

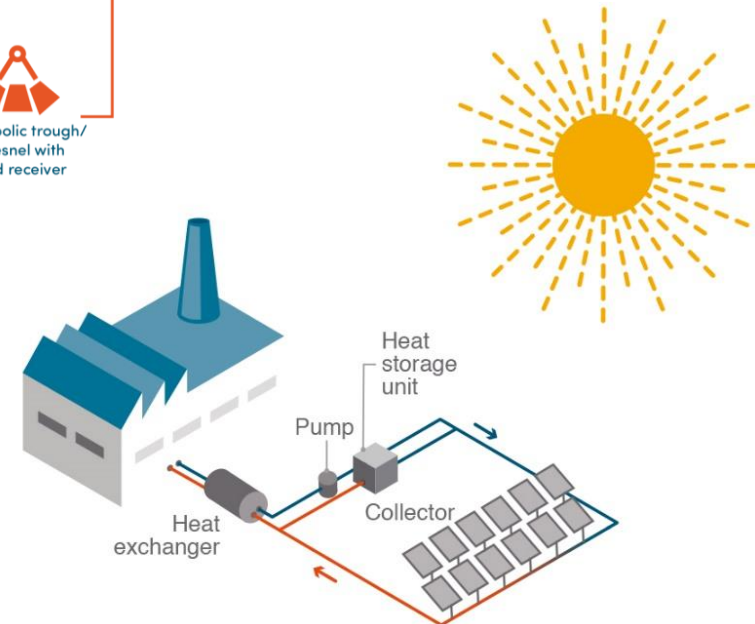


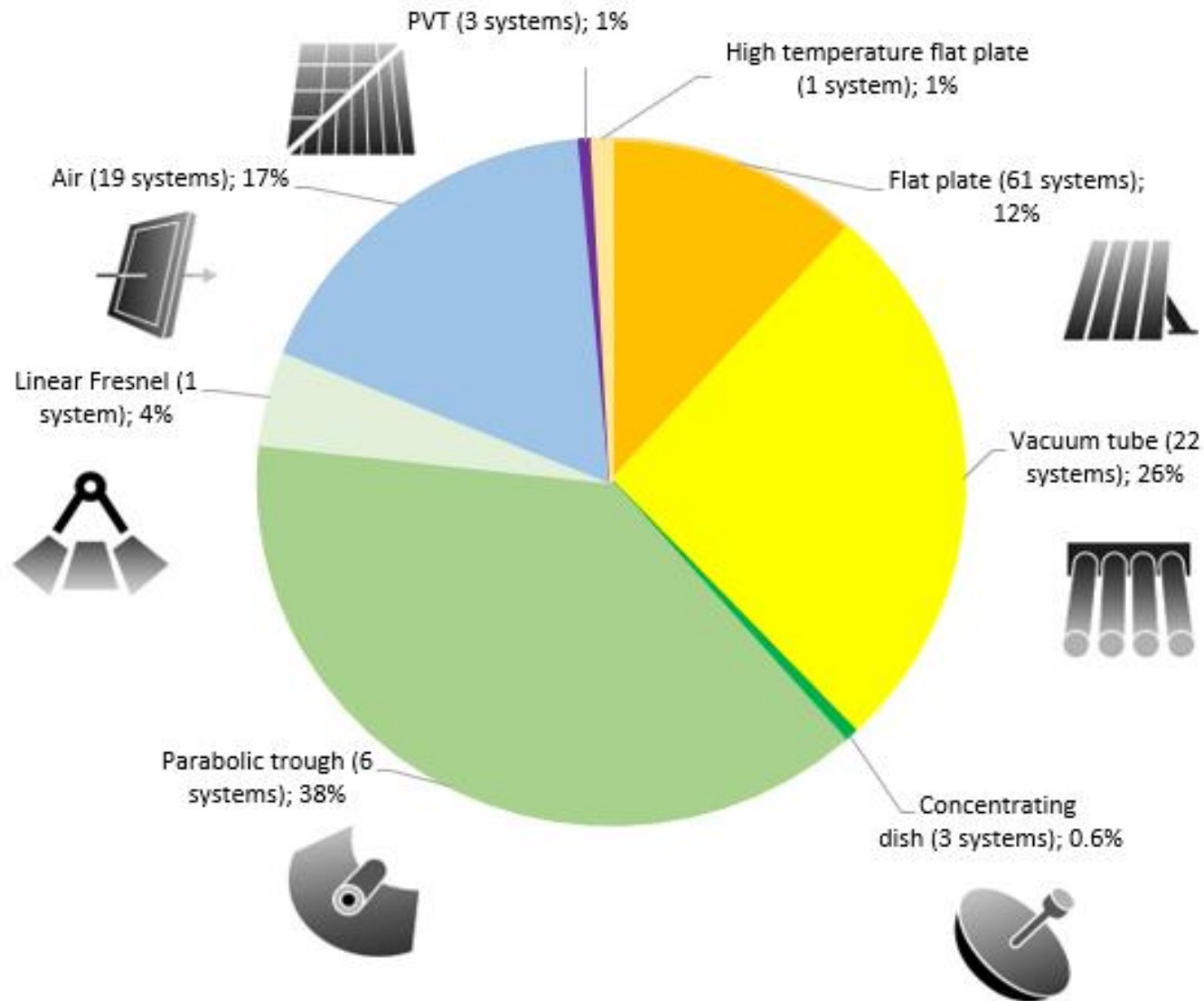
Industrial heat decarbonization: challenges, trends and outlook

