Savosolar

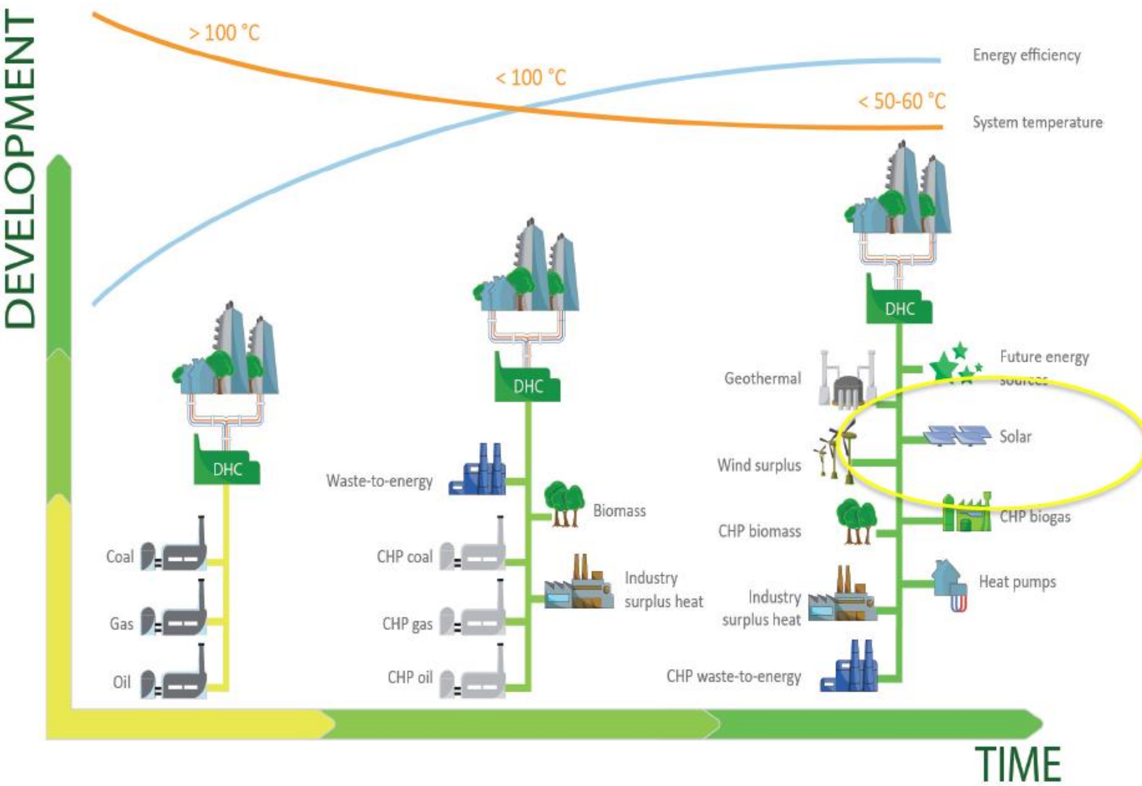
Solar thermal technology taken to the next level

Solar Thermal
Innovative technology and essential energy source in smart energy systems

4th International Conference on Smart Energy Systems and 4th Generation District Heating 2018 #SES4DH2018

Aalborg, 13 November 2018

Solar thermal
– essential energy source in smart energy systems



higher efficiency and lower supply temperature applies for solar thermal

District heating:
- Solar can supply 100 % of demand in summer

Industry:
- Solar can operate at optimal efficiency (e.g. pre-heating for steam production)

