Solar Thermal Opportunities In District Heating

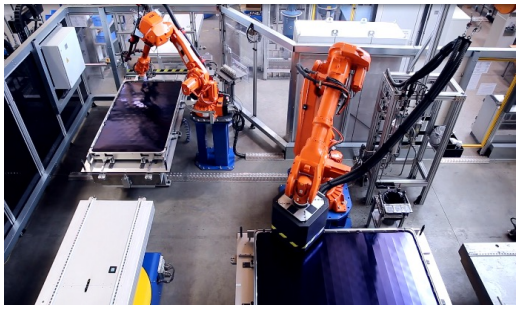
Biomass & Solar Thermal / Two technologies that work brillantly together

ARCON SUNMARK IS A BRAND OF GREENoneTEC

Ing. Klaus Kucher
Key Account Manager International
GREENoneTEC Solarindustrie GmbH

Dr.-Ing. Sebastian Schramm
Business Development Manager
GREENoneTEC Solarindustrie GmbH

GREENoneTEC | facts & figures



- Europe's leading solar thermal manufacturer and in the top 3 globally
- Complete in-house production and assembly *"Made in Austria"*
- Wide portfolio based on decades of operational experience and R&D

Business units

OEM
Customized Collectors
Absorbers

SYSTEMS
(stand-alone)
Sunpad, Thermosiphon

PROJECTS
(large-scale)
District heating, Process heating

GREENoneTEC | market leadership strengthened

GREENoneTEC

ARCON SUNMARK

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- GREENoneTEC acquired key assets of Arcon-Sunmark in 2020
  - Knowhow and project pipeline has been taken over
  - Production line transferred to our factory in Austria

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Acquisition of strategic importance

Submitted by Baerbel Epp on April 3, 2020

This week, a historic acquisition took place in the solar heating and cooling industry. Greenonetec, the largest collector manufacturer in Europe, purchased key parts of the business of Danish-based Arcon-Sunmark, the European leader in developing solar district heating projects. The acquisition followed months-long negotiations between Greenonetec CEO Robert Kanduth (right) and Torben Sørensen, Group Executive Officer at VKR Holding,

Arcon Solar | Arcon Solar Sunmark Solution | GREENoneTEC

1974 | 2015 | 2020

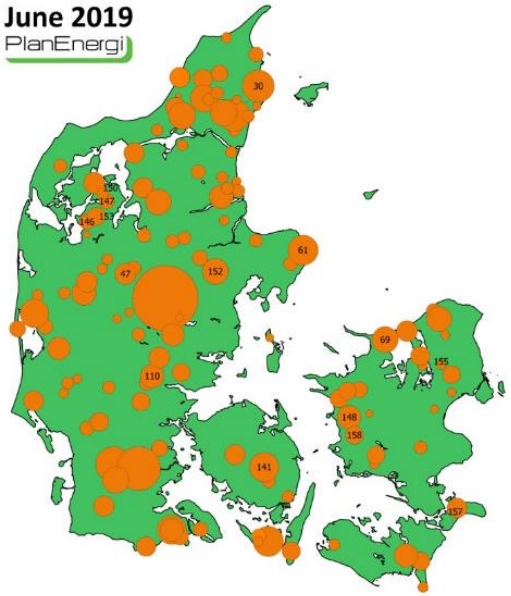
ARCON SUNMARK

ARCON SUNMARK IST EINE MARKE VON GREENoneTEC

GREENoneTEC | business unit “Large-scale projects“

- 80% of large-scale systems worldwide are using the GREENoneTEC collector technology
- GREENoneTEC stands for
  - The most cost competitive solar heat production
  - Solutions on the highest levels of quality, safety and durability
- What we can offer
  - Planning and technical support
  - Technology optimized for large-scale project business regarding installation, transport, maintenance, price-performance ratio
  - Just-in-time delivery to project site with highest reliability
- Business network
  - General planner, general contractor
  - Associated technology providers such as seasonal storage
  - Financing partner

