

Concentrated solar thermal (CST) for heat networks



 ZTEQ

DA|R|E|L

Marc Peters – DAREL Group

VZKC - Vereniging voor ZonneKrachtCentrales

Gouda, 28 Augustus 2021

Intro DAREL

DAREL intro

We help organizations that 'DARE to Lead' to realise plans that contribute to a cleaner and more resilient world, and that are sound business

- ❑ Founded in 2017 by a group of experienced industry leaders from the energy sector with the goal to accelerate the energy transition
- ❑ Extensive network in the wider energy industry sector in the Netherlands and beyond
- ❑ Player / leader in development of high-profile energy transition projects in the Netherlands, many through long-term advisory role for Port of Rotterdam
- ❑ Strong partner network, especially with consultancy firms, key suppliers, knowledge institutes and industry players
- ❑ Takes 'skin in the game' through venturing in new business and by participating in projects
- ❑ Building wider societal support by development of educational and training modules on the energy transition for secondary schools, universities and business masterclasses.



DAREL Business portfolio 2020/2021 - projects with Port of Rotterdam



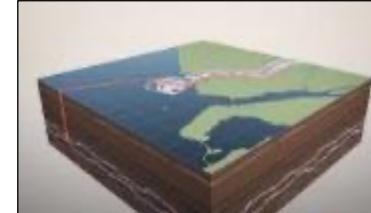
NSWPH Strategy



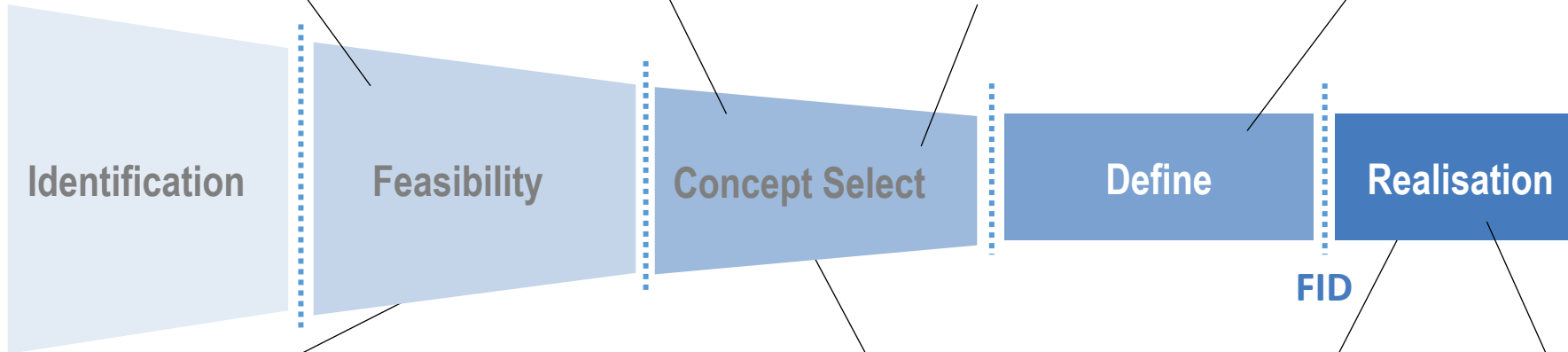
Heat transport /Warmteling



Waste to Chemicals – W2C



Porthos: R'dam CCUS



Other support...

- CO2-hub
- E-shunters
- Circular PV
- Future feedstock
- Biondoil
- Renewable Chem & Fuels
- Cluster Energy Strategy
- HBDI
- ET Masterclass for PoR



H2 Masterplan for Rotterdam



H-vision: R'dam hydrogen



RHINE



Shore power



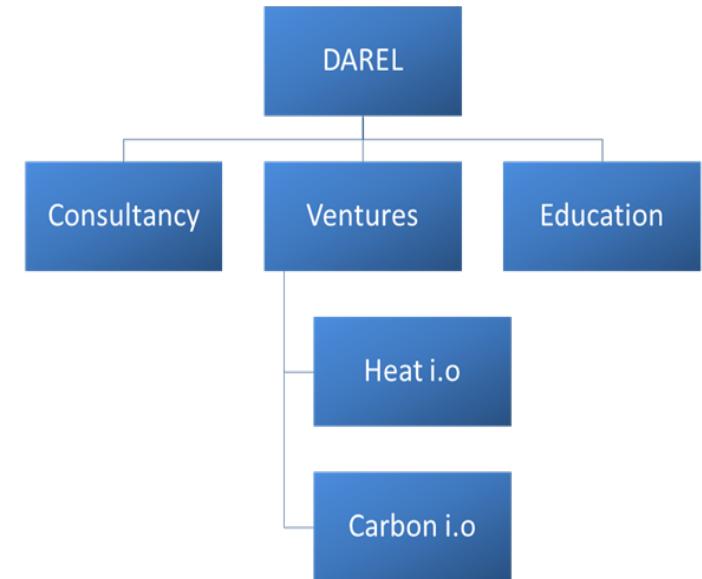
Zero Emission Shipping (ZES)