Euroheat & Power, www.4dh.eu

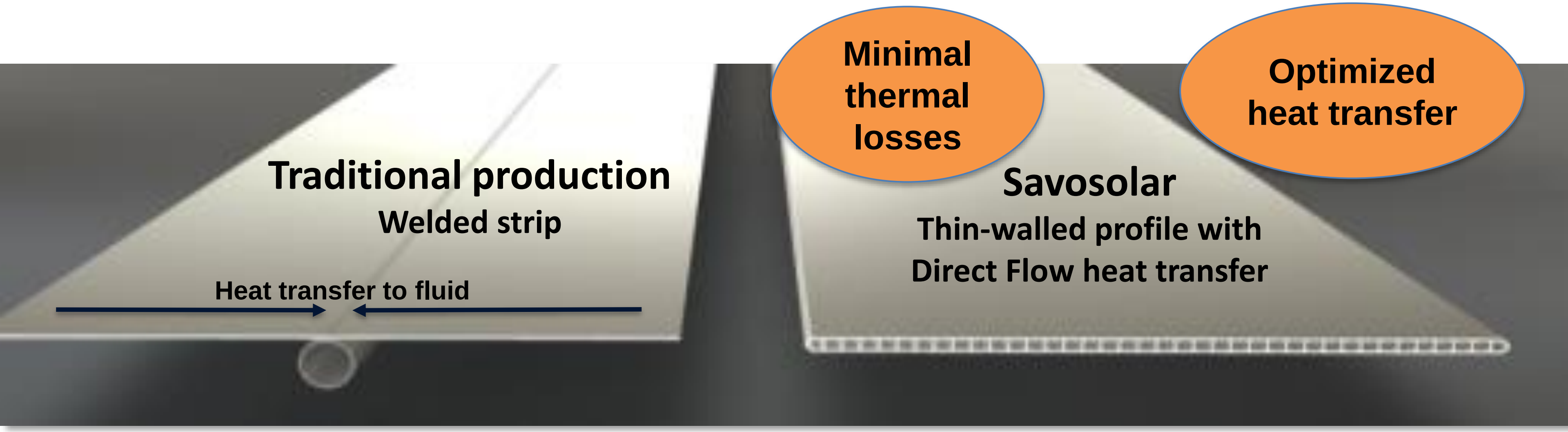
Solar thermal
– Technology, projects and markets

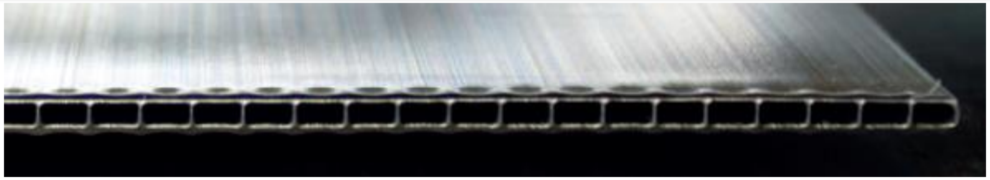
1. The collector
   - Savosolar solar thermal technology
   - Solar field design
2. The energy system of which the solar plant is part
   - Reference projects
3. Organization and planning
   - Solar district heating experience in Denmark
   - Market approach