Denmark | World champion using Solar thermal in DH

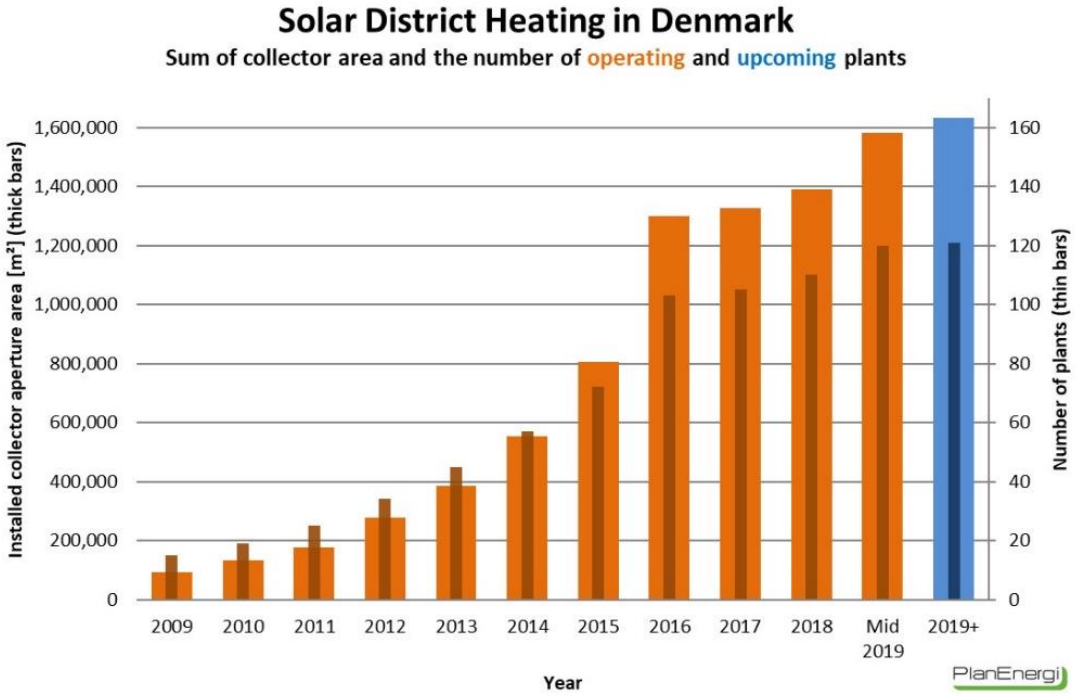


New plants & expansions in operation

#	Plant	Collector area (m2)
30	Sæby	(11921)+25313
47	Karup	(8000)+8127
61	Grenaa	(12096)+20673
69	Nykøbing Sjælland	(20084)+4914
110	Jelling	(15290)+4835
141	Ringe	31224
146	Remsing-Lem-Lihme	8537
147	Roslev	8455
148	Høng	20160
150	Durup	5040
152	Hadsten	24517
153	Balling-Rødding	12020
155	Egedal	3458
157	Lendemarke	2304
158	Halskov	11733