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www.solrico.com, www.solarthermalworld.org**

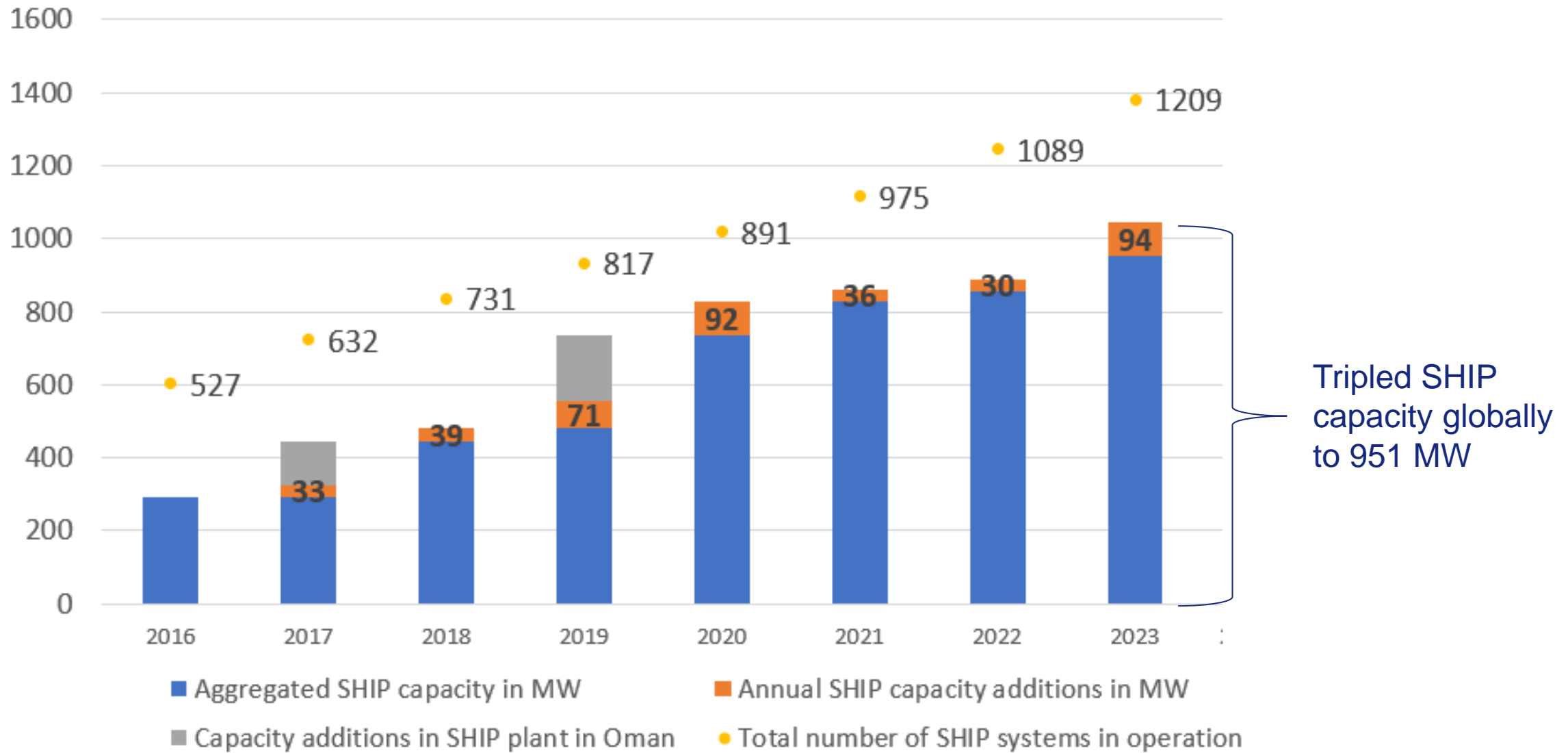
What is SHIP – Solar Heat for Industrial Processes?