DAREL Business portfolio 2020/2021 - projects with other clients



DAREL's strategy - staircase model

Building societal support is pivotal to DAREL's objectives



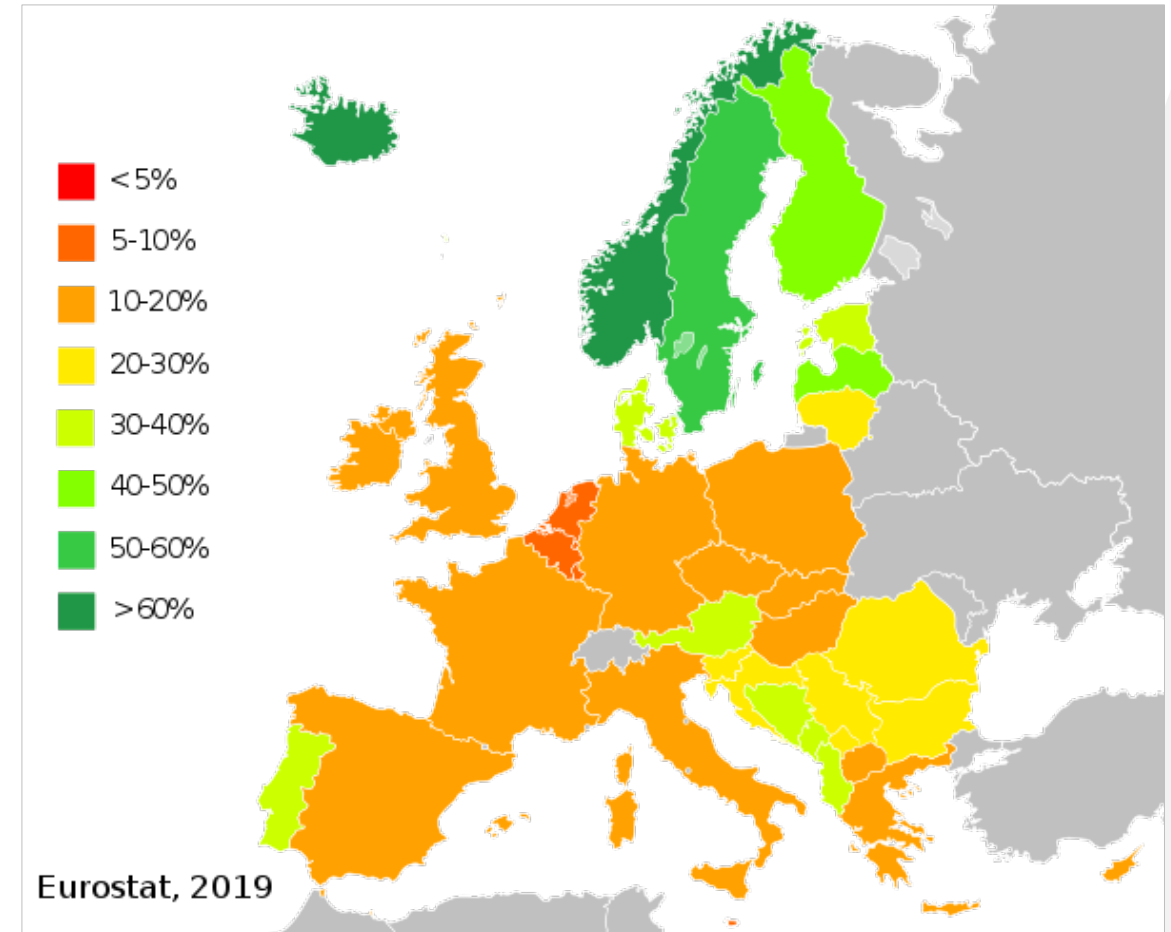
Concentrated solar thermal (CST)

Qualitative comparison of heat sources

- ❑ Solar thermal in combination with seasonal storage is a favourable solution compared to other heat sources.
- ❑ CST and flat plate (FP) solar collectors have a complementary temperature and efficiency range