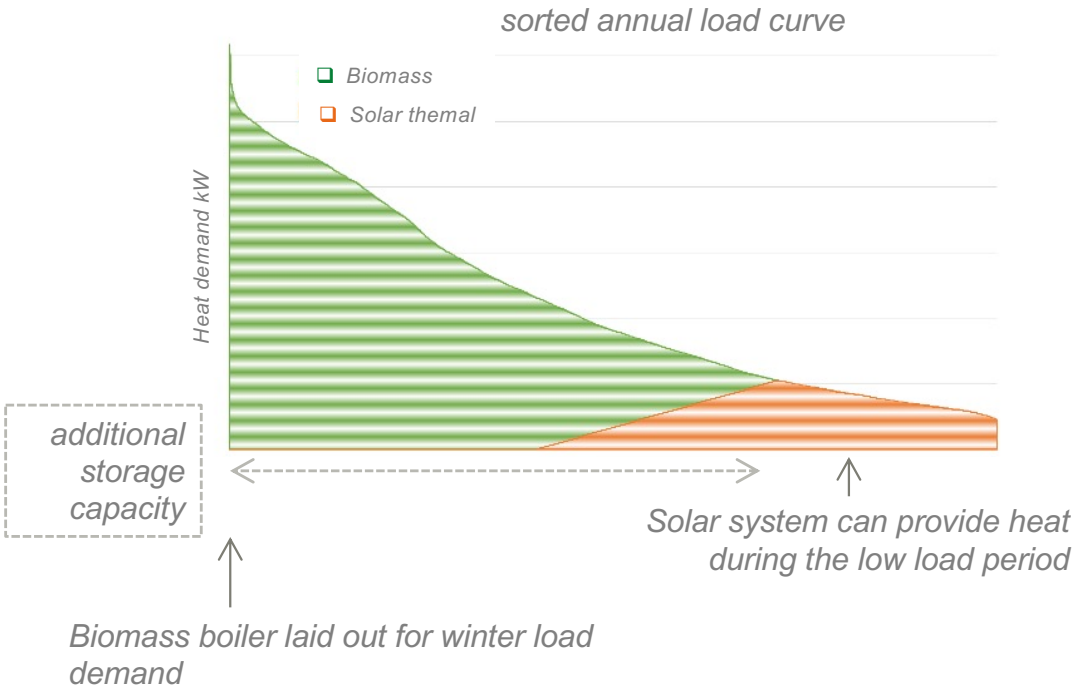
In operation

Total collector area (in operation): 1 581 716 m²



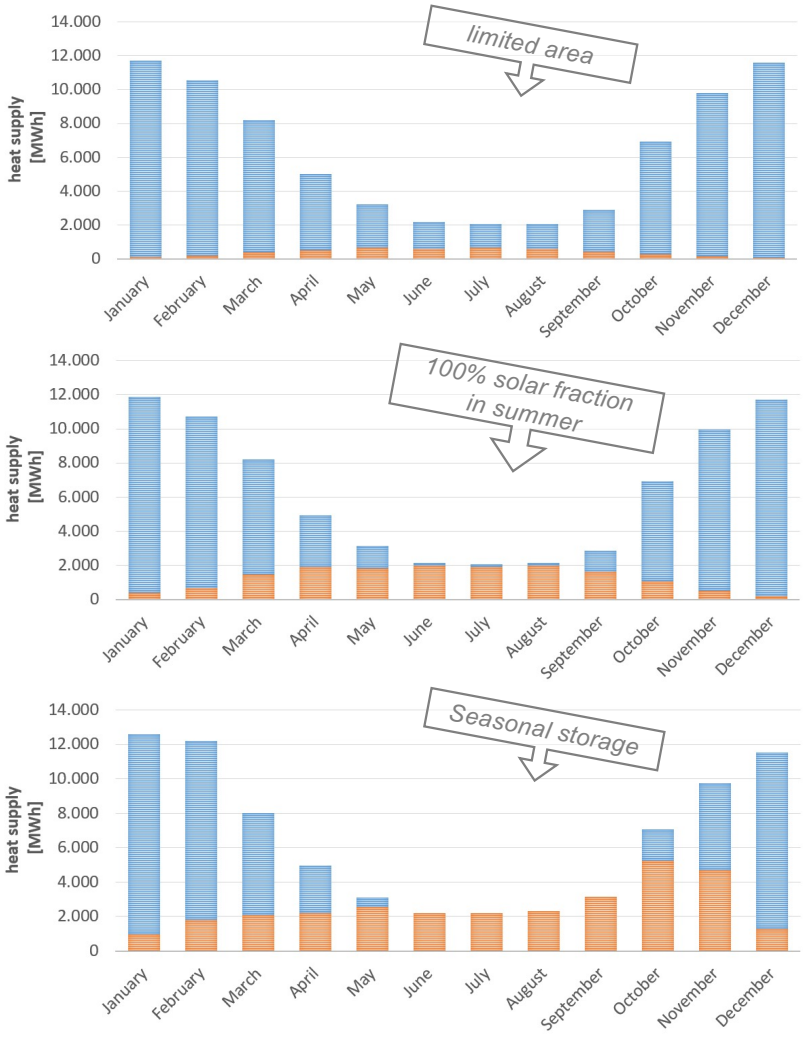
Advantages combining Biomass with Solar Thermal