SECTOR	LOW		MEDIUM
	Below 75 °C	75 to 150 °C	150 to 400 °C
Agriculture	<ul style="list-style-type: none"> Greenhouse heating Drying 		
Industry	<ul style="list-style-type: none"> Washing Heat treatment Drying 	<ul style="list-style-type: none"> Boiling Pasteurising Sterilising Bleaching Dyeing 	<ul style="list-style-type: none"> Distilling Nitrate melting Pulping Drying of paint
COLLECTOR TYPE	Air Collector Hybrid PVT (PV and Thermal)	Flat plate Evacuated flat plate Vacuum tube Vacuum tube CPC	Small parabolic trough/linear Fresnel without evacuated receiver Concentrating dish Large parabolic trough/linear Fresnel with evacuated receiver

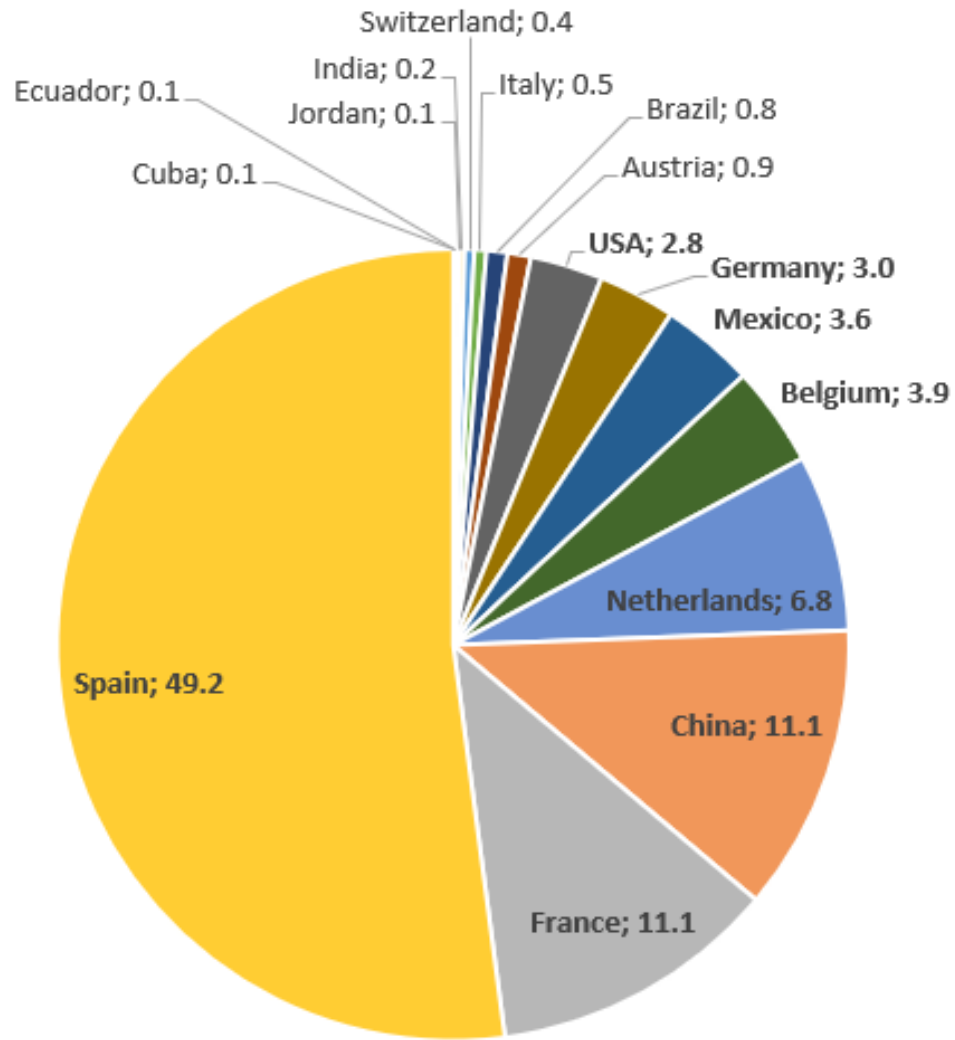




Solar industrial heat market development 2016 to 2023



SHIP capacity additions in 2023 in MW per country [Total: 94 MW]



Two new SHIP plants in the state of Sonora, Mexico's mining region



Client: Hanka (ammonium nitrate producer)
Site: Sonora, Mexico