		HEAT SOURCE / SUPPLY										
		Solar heat CST	Solar heat FP Flat plate	Solar heat CST,FP & storage	Residual heat	Geo-thermal	Aqua thermal	Biomass	Electric heat from renewable	Blue Hydrogen	Green Hydrogen	Fossil
Technical	Technical readiness	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Green
	Intermittency	Red	Red	Green	Yellow	Green	Green	Green	Red	Green	Yellow	Green
	Local availability	Green	Green	Green	Yellow	Yellow	Yellow	Green	Green	Yellow	Yellow	Green
	Sustainability	Green	Green	Green	Green	Green	Green	Red	Green	Green	Green	Red
	Energy efficiency (10-80°C)	Green	Green	Yellow	Green	Green	Yellow	Red	Yellow	Green	Yellow	Green
	Energy efficiency (> 80°C)	Green	Red	Yellow	Yellow	Green	Red	Red	Yellow	Green	Yellow	Green
	Pressure, Temp range	Green	Yellow	Yellow	Yellow	Green	Red	Green	Green	Green	Green	Green
Economic/ Commercial	Scaling / modularity	Green	Green	Yellow	Yellow	Red	Yellow	Green	Green	Yellow	Yellow	Green
	Land usage	Yellow	Yellow	Yellow	Green	Green	Green	Red	Red	Green	Yellow	Green
	Leadtime	Green	Green	Yellow	Yellow	Red	Yellow	Green	Yellow	Red	Red	Red
	LCOE (€/MWh) ¹⁾	15-40	15-40	+30%	20-40	20-55		20-45	>60	15-45		10-25
	Funding incl SDE+	Green	Green	Green	Red	Yellow	Yellow	Yellow	Green	Red	Green	Green
Organisational	Stakeholder complexity	Green	Green	Green	Yellow	Red	Yellow	Yellow	Green	Yellow	Yellow	Green
Societal	Public support	Green	Green	Green	Green	Yellow	Green	Red	Green	Green	Green	Red
Overall risk profile		Green	Green	Green	Yellow	Yellow	Yellow	Red	Red	Red	Red	Green

- ❑ Application of Solar Thermal fits the EU and global climate agenda for decarbonization of the energy sector
- ❑ Gap between EU/national targets in 2020/2030 and the current performance of various countries leaves plenty of room for the application of Solar thermal as a sustainable source
- ❑ Most countries in the AZTEQ/DAREL portfolio (NL, B, Lux, D, F, E and P) did not meet their 2020 targets; they have a large gap between the current use of renewable energy and the EU/national targets.



Overall share of energy from renewable sources
(% of gross final energy consumption, 2019)

WAASLANDHAVEN

Techniek zorgt voor 10% minder CO₂-uitstoot, producent wil ook fabriek openen op oude Opel-site

Eerste industriebedrijf in Europa dat verwarmt met zonnespiegels



Nieuw wapen tegen klimaatopwarming: 2000 jaar oude Griekse spiegels

Tijdens de slag om Syracuse in 214 voor Christus zou de Griekse geleerde Archimedes de Romeinse vloot hebben bestookt met een nieuw wonderwapen: de parabolische zonnespiegel. Grote, gekromde spiegels die de zonnestralen opvingen en bundelden tot een gloeiend hete straal waarmee Grieken de houten Romeinse schepen in brand staken. Ruim 2000 jaar later duiken de parabolische spiegels op in de Antwerpse haven. Niet om schepen te kelderen, maar om fabrieken te voorzien van groene warmte. En daarvoor hebben ze almaar minder zon nodig.

Luc Pauwels
wo 23 okt 22:00

PORTSTRATEGY

INSIGHT FOR PORT EXECUTIVES

Pioneering solar heat project launched

TV Oost - Baanbrekend project met zonnespiegels in de haven van Antwerpen

Embed

In de Waaslandhaven is een zonnespiegelpark geopend dat uniek is in de Europese industrie. Met behulp van zonne-energie, in plaats van aardgas, wekt chemisch dienstverlener ADPO zogenoemde 'groene' stoom en warmte op. En die stoom kan dan weer gebruikt worden om machines te laten draaien. Bedoeling is om de CO₂-uitstoot van de industrie te verminderen, in de strijd tegen de opwarming van de aarde.



Antwerpen heeft eerste zonnespiegelpark van de Benelux

Belgen tekenen voor Europese primeur met verwarming via zonnespiegels

Het Limburgse energiebedrijf Azteq heeft in de Antwerpse haven een installatie in gebruik genomen die via zonnespiegels warmte produceert om opslagtanks te verwarmen.