- Avoidance of adverse part load operation of boiler during summer months
  - Boiler life time increases positively
- Reduced energy usage for boiler operation
- Reduced start-stop cycles due to bivalent usage of heat storage
  - The heat storage can be used as a buffer during colder months
- Controllable planning for neccessary revisions and maintenance of the boiler
  - The biomass boiler can be completely switched off during summer months
- Stabel & predictable heat cost over total solar plant life (min. 20 years)
  - „The sun doesn‘t send an invoice“
  - Very low OPEX costs

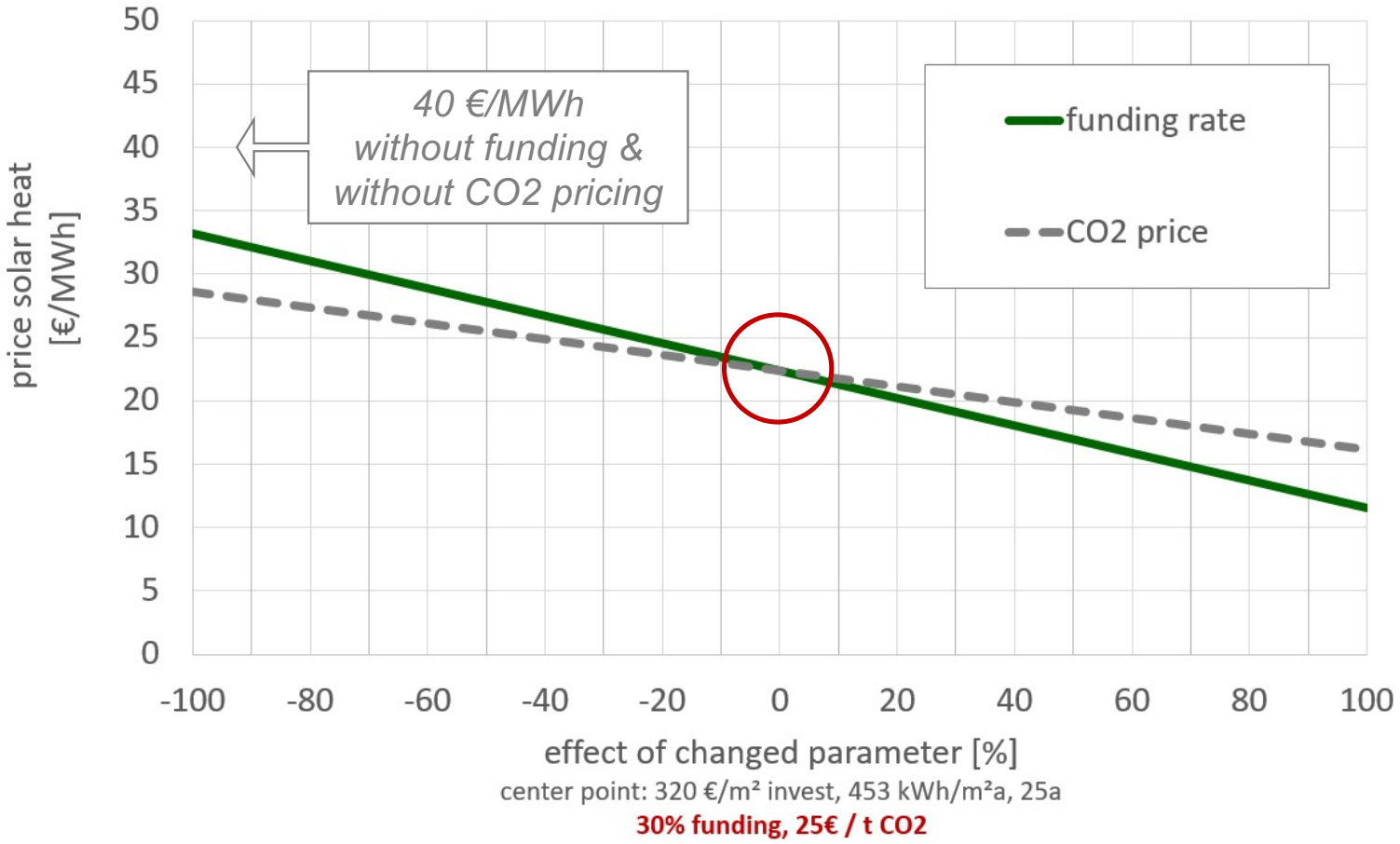


Economic consideration - exemplary design variants

Example Litauen/Vilinius	Variant A - DG limited area	Variant B - DG 100% sol.fraction in summer	Variant C seasonal storage
heat demand [MWh/a]			**76.638**
Solar system			
Solar output [MWh/a]	**4.534**	**15.908**	**34.215**
solar fraction	5,9%	20,8%	44,6%
specific solar output [kWh/m²a]	453	398	342
Collector area [m²]	**10.000**	**40.000**	**100.000**
needed land area [m²]	25.000	100.000	250.000
Storage			
Volume [m³]	**750**	**5.000**	**160.000**
Costs			
CAPEX [€] *without land or lease cost*	3.200.000	10.450.000	23.600.000
CAPEX spezific [€/m²]	320	261	236
Investment grant [€]	960.000	3.135.000	7.080.000
funding rate [%]	30%	30%	30%
CAPEX with funding [€]	**2.240.000**	**7.315.000**	**16.520.000**
OPEX [€/a]	15.000	40.000	60.000
economic indicators			
price of solar heat [€/MWh] *2% interest rate 25 €/tCO2 fix for 25 years*	**22,4**	**19,8**	**20,2**
savings fuel cost [€] *43 €/MWh fuel costs 2% increase in fuel costs over 25 years without CO2 emission costs*	6.435.281	22.578.655	48.562.587