Project developer: Inventive Power (Mexico)
Collector type: parabolic trough collectors
Collector field: 1,300 m² / 0.6 MW
Solar heat temp.: 160 °C
Commissioning: April 2023
Business model: Turnkey installation include steel tanks with 24 m³

Client: Grupo Mexico (copper mine)
Site: Sonora, Mexico
Project developer: Flemming Jorgensen (Mexico)
Collector type: flat plate collectors
Collector field: 910 m² / 0.8 MW
Solar heat temp.: 65 to 95 °C
Commissioning: December 2023
Business model: Turnkey installation with European technology

“Although the SHIP market has demonstrated a high growth potential, the sales cycle for industrial clients has not shortened as we had expected.”

“Customers are cautious because the energy market situation cannot be assessed. Gas prices dropped while interest rates increased.”

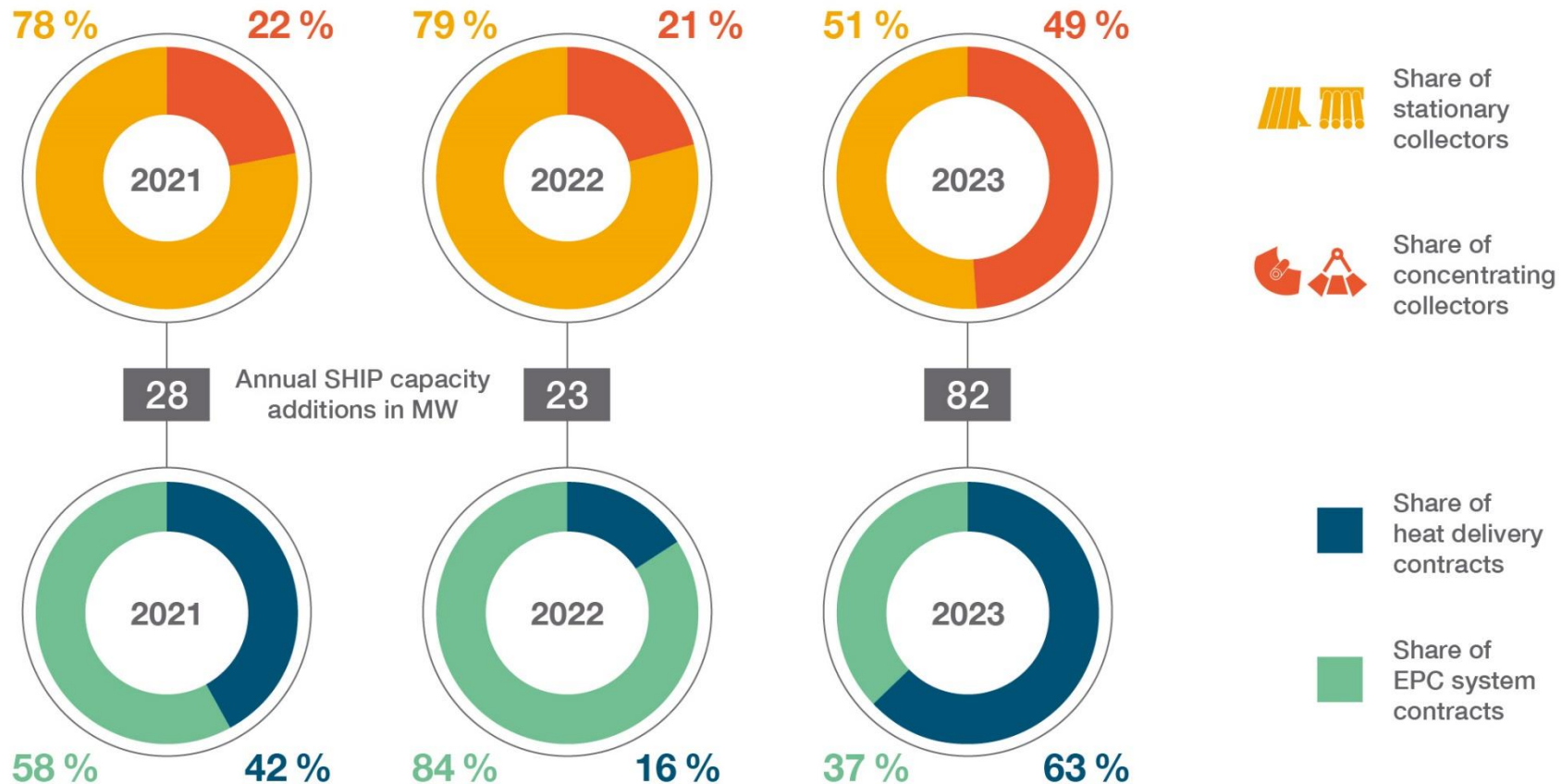
“Although we had many leads in various countries, we did not close any projects during 2023.”