MARC DE ROO

Het zonnespiegelpark is 1.100 m² groot en staat op de terreinen van

temperatuur oplopen tot 400 graden en is het mogelijk de warmte op te slaan in geïsoleerde vaten, zodat die 's nachts kan worden gebruikt.'

'Tot nu gebruikten we gas voor de productie van stoom', zegt Filip De Dijkster van het familiebedrijf Adpo. 'Dankzij de installatie kunnen we ons gasverbruik en onze CO₂-uitstoot met 10 procent verminderen.' Adpo gebruikt de warmte om de

Wij zetten 68 procent van de zonnewarmte om in energie. Een zonnepaneel maar 15 à 18 procent.

KOEN VERMOUT
CEO AZTEQ

de verdere uitrol in West-Europa mogelijk te maken. Vermout: 'Het is de bedoeling dat we elders wel grotere zonnespiegelparken bouwen, tot 1 hectare groot.' Volgens Vermout is er veel interesse vanuit het buitenland. 'Onze troef is dat we groene warmte maken via de zon tot heel hoge temperaturen. Dat kan interessant zijn voor bottelarijen, brouwerijen, voedingsverwerkende



Baanbrekende zonnespiegel voorziet ADPO van groene warmte

23 oktober 2019

Logistiekbedrijf ADPO in Beveren heeft een Europese primeur op zak: het zonnespiegelpark in de procesindustrie. Met zonnespiegels van het type Heli-SCSP genereert het groene warmte voor industriële processen.



Port of Antwerp installs Europe's first industrial concentrated solar power



Antwerp Inaugurates Solar Farm

By Max Schwerdtfeger • 23 October 2019, 15:45 BST • Environment and Sustainability, Ports and Terminals

The Port of Antwerp has inaugurated the first Concentrated Solar Thermal farm (CST) in Europe as part of its efforts to make its operations more environmentally friendly.



Europese primeur in Waaslandhaven : zonnespiegelpark van ruim 1000 vierkante meter

HavenWaaslandhavenZonnespiegelpark

Embed

In de Waaslandhaven is een zonnespiegelpark van ruim 1000 vierkante meter voorgesteld. Het gaat om een Europese primeur. Het gaat om een proefinstallatie. Als de resultaten positief zijn komt er volgend jaar een uitbreiding.



Home Nieuws Productzoeker Inst

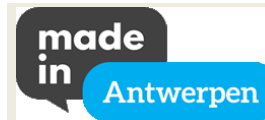
Elektrisch Rijden

14 november 2018

Berenschot

Azteq bouwt in Turnhout Europa's grootste installatie met zonnespiegels

Azteq is bij Avery Dennison Performance Tapes in Turnhout gestart met de bouw van Europa's grootste installatie voor geconcentreerde zonnewarmte (cst) met zonnespiegels op een terrein van 10.000 vierkante meter.



