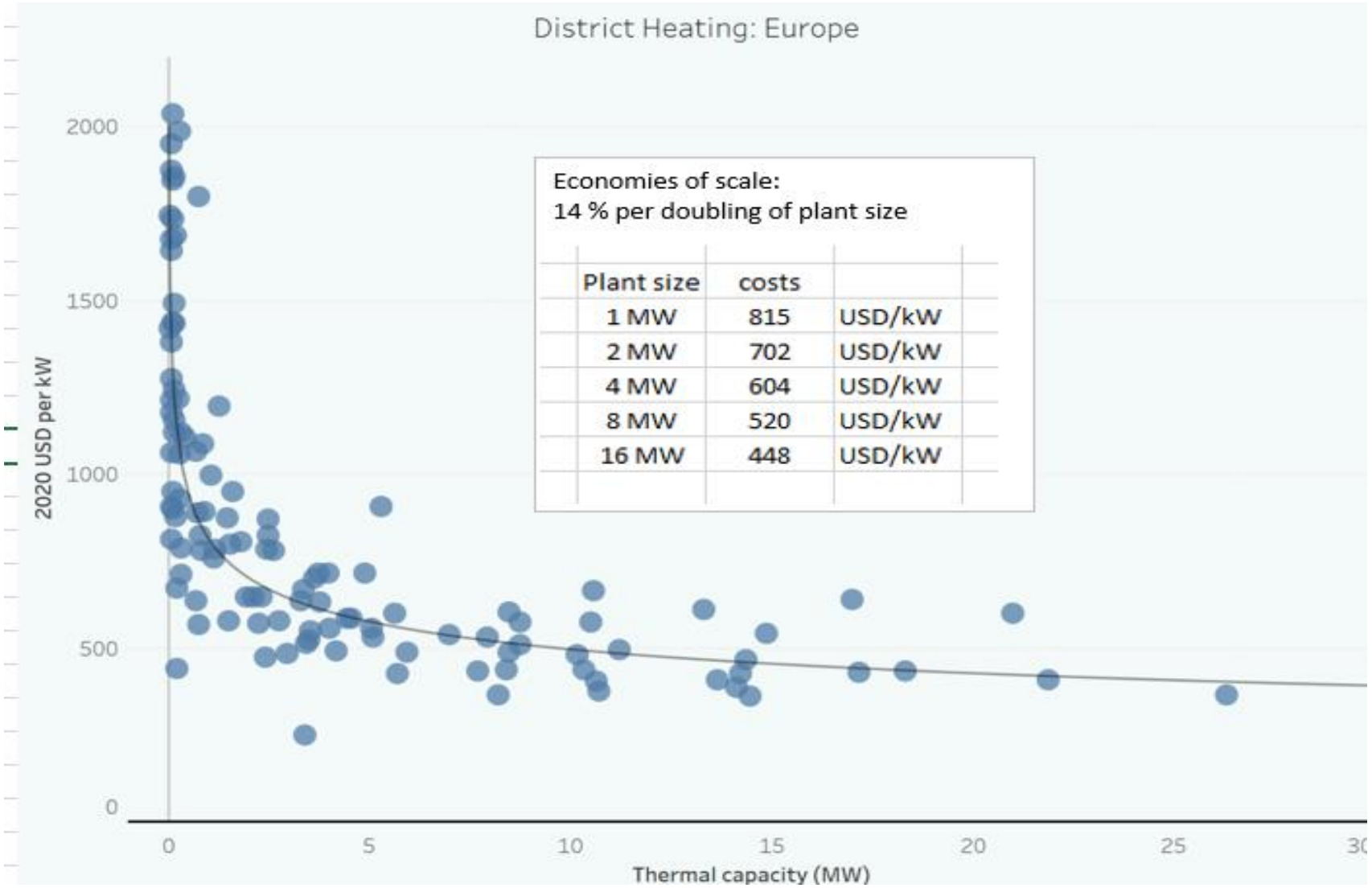
Reasons: Improvements in supply chain, improved collectors and system designs

Observation: Total installed costs are difficult to plot, because kW/m^2 differs significantly from region to region