- Difficult to close contracts
- Long project development times
- High dependency on energy prices

- But demand and requests are increasing

Concentrating collectors are on the rise



Heat delivery contracts dominate the future SHIP market

Source: solrico, July 2024
Annual industry surveys between 2016 and 2024 without projects in China



Client: Heineken (brewery)
Site: Sevilla, Spain
Project developer: Engie / Solarlite (Spain / Germany)
Collector type: parabolic trough collectors
Collector field: 43,414 m² / 30 MW
Solar heat temp.: up to 210 °C
Commissioning: September 2023
Business model: Heat purchase agreement with Engie (20 years)



Client: Lactalis (dairy)
Site: Verdun, France
Project developer: New Heat (France)
Collector type: Flat plate collectors
Collector field: 15,000 m² / 10.5 MW
Solar heat temp.: 80 °C
Commissioning: March 2023
Business model: Special Purpose Vehicle as ESCO

Heat purchase agreements are a business model to overcome the barriers



Client: Heineken (brewery)
Site: Valencia, Spain
Project developer: Solatom (Spain)
Collector type: Linear Fresnel collector
Collector field: 6,000 m² / 3 MW
Solar heat temp.: 220 C°
Commissioning: September 2023
Business model: Heat purchase agreement with CSIN (Spain)



Client: Ball Corp (packaging)
Site: California (USA)
Project developer: SOLID Solar Energy Systems (Austria)
Collector type: Flat plate collectors
Collector field: 4,000 m² / 2.8 MW
Solar heat temp.: 70 °C
Commissioning: May 2023
Business model: Heat purchase agreement with Tigi Solar (Israel)

Many special projects



Client: Oil & Gas producer
Site: Qarat al Milh, Oman
Project developer: Heliovis (Austria)
Collector type: parabolic trough collectors in an inflatable tube
Collector field: 1,683 m² / 0.9 MW
Commissioning: Beginning 2024