Economic consideration - effect of investment funding and co2 pricing



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Boosting efficiency and flexibility with thermal energy storage

Optimized integration with other energy systems and solutions

- For higher efficiency and optimal operation, the PTES or TTES can be integrated with other renewable solutions and systems including (but not limited to):
  - CHP (Combined Heat and Power plant)
  - ORC (Organic Rankine Cycle)
  - Heat pump systems
  - Solar heating systems
- The turnkey PTES / TTES solution is customized to fit individual energy requirements for the best possible integration with the existing energy infrastructure.

By integrating a PTES with a solar heating plant, excess heat produced during summer can be stored and released during winter, when the heat and hot water demand increases.

To add flexibility to the heat production and create balance between supply and demand, a PTES can be integrated with the existing energy infrastructure eg. an integrated heat pump system or an integrated system consisting of a solar heating plant and a heat pump

Example of PTES system integration:

Case: Marstal district heating plant

- The implementation of renewable energy at the district heating plant in Marstal started in 1994. Throughout the years, the plant has increased the share of renewable energy in their heat production by expanding existing solar fields and integrating different renewable energy technologies.

Overview of solar heating systems and Pit Thermal Energy Storage at Marstal district heating plant.

Technology combination:

- Solar heating plant
- Bio-oil boilers
- Steel tank water storage
- Wood chip boiler
- ORC
- Heat pump
- Pit Thermal Energy storage