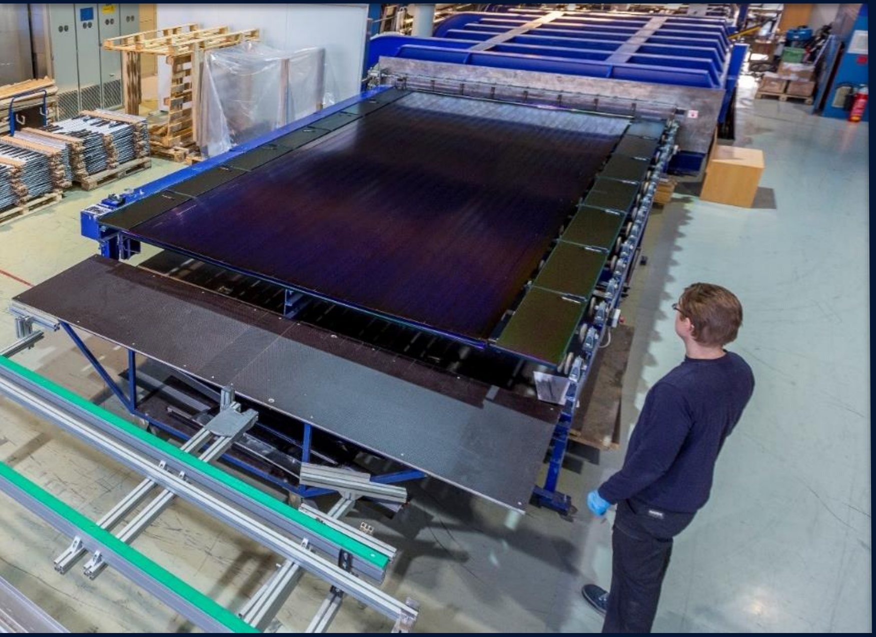
- Absorbers – profile with optimal heat transfer and coating
- Collector design – minimise heat loss (internal hoses)
- Solar field design – shared foundations, double stanchions
- DH and industrial applications – optimizing solution
- Local partners – maximizing local benefits

Unique technological advantage

- **Absorber strips** made from aluminium profiles as used in automotive heat exchangers
- One-of-a-kind **coating** technology, which makes it possible to coat entire absorbers after assembly
- Has resulted in **the market's most efficient** large area collector







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Absorber

Actual absorber size compared to person

Further advantages

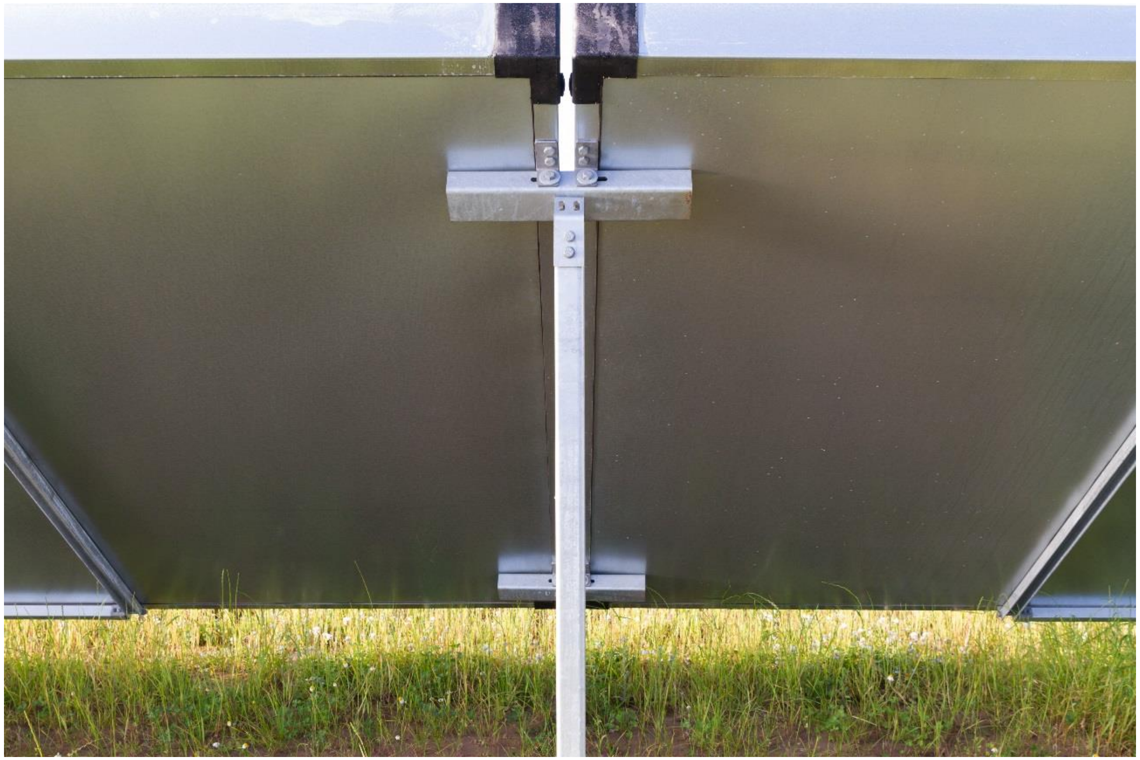
- Awarded with the Intersolar Award 2011 for "the biggest absorber development in the industry the last 30 years"
- Double glazed collectors with superior glass insulation
- Solar Keymark certified and ISO 9001 certified
- Only producer of large area collectors with PED module II certification according to directive 97/23/EG of the European Parliament
- Mounting solutions for both fields and roofs – fields preferred
- Etched (as opposed to coated) anti-reflective glass treatment without deterioration over time
- Several large scale district heating solar fields – up to 20,000 m^2 in size