Adpo investeert in eerste zonnespiegelpark in Antwerpse haven

BART DE BRUYN 23 OKTOBER 2019

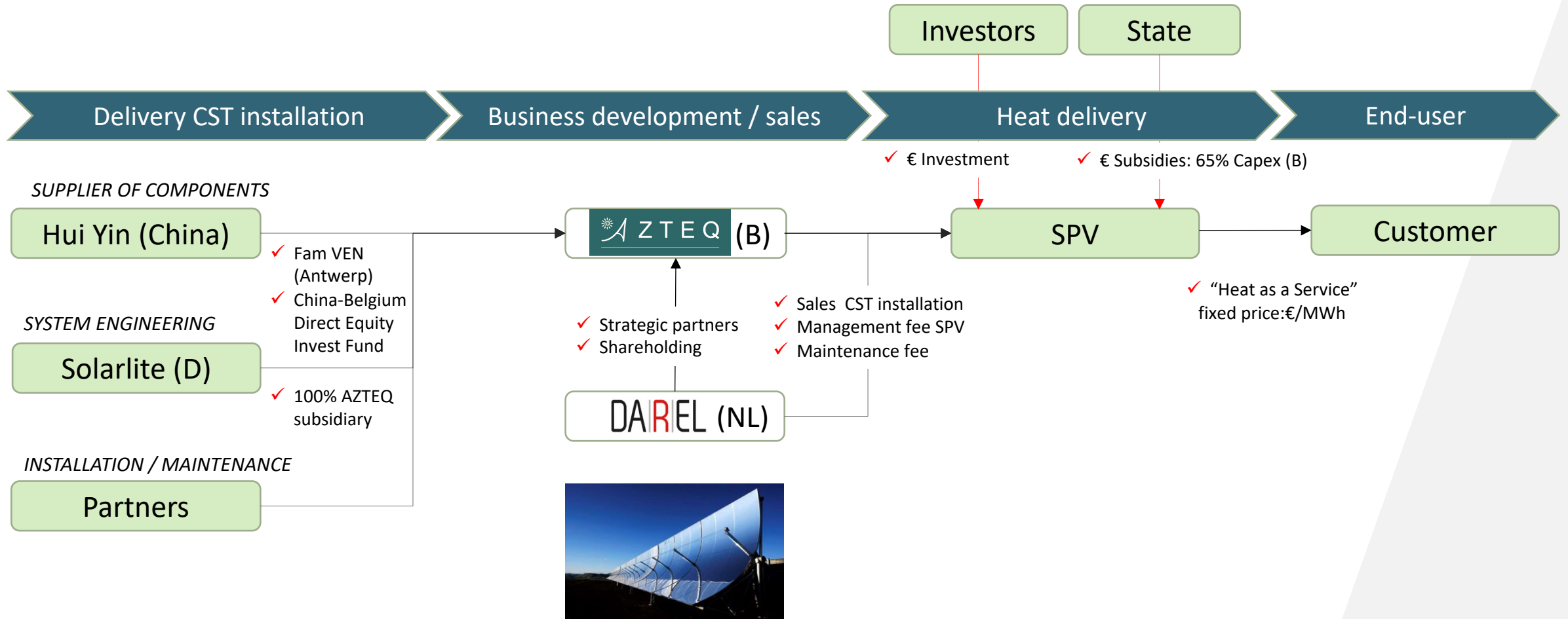


NIEUWS > ONDERNEMEN > MILIEU & ENERGIE

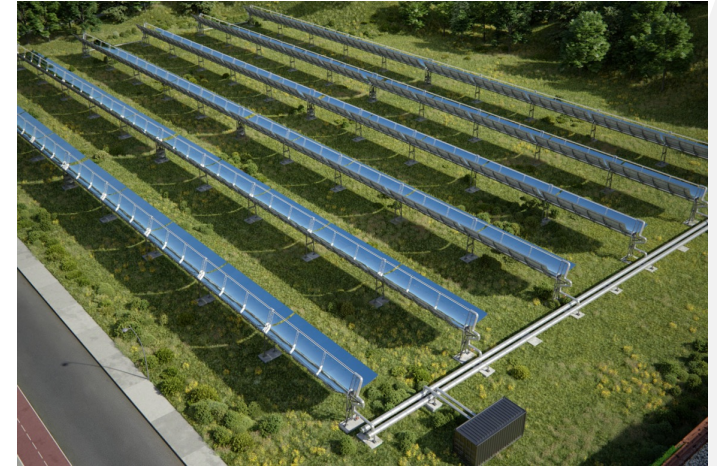
Turnhoutse fabriek gaat ovens verwarmen met zonnespiegels



Kansen voor zonnewarmte in het hart van de energietransitie



- ❑ Delivery of sustainable heat/steam on-site at competitive rates, by using concentrated solar thermal (CST) technology
- ❑ A zero-carbon solution with no supply chain that makes optimal use of space
- ❑ System is easily integrated into existing heat infrastructure
- ❑ Overall CO₂ emission reduction by combining sustainable intermittent heat from sunlight with existing heat sources
- ❑ No upfront investment required, only a fixed term purchase agreement for steam. DAREL/AZTEQ will handle financing, project development and maintenance.
- ❑ Reliable and constant performance guaranteed for >25 years with a fixed fee maintenance contract
- ❑ Unique opportunity to prevent cost increases due to increasing CO₂ emission prices
- ❑ Flexible commercial options : Heat/Steam as a Service ↔ Turnkey



Why CSP?

- ❑ Optical efficiency 76%
- ❑ Thermal efficiency 68% @ 340°C (three times more than solar PV)
- ❑ Competitive to other sustainable heat sources
- ❑ NL/Belgium receive an average of 950+ usable solar hours per year

What is CST?