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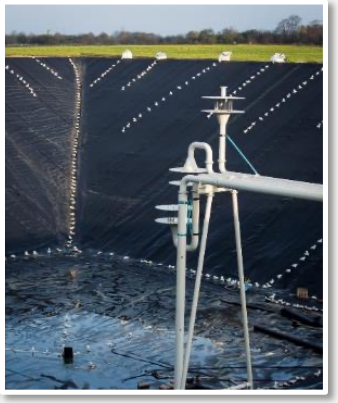
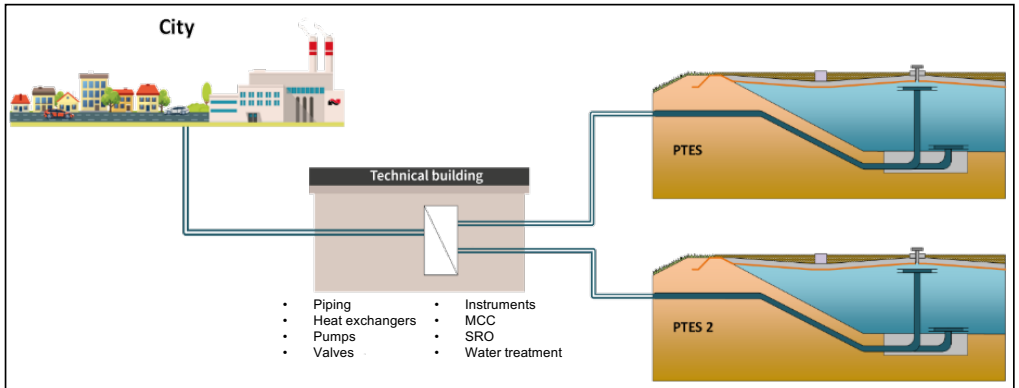
The technology and functionality of PTES

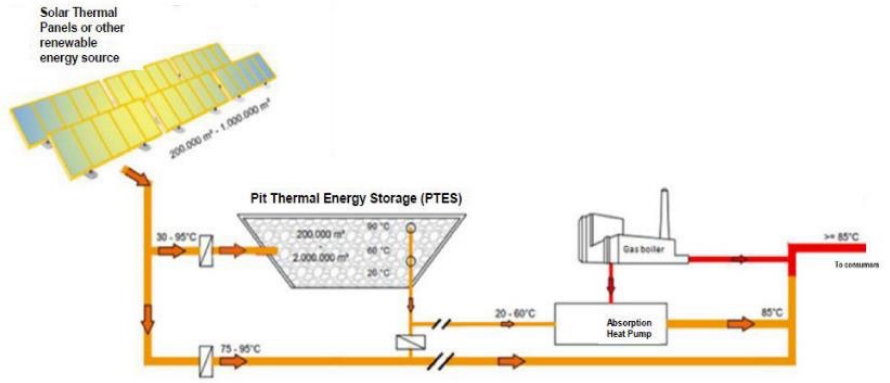
Description of the Pit Thermal Energy Storage technology

- A Pit Thermal Energy storage is a large water reservoir used for storing thermal energy.
- Excavated soil from the lower part of the storage is used as an embankment around the storage.
- The reservoir is lined with plastic linings to retain heat and prevent leakages, while the top of the storage is covered by a floating insulating cover used to retain the heat and keep the storage tight from rainwater.
- Excess energy is stored as low-temperatur heat (up to maximum 90 °C - the higher the temperature level, the higher the storage capacity.
- Excess heat and electricity is used to heat up the water in the storage to approx. 80-90 °C. When the heat demand increases, cooled return water from the district heating network is passed into the bottom of the storage. The heated water at the top is thus sent out to the consumers.





Solution diagram showing the Pit Thermal Energy Storage solution offered and supplied by Aalborg CSP with heat exchanger integration. Depending on invidual requirements and energy needs, a second PTES can be added to the system.



Principle diagram showing a possible PTES solution, where a PTES is integrated with a solar heating plant consisting of flat solar-thermal panels, an absorption heat pump and an existing gas boiler.

German | Bioenergiedörfer – already a success

GREENoneTEC 1

Solare Wärmenetze @solnetz · 17. Sep.

Deutscher Solarpreis von @EUROSOLAR_D für Sonnen- und Bioenergiedorf Mengsberg mit solaren Wärmenetz. Ehrung der #Energiegenossenschaft für "Gemeinschaftliches und nach- haltiges Energieprojekt mit großem bürgerlichem Engagement". @Viessmann @_Genossenschaft

2

Solare Wärmenetze hat retweetet

naturstrom @NATURSTROM_AG · 10. Juli

Antwort an @solnetz @FNR_de und 4 weitere

Schön, dass ein Foto unserer Heizzentrale in #Moosach diesen Tweet schmückt. Wir haben sie übrigens noch ein bisschen verschönert – mit #warmingstripes, die die Klimadaten Bayerns von 1880 bis 2018 abbilden.