~ 0.8 kW/m^2 in India
~ 0.6 kW/m^2 in Europe
~ 0.4 kW/m^2 in Mexico

Economy of scales

Economies of Scale in District Heating Installed Costs



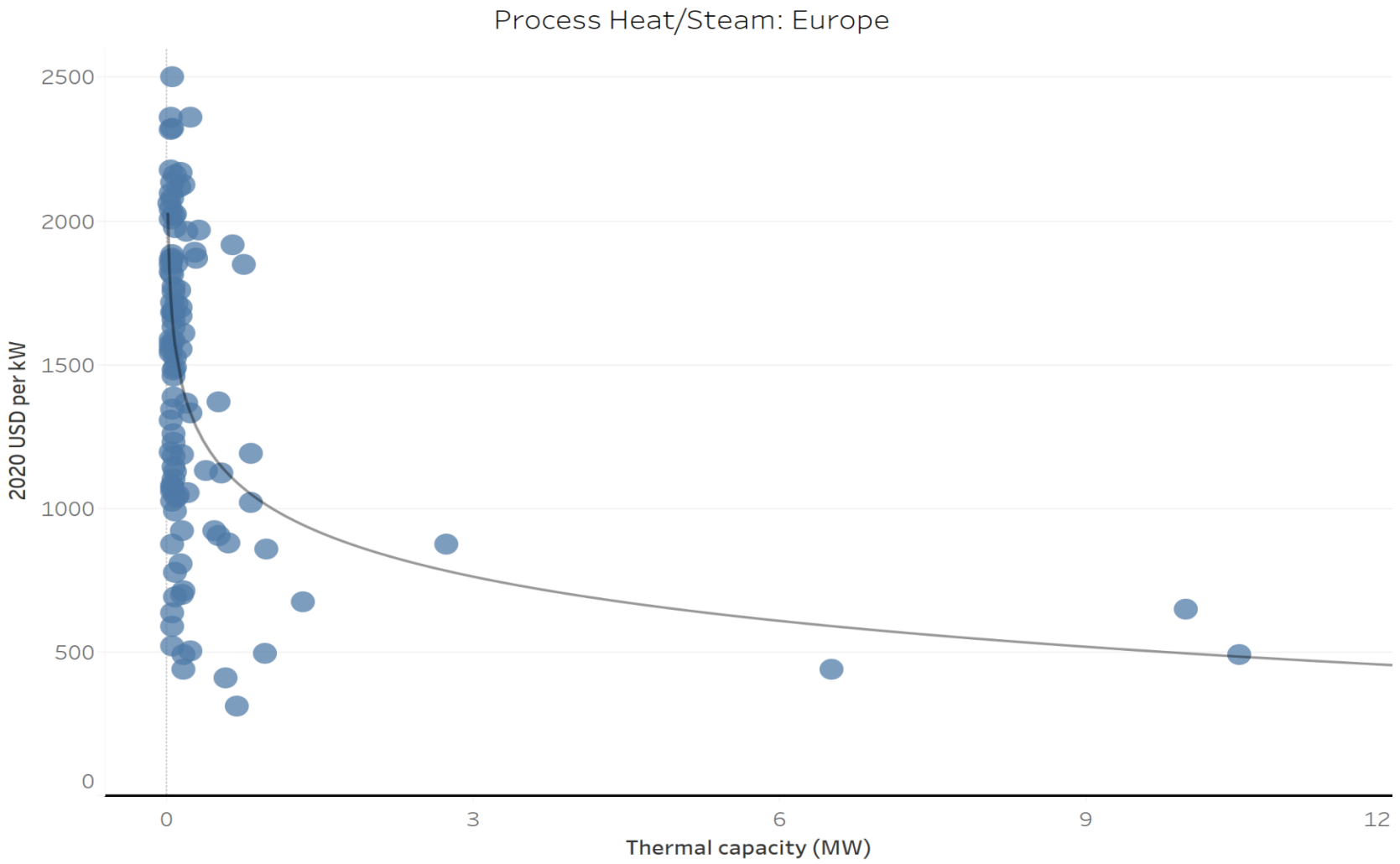
District heating in Europe (including Silkeborg)