- ❑ Parabolic mirrors rotate with the movement of the sun and concentrate sunlight onto a collector tube in the focal point
- ❑ Oil inside the collector tube is heated up to 400°C and is used as a high quality thermal energy source
- ❑ Heat exchanger is used to generate steam, which can be injected directly into existing steam networks. The cooled oil flows back to the collector tubes
- ❑ Heat maybe stored in modular thermal batteries that balance supply and demand during multiple days- and nights



SUSTAINABLE

Heat is produced directly from solar irradiation and it can be easily combined with other heat sources

LOW RISK

CSP technology is relatively simple with few moving parts, guaranteed yields and fixed heat costs over its lifespan

COMPETITIVE

CSP's LCOE is competitive to other sustainable heat sources. Subsidies make CST competitive to natural gas

PROVEN TECHNOLOGY

Used since the 1980's to generate electricity

MODULAR STORAGE

Heat energy can be stored by storing thermal oil in modular containers (up to 400°C)

CST in NW Europe?

- ❑ Five CST plants have been built in Belgium and Denmark in recent years
- ❑ CST plants operate alongside natural gas fired boilers in district heating and industrial steam networks
- ❑ Consumption of natural gas and associated emissions are reduced by providing intermittent sustainable heat
- ❑ NW Europe offer similar hours of solar irradiation & meteorological conditions

Opportunity

- ❑ No presence in the Netherlands yet
- ❑ Window of opportunity is NOW
- ❑ High energy yield, no supply chain and no CO2 emissions
- ❑ Flexible commercial options

Brondeslev, Denmark (2016)



- 27'000m² installation for district heating
- 330°C output, 16.6 MW

Antwerp, Belgium (2020)



- 1100m² installation for a steam network in a chemical complex
- 160°C output, 0.55 MW

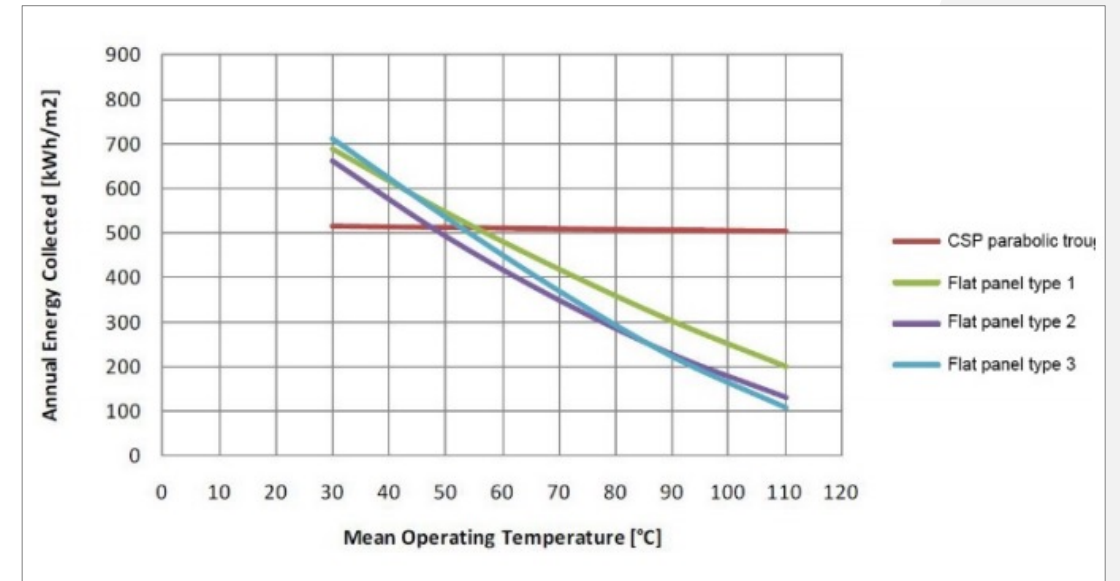
CST in combination with flat plate (FP) solar collectors