Photos: Heliovis



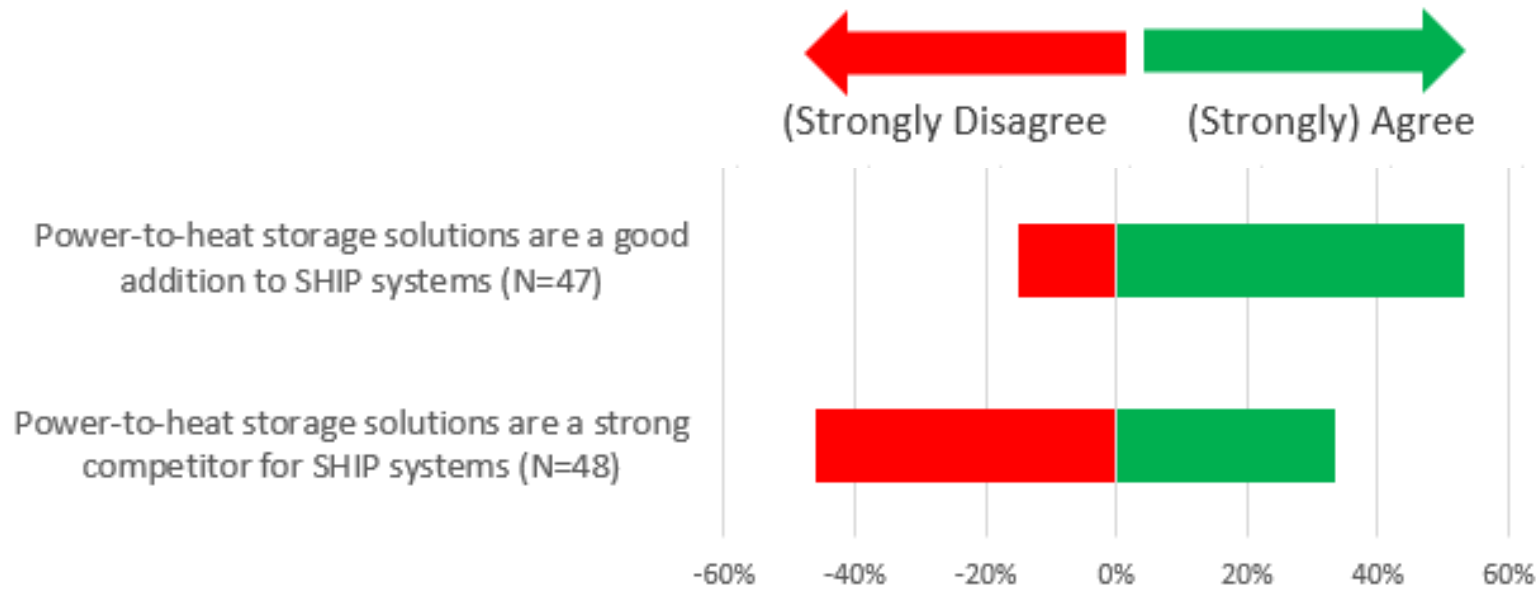
Concentrating collectors with high-temperature heat storage



Photo: Avery Dennison

Client:	Avery Dennison (Chemical industry)
Site:	Turnhout, Belgium
Project developer:	Azteq, Belgium
Collector type:	Parabolic trough collectors
Collector field:	5,539 m ² / 3.9 MW
Solar heat temp.:	up to 380 C°
Business model:	Heat purchase agreement
Storage tank:	ThermalBattery (5 MWh)
Storage provider:	Energynest, Norway
Storage type:	Solid-state storage with concrete tubes
Operation mode:	Heat-to-heat (Thermal oil) Charging at 380 °C / discharging at 310 °C
Solar share:	around 20 %

Do you agree or disagree with the following statements regarding trends in the global solar process heat market?



Survey February/March 2024, Source: solrico





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Reliable, zero-emissions industrial heat and power

Antora's factory-made thermal batteries convert low-cost, intermittent renewable electricity into reliable industrial energy. Our mission is to stop climate change.



Screenshots: <https://1414degrees.com.au/>

Companies sorted by year of foundation

Company name	Headquarters	Year of foundation
Kraftanlagen GmbH	Germany	1923
Magaldi Green Energy	Italy	1929
Sunamp	Great Britain	2005
Carbon-Clean Technology	Germany	2008
1414 Degrees	Australia	2009
Storworks Power	USA	2010
Energynest	Norway	2011
Brenmiller Energy	Israel	2012
Storasol	Germany	2013
Eco-Tech Ceram	France	2014
Heliac	Denmark	2014
Kraftblock	Germany	2014
Pintail Power	USA	2014
Alumina Energy	USA	2015
247Solar Inc	USA	2015
Element16	USA	2016
Kyoto Group	Norway	2016
Lumenion GmbH	Germany	2016
Malta Group	USA	2018
Polar Night Energy	Finland	2018
Antora Energy	USA	2018
E2S Power	Switzerland	2019
MGA Thermal	Australia	2019
Rpow	Spain	2019
Kaaj Energy	Canada	2020
Rondo Energy	USA	2020
Electrified Thermal Solutions	USA	2021
Hyme Energy	Denmark	2021
Build to zero	Spain	2022
Terrajoule Energy	USA	2022
Exergy3	Great Britain	2023