Minimal thermal losses in connections

- Integrated connection hoses (patent pending)
  - Minimizes thermal losses in the connections
  - Allows for mounting with only 40 mm distance between panels
  - Reduces shadowing effects compared to traditional connections
  - Protects the connection hoses from external wear from weathering and bird attacks

Maximum use of available land – heat density

- Shared collector foundations (patent pending)
  - **Minimises** the number of foundations
  - Ensures that collectors are **aligned** with each other
  - Offers a **visually** pleasing result which is less noticable in the landscape



Foundations below the collectors
Space for driving a vehicle
Few foundations
Leveling of land not required

Jelling Varmeværk, Jelling, Denmark – 15,300 m^2

Jelling Varmeværk, Jelling, Denmark – 15,300 m^2 (+4.800 in 2019) Savosolar

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Jelling Varmeværk, Jelling, Denmark – 15,300 m²

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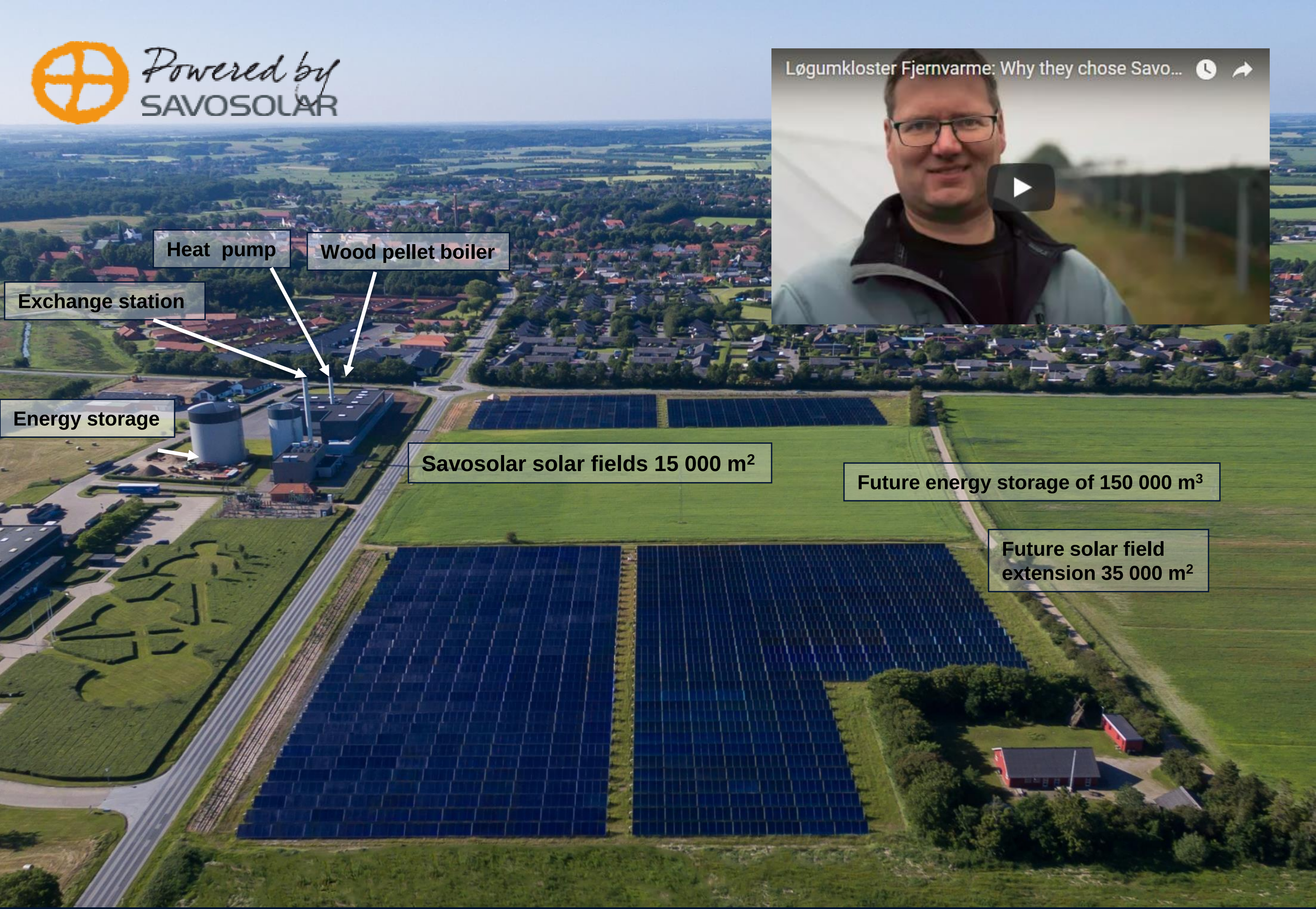