10

Solare Wärmenetze @solnetz

Solarenergiedorf Mengsberg, T…

Video: youtu.be/ig-BGwnvy2Q -

genossenschaftliche #Fernwärme…

hat. @EUROSOLAR_D @RenewsT…

Solarenergiedorf Mengsberg

Das Solarenergiedorf Mengsberg, gewinner des Deutschen Solarpreises, versorgt seine Bewohner seit 2018 erfolgreich mit nachhaltiger Energie …

youtube.com

1 5

· 10. Juli

…t schon 9 in Deutschland – haben gute …rb Bioenergiekommunen 2019 von @FNR_de / …ergie-kommunen.de @FV_Holzenergie …NATURSTROM_AG

2 6 19

aus, da die Grundlast im Netz auch im Sommer wesentlich höher liegt als die maximale Leistung der Kollektoren. Wo allerdings, wie in den bislang neun in Deutschland realisierten Solarwärmedörfern, die Solaranlage zur vollständigen Deckung des Sommerbedarfs ausgelegt ist, da wird ein – relativ kleiner – Pufferspeicher von einigen hundert Kubikmetern schon deshalb benötigt, um einige Regentage überbrücken zu können. Deutlich größer fallen Speicher aus, wenn sie – wie in manchen dänischen Netzen – Sommerwärme in den Winter hinüberretten sollen oder wenn sie von Energieversorgern zugleich als Flexibilität für den Strommarkt genutzt werden. Solche Multifunktionsspeicher müssen neben der Solarwärme schnell große Wärmemengen aus KWK-Anlagen oder aus Power-to-Heat-Anwendungen aufnehmen können. Die höheren Kosten solcher Speicher sind daher nur zum Teil der Solaranlage zuzurechnen.

Ein weiterer Kostenfaktor sei die Lage der Solarfläche und die Beschaffenheit des Untergrundes, weiß Sebastian Schramm vom Kollektorhersteller Greenonetec zu berichten. Wo das Gelände sehr wellig, die Geometrie des Solarfeldes ungünstig oder der Untergrund felsig sei, werde es etwas teurer.

Wie entscheidend ist der Zins?

Aber wie rechnet überhaupt ein Fernwärmeversorger, wenn er sich mit dem Gedanken trägt, in eine Solarthermieanlage zu investieren? Üblicherweise werde mit der Interne-Zinsfuß-Methode kalkuliert, berichtet Thomas Pauschinger vom Steinbeis-Forschungsinstitut Solites. So hält es das Institut auch bei seinen Machbarkeitsstudien für Solarprojekte. Häufig sei dabei vom Stadtwerk ein üppiger interner Zinssatz als Ziel vorgegeben. Für eine Solaranlage, die gegenüber anderen Energieerzeugern mit vergleichsweise hohen Investitionskosten, aber dafür sehr geringen Betriebskosten antritt, sei es daher oft schwierig, das Plazet der Betriebswirte zu erlangen.

Letztlich hängt es davon ab, welche Risikozuschläge die Kaufleute für die verschiedenen Technologien in ihre Zinsvorgabe einbauen. In diesem Punkt kann die Solarthermie durchaus auftrumpfen – sofern nicht die grundsätzliche Skepsis gegenüber allem Neuen als Risiko eingepreist wird. Denn Versorger begreifen zunehmend, dass die Solarthermie langfristige Stabilität in ihre Kalkulation bringt. Ist die Anlage einmal gebaut, so steht deren Wärmepreis über ein Vierteljahrhundert im Voraus fest. Die Sonne scheint verlässlich zum Nulltarif, während die Brennstoffkosten bei fossilen Energien und selbst bei Holz schwer zu prognostizieren sind.

Die Motivation für Stadtwerke, die sich jetzt vermehrt für Solarthermieanlagen interessieren, ist häufig auch der Primärenergiefaktor ihres Fernwärmenetzes. Solarthermie kann diesen Wert deutlich verbessern, wenn sie fossile Energien ersetzt, und ist durch die Energieeinsparverordnung (EnEV) somit ein geldwerter Faktor im Wettbewerb mit Erdgas um die Versorgung kommerziell bewirtschafteter Wohnungsbestände.