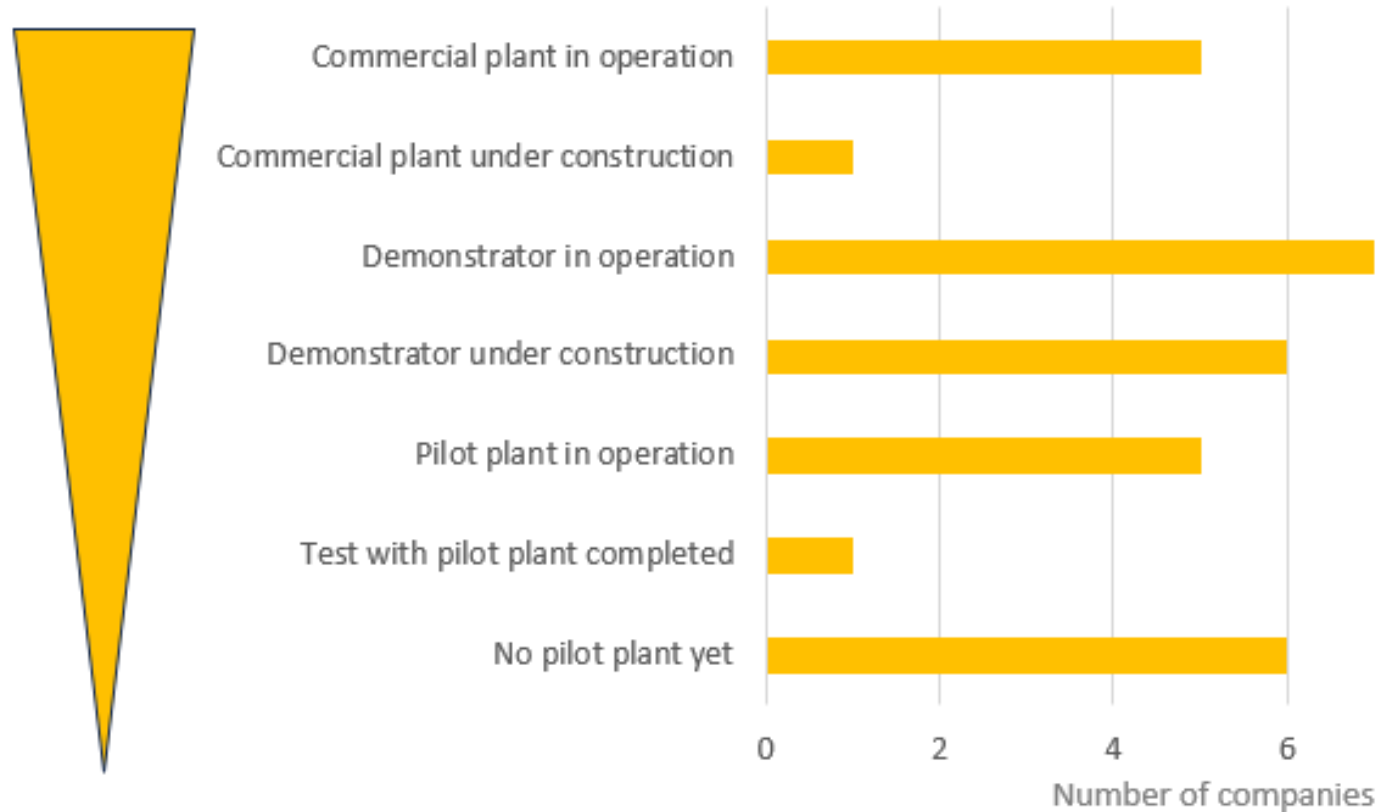
11 companies offer their products exclusively to industrial customers. 90 % target industrial heat off-takers as one of their customer groups.

It is a fairly young industry with the large majority of the companies founded in the last 15 years. Only two established companies in plant engineering are on the list (light orange)

Three companies plan to offer heat-as-a-service contracts: Rondo (USA), Kaaj Energy (Canada) and Exergy3 (Great Britain).