Clear evidence of economies of scale in district heating

Austrian systems smaller & often roof mounted

Large fields also in SHIP will be able to reach economy of scales

Economies of scale



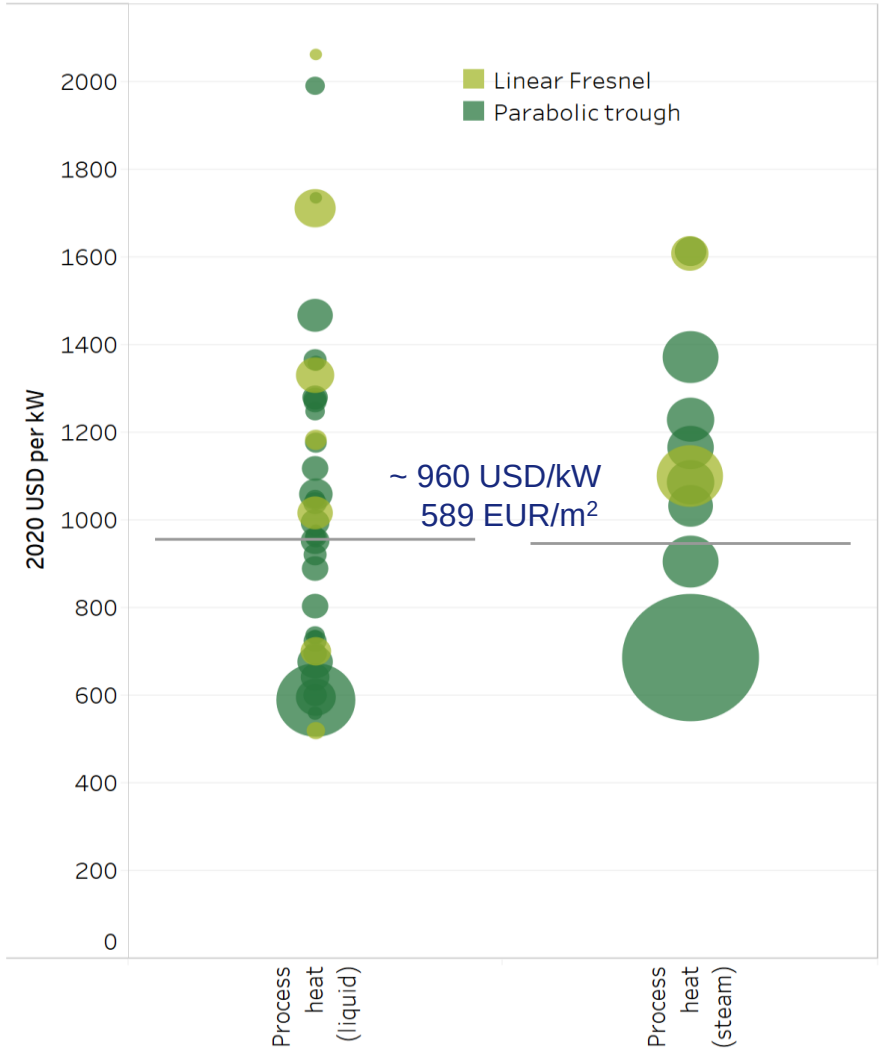
SHIP in Europe shows the same economy of scale as SDH in Europe

Small number of multi-MW large plants yet commissioned.

Projects from:
Austria, Belgium, Cyprus, France, Germany, Greece, Italy, Netherlands, Spain