Advantages

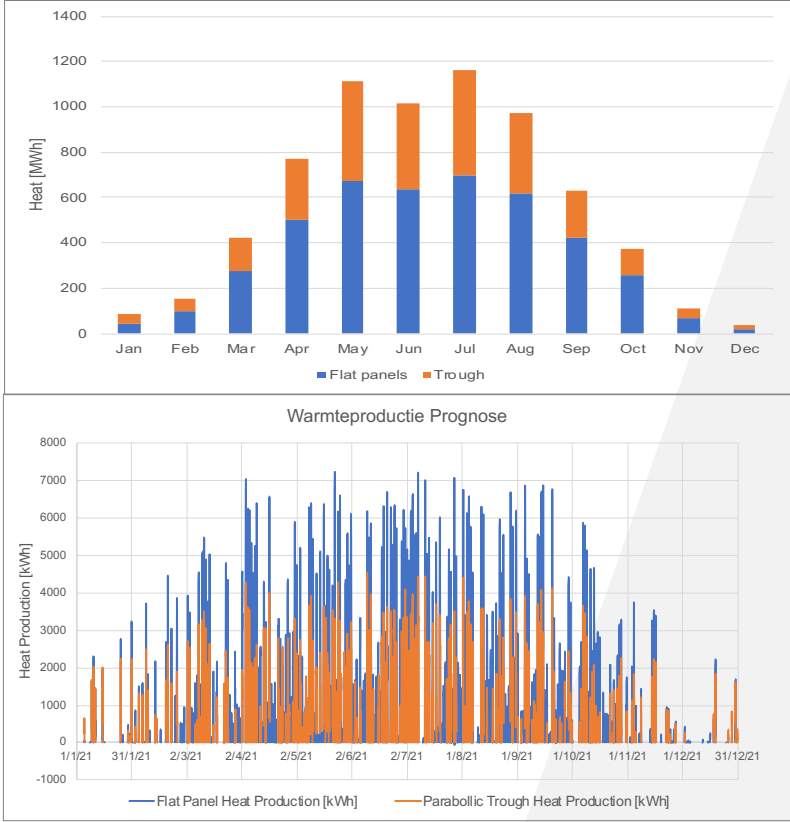
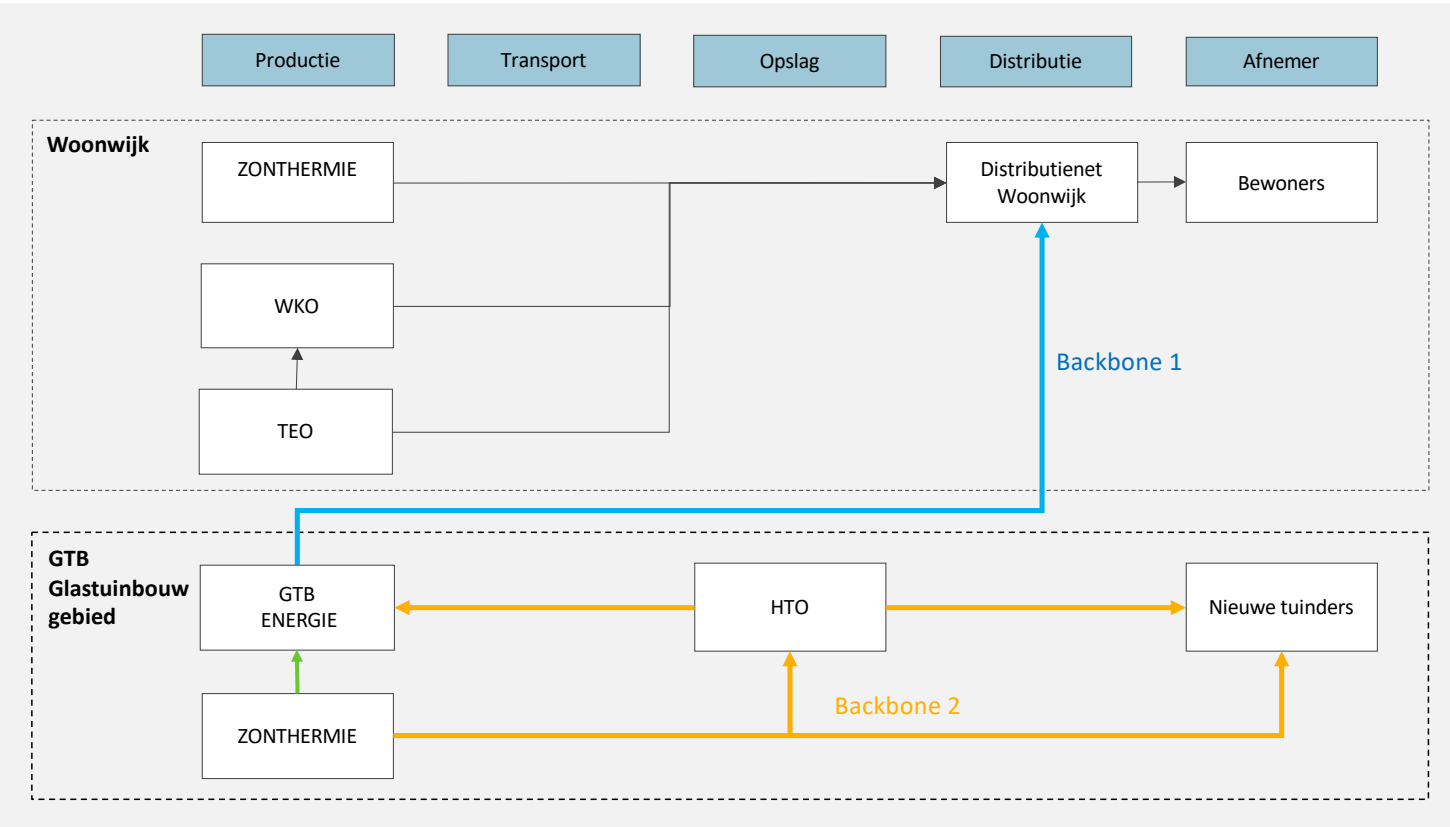
- ❑ CST and flat plate (FP) solar collectors have a complementary temperature and efficiency range
- ❑ FP/CST combination allows FP to continue to perform optimally at lower temperatures
- ❑ CST has a higher heat yield per land area
- ❑ FP/CST combination normally results in increased heat production
- ❑ CST has a wide temperature range and offers a lot of system flexibility because the technology is easy to combine with low temperature solutions (e.g. aquathermal, residual heat)
- ❑ CST can easily be turned on/off, preventing any overheating of the system in the summer months
- ❑ The unique FP/CST combination in the Netherlands opens up possibilities for additional subsidies (DEI+, LIFE)