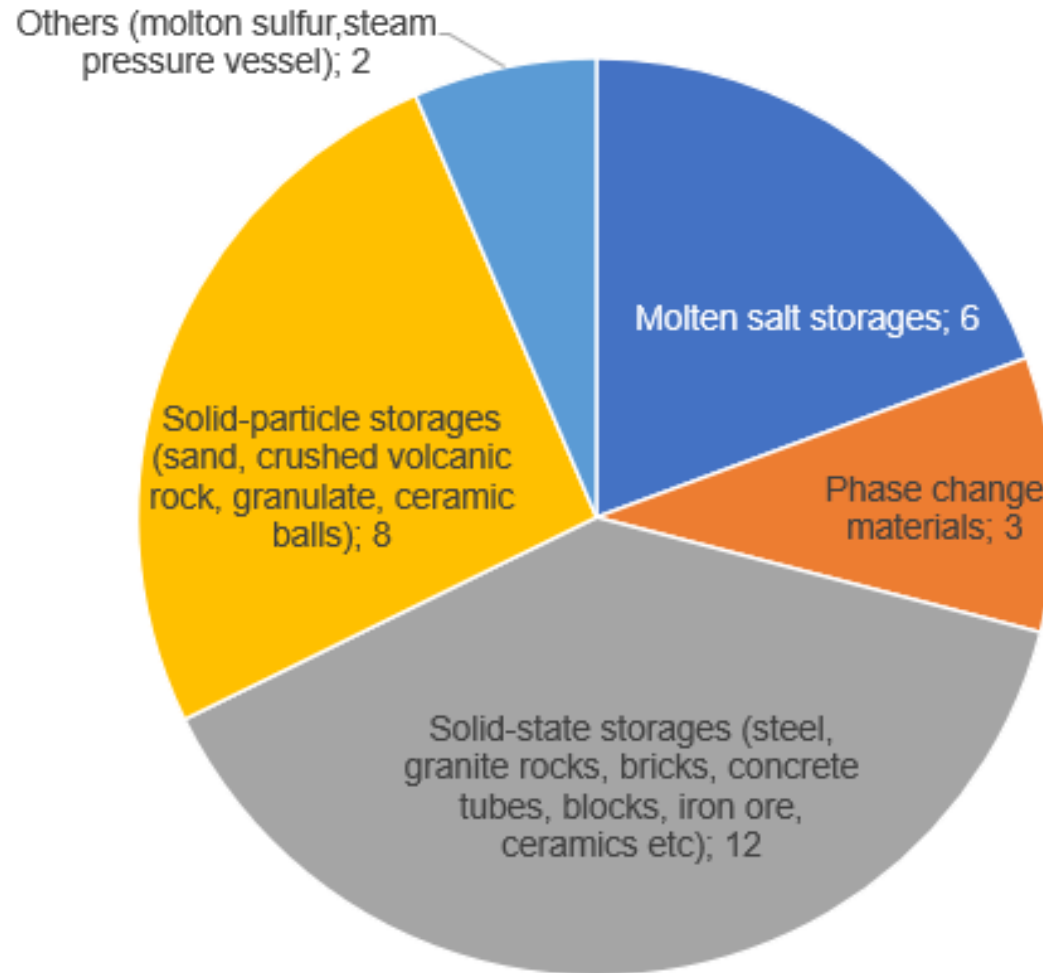
USA (10 companies) and Europe (16 companies) are technology hubs.

Level of commercialisation



Only five companies have implemented commercial projects with high temperature storages

Find all the results of the survey among medium/high temperature storage tank solution providers:
<https://shorturl.at/mQqFL>



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<https://shorturl.at/mQqFL>

Photos of commercial high-temperature storage tank solutions



Find descriptions about the commercial high-temperature storage systems on solarthermalworld.org:
<https://shorturl.at/mQqFL>

- ▶ News articles about the most recent SHIP Supplier Surveys: <https://solarthermalworld.org/modulus/>
- ▶ Check out the SHIP Supplier World map: <http://www.solar-payback.com/suppliers/>
- ▶ Use photos of SHIP plants for your presentations: https://www.solar-payback.com/gallery/gallone_en.php
- ▶ Find the all the results of the survey among medium/high temperature storage tank solution providers: <https://shorturl.at/mQqFL>
- ▶ Keep updated on trends in the solar thermal industry by subscribe the monthly newsletter of solarthermalworld.org: <https://solarthermalworld.org/newsletter/>
- ▶ Follow us on twitter: <https://twitter.com/solarthermal>
- ▶ And further questions and comments to: Bärbel Epp: epp@solrico.com