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Løgumkloster Fjernvarme, Løgumkloster, Denmark – 15,300 m^2 Savosolar

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Lolland Forsyning, Søllested, Denmark – 4,700 m^2

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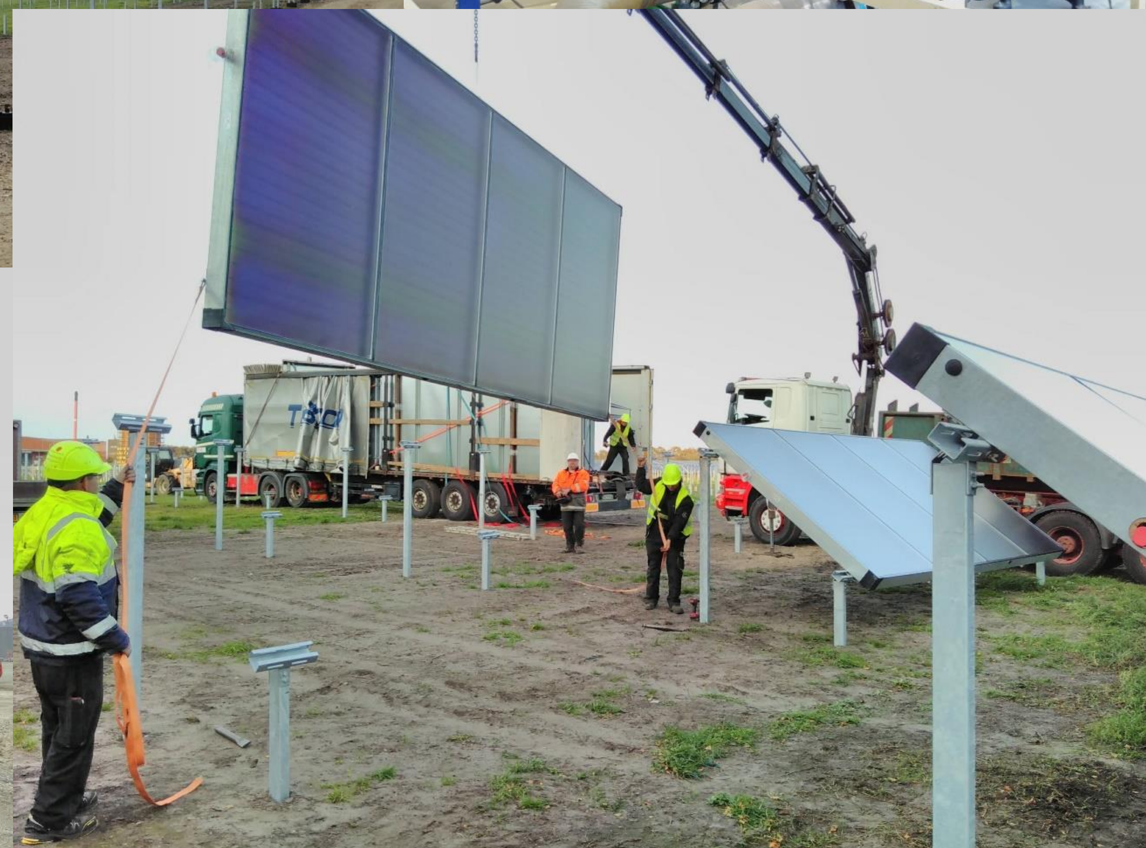
SG and DG
Double stanchions