Charting under discussion

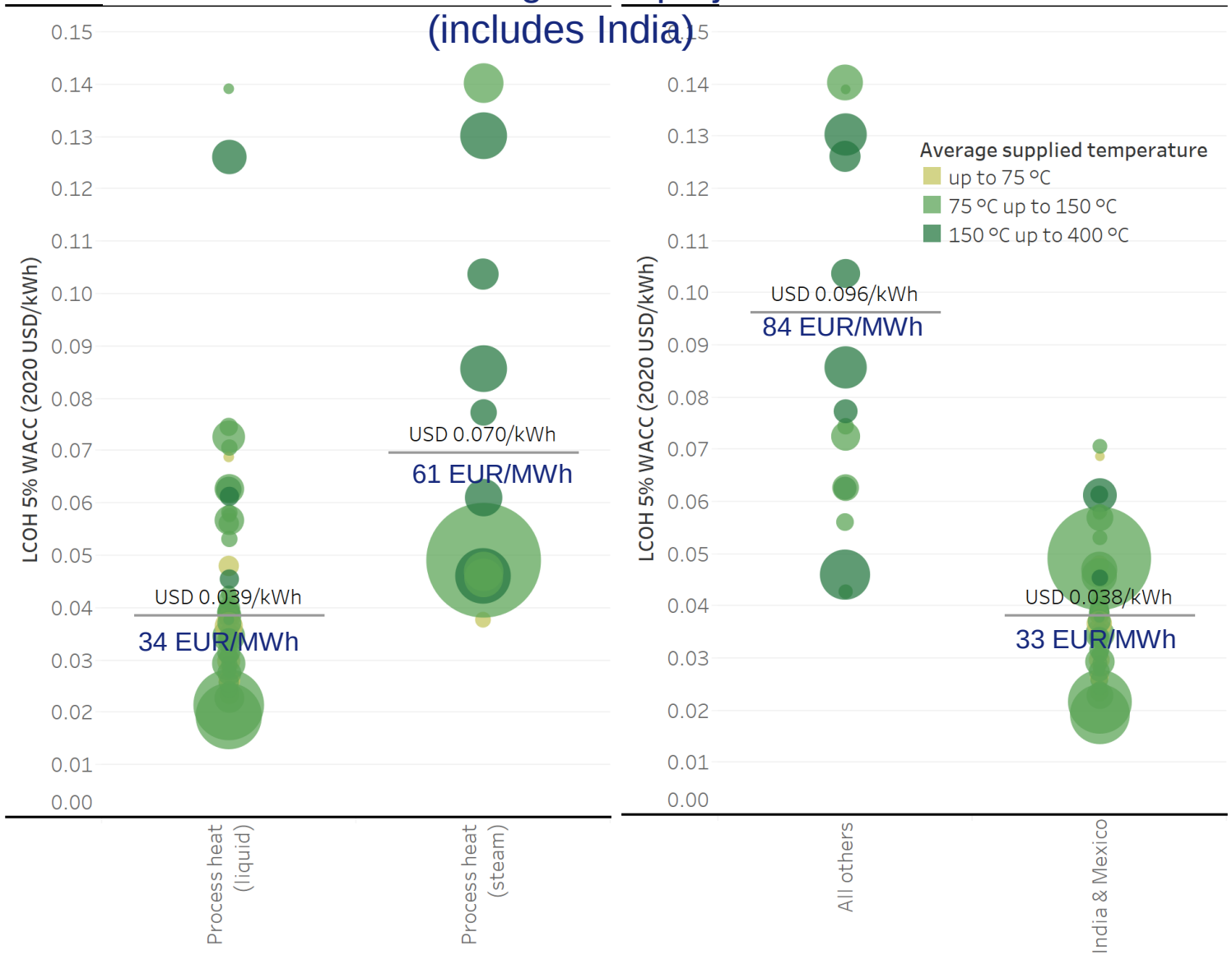
Total installed costs (left) / LCOH (right) of concentrating SHIP projects worldwide without India



Please also note, all USD/kW values are multiplied by 0.6132 to be converted into EUR/m2 aperture area considering the average exchange rate between USD and EUR in 2020 which was 0.876 and conversion factor of 0.7 kW/m2

LCOH of concentrating SHIP

LCOH of concentrating SHIP projects worldwide (includes India)



All others includes projects in Europe plus some concentrating SHIP plants outside Europe which were realised with German technology (only projects outside India / Mexico)

Average costs lower in non OECD countries

Planned publications

https://www.ises.org/what-we-do/webinars

- Chapter on solar heat costs within the Renewable Energy Generation Costs in 2020 Report by IRENA to be published in the next weeks
- Full report about solar heat costs published by IRENA/Solar Payback under the title “Renewable heat costs: large scale solar thermal in the third quarter of 2021

Thanks for your attention!

Bärbel Epp, epp@solrico.com

www.solrico.com, www.solarthermalworld.org

www.solar-payback.com