Disadvantages

- ❑ CST collectors are usually slightly more expensive than VFP collectors
- ❑ CST makes the 'Balance of Plant' slightly more expensive due to the combination/integration of 2 solar subsystems (FP and CST)



Integrated heat system concept including solar thermal





Turnkey Delivery

FULL OWNERSHIP

- ❑ Client investment, ownership
- ❑ Maintenance in-house
- ❑ Project development & construction by DAREL/Azteq
- ❑ System performance guarantee

Build-operate-transfer

HEAT & MAINTENANCE

- ❑ Heat purchase agreement
- ❑ Project development, construction & operations by DAREL/AZTEQ
- ❑ Transfer ownership of installation to client

Heat Purchasing Agreement

HEAT AS A SERVICE

- ❑ No investments, no ownership
- ❑ Heat purchase agreement (HPA)
- ❑ Access to utilities
- ❑ Financing, project development, construction, operations & maintenance by DAREL/AZTEQ

Input

- ❑ Heat demand profile
- ❑ Total annual heat consumption in MWh
- ❑ What is client currently paying for natural gas?
- ❑ Product to be delivered: Steam, Pressured water, Thermal oil, Hot air, Cooling,
- ❑ Required pressure and temperature
- ❑ Overview, process diagram of current heat system
- ❑ Incl. existing heat sources: gas boiler, CHP, residual heat, biomass...
- ❑ The need for heat storage, required buffer capacity
- ❑ Available plot space for CST installation
- ❑ Distance CST installation to existing infrastructure, boiler house
- ❑ Quality of substrate for foundation
- ❑ Superstructure: car park, rooftop
- ❑ Commercial preference: Turnkey delivery<-> HPA

Output

- ❑ Capacity [MW]
- ❑ Heat output [GWh / yr]
- ❑ Investment CAPEX [€]
- ❑ Operational costs OPEX [€ / yr]
- ❑ Cash flow analysis [€]
- ❑ Net present value [€]
- ❑ Return on investment [%]
- ❑ Heat price, LCOE [€ / MWh]
- ❑ CO2 emission reduction costs [€ / ton]

Boundary conditions

- ❑ Drive to reduce CO2 emissions
- ❑ Preferably continuous demand for heat
- ❑ Existing heat/steam network
- ❑ Land area
- ❑ Access to utilities
- ❑ Heat purchase agreement or full ownership

Some key figures

- ❑ Capacity: 5MW/10'000m² aperture area
- ❑ Ratio land / aperture area: 2
- ❑ Annual load hours: 900-1000 (Netherlands)
- ❑ Capex: 200 - 350 EUR/m² aperture area
- ❑ Opex: 1% Capex (3.5 EUR/m² aperture area)
- ❑ Lifetime: 16 year duration (SDE+: 15 + 1)
- ❑ Real system lifetime: 30+ years
- ❑ Heat as a Service price: 15-40 €/MWh
- ❑ Natural gas price €15-17/MWh*
- ❑ CO₂ emissions natural gas 0.215 kg / kWh
- ❑ SDE+ subsidy included

* ENDEX Dutch Gas (variation over 2021 YTD, dd 12Feb2021) , [EnergieMarktInformatie.nl](https://www.energiemarktinformatie.nl)



THANK YOU

 AZTEQ

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