Very wet land area – high heat density was important to meet customers requirements

Fors A/S, Jyderup, Denmark – 9,200 m²



Grenaa Varmeværk, Denmark – 20.673 m^2 (2019)

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Powered by SAVOSOLAR

High heat density also important for roof installations

Ystad Energi, Ystad, Sweden – 530 m²

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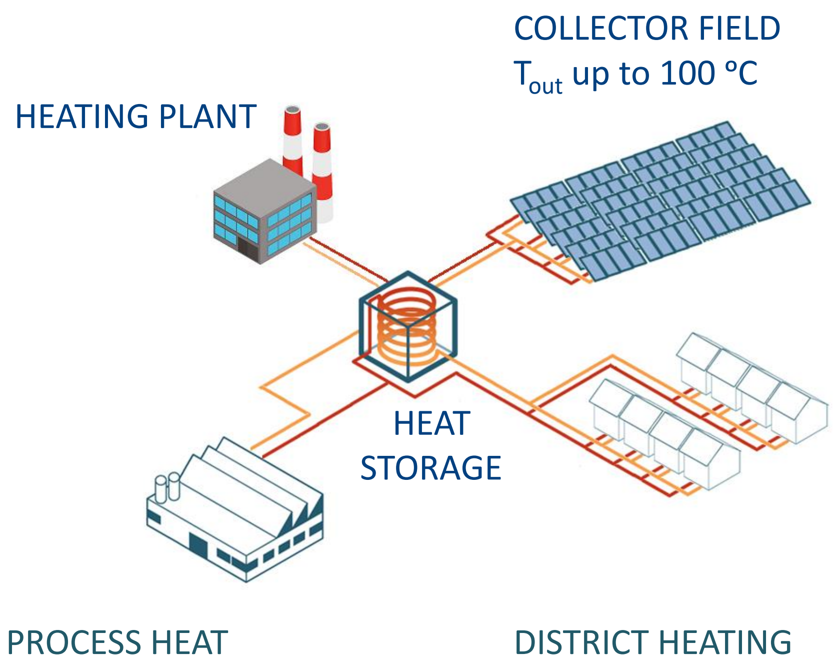
Solar thermal plant – turnkey



- Savosolar work with local partners
  - Local economy
  - Local competences
- The whole solar thermal system, comprising:
  - Collector field
  - Piping (solar field and transmission)
  - Pumps
  - Heat exchanger
  - Control
  - Heat storage (tank)
  - Building
  - Ground works

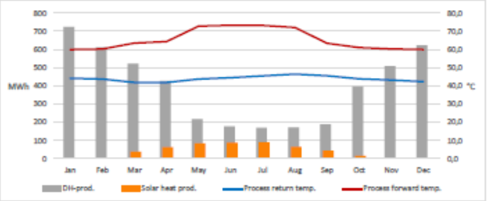
Solar thermal plant – initial design

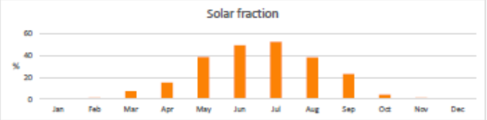
- Savosolar has own energy calculation tool
  - Location and weather data (Meteonorm)
  - Temperatures (requirements from customer, design for piping, heat exchanger)
  - Collector parameters (tilt angle, row distance)
  - Field design – double stanchion, row length (flow rate is limiting parameter)
  - Tank storage calculation
- Interface to customer
  - Data input and report
  - Hour (calculations), month, year, solar fraction (presentation)
- Efficiency values
  - Solar keymark
- Design parameters can include
  - Summer load (DH)
  - Area restriction
  - Other heat production technology
  - Heat storage

Lower supply temperature implies higher efficiency (thus lower energy cost)
Consequently: reduce the temperature in (part of) the DH system, before designing and implementing a solar thermal plant
Or e.g. combination with heat pump

Monthly summary

	Process return temp.	Process forward temp.	Solar heat prod.	DH-prod.	Solar fraction
Month	°C	°C	MWh	MWh	%
January	44	60	1	724	0
February	44	60	7	612	1
March	42	63	38	522	7
April	42	64	64	427	15
May	44	73	84	217	39
June	44	73	87	177	49
July	45	73	89	170	52
August	46	72	66	172	38
September	46	63	43	188	23
October	44	61	16	395	4
November	43	60	5	509	1
December	42	60	1	622	0
TOTAL	44	70	501	4735	11





Savosolar winning market concept

Solar district heating in Denmark

- Phases of a solar thermal system
  - Preparation and planning
  - Establishing
  - Commissioning
  - Operation and maintenance
- Target groups
  - Boards
  - Municipalities
  - Operators
- Six examples of solar district heating systems
  - Based on interviews
- Links to more information
  - E.g. www.solarheatdata.eu


Solar District Heating
Inspiration and Experiences from Denmark
DANSK FJERNVARME
PlanEnergi
25/8 2017 - Danish District Heating Association / PlanEnergi

http://task55.iea-shc.org/publications

Solar district heating in Denmark

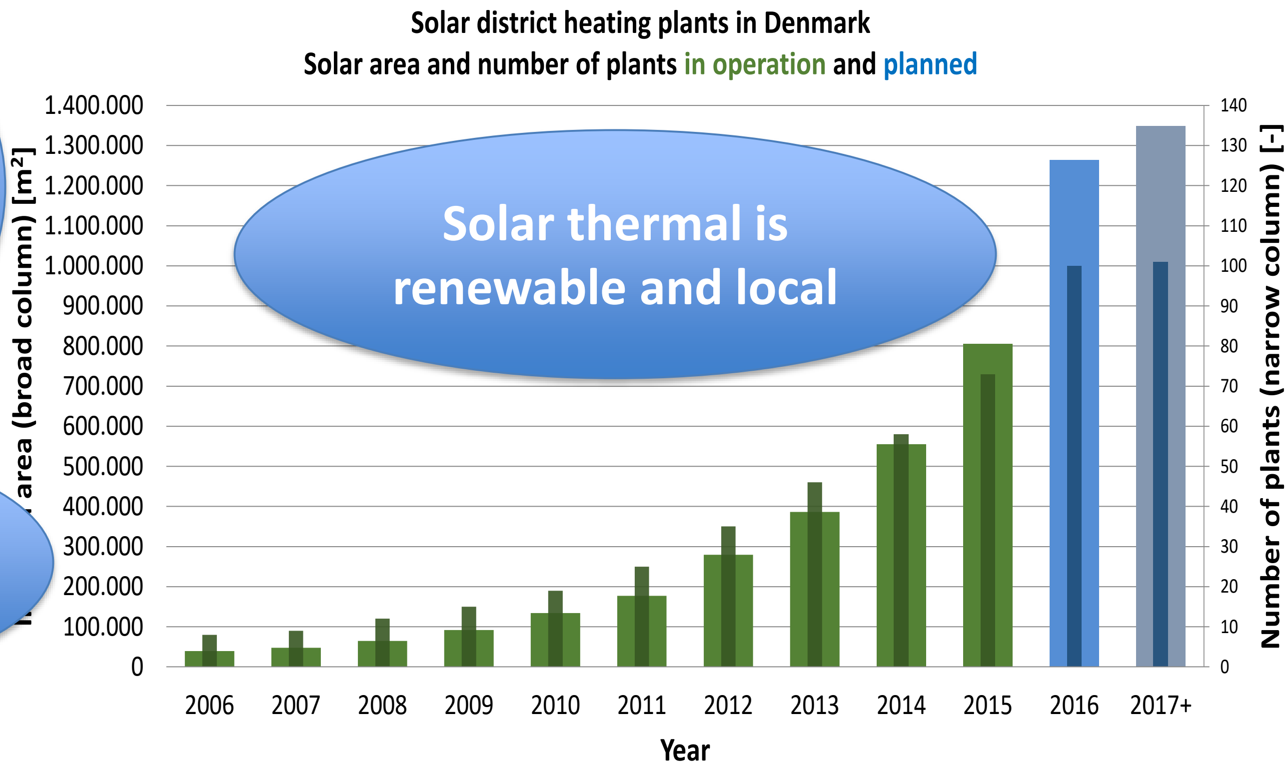
Reduced CHP-production – different production structure

Central – decentral
Diversified systems
Solar thermal is modular; easy to expand and combine with other technologies

Reduction of heat price primary driver for substituting natural gas with biomass

Increased use of biomass
- Environment?

Solar thermal is renewable and local



Complementary technologies

- Biomass boiler
  - Saving lifetime of biomass boiler when low/no summer load
  - Reducing operation costs (low for solar thermal)
  - Solar thermal more efficient at lower output temperatures
  - Biomass boiler more stable and efficient operation with heat storage
- Heat pump:
  - Higher efficiencies: lower output temperature from solar thermal, higher input temperature for heat pump
  - Flexible operation – matches variable (efficient) production from solar thermal (consider correlation between parameters – e.g. solar irradiation and electricity prices) – storage required.

Heat storage – enabling diversification

- Heat storage is always required for solar thermal
- Diurnal or seasonal – different technologies
  - Diurnal – tank storage, 20-35 % solar fraction
  - Seasonal – e.g. pit thermal heat storage, 50-70 % solar fraction
- Storage enables optimization of electricity production as well as heat production
  - E.g. electrical heat pumps
  - Enabling lower output temperature (higher efficiency) – supplemented by e.g. heat pumps
  - Also possible without storage, but probably not feasible

Solar thermal plant – pros and cons

<u>Advantages include:</u>

- Stable energy price
  - No fuel costs
  - Tax (?)
  - Low operation costs
  - Same high yield – also after 20 years
- Local resource
  - No transportation costs
- Environment
  - E.g. utilize old landfill sites (synergy with city planning)
  - No noise or visual impact
- Green energy
  - No emissions

<u>Challenges include:</u>

- Sensitive to availability of long term financing
- Requires coordination with city planning (land use), long term
- Control system of energy plant may be more complicated
  - “A boiler you cannot stop”
  - Requirements for operation of the plant

The sun rises in the North!

SAVOSOLAR - solar thermal technology taken to the next level

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Please visit www.savosolar.com

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