„Wichtige Impulse für eine große Solarthermieanlage sind häufig auch politische Vorgaben zur Dekarbonisierung der Wärmenetze oder die sinkenden Stromerlöse aus KWK-Anlagen", stellt Pauschinger fest. Die Investitionskosten seien oft gar nicht das entscheidende Argument. Wenn ein Stadtwerk Solarthermie wolle, dann werde auch eine etwas geringere interne Verzinsung akzeptiert. Sein Fazit: „Die Wärmegestehungskosten großer Solarthermieanlagen sind mittlerweile in der Regel attraktiv."

Guido Bröer

BIOENERGIEDORF MENGSBERG

Foto: BEG Mengsberg

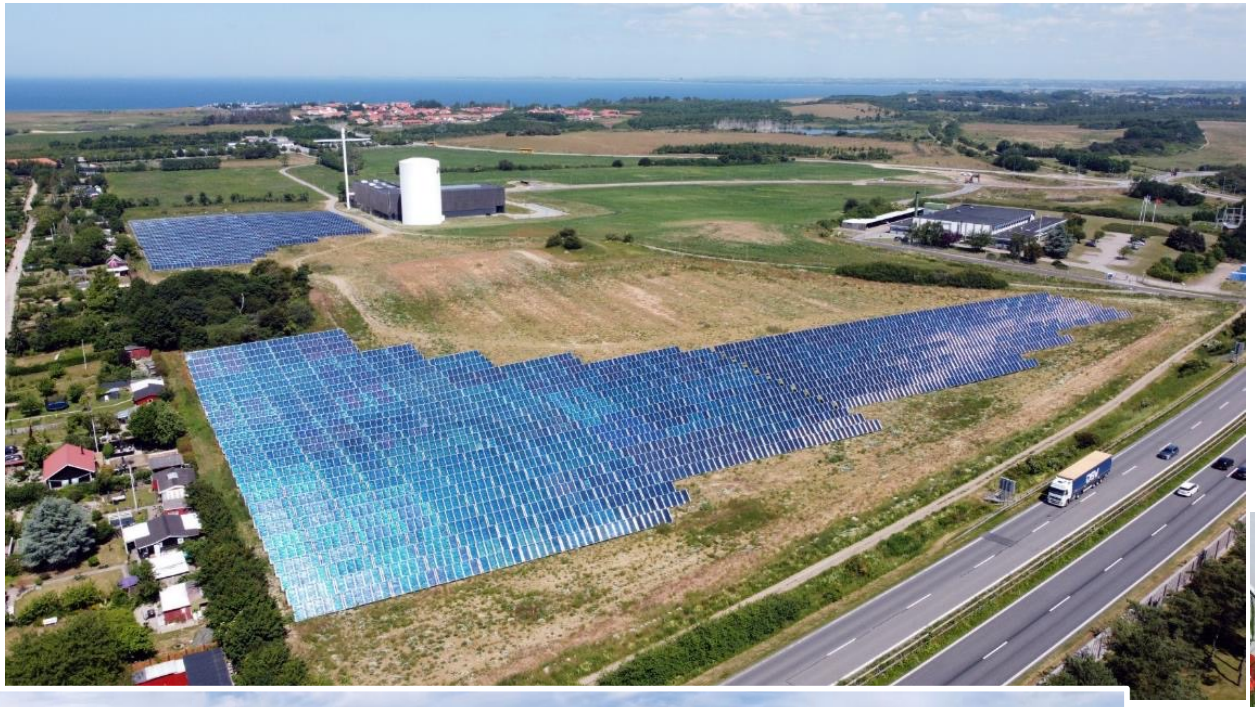
Kosten und Wirtschaftlichkeit

Das Beispiel der 2950 m² großen Kollektoranlage im Energiedorf Mengsberg zeigt, dass Solarthermieanlagen in Wärmenetzen heute aus Sicht der Betreiber ein wirtschaftlich attraktives Element sind:

• Investitionskosten: • Kollektorfeld inkl. Aufständerung • Verrohrung im Kollektorfeld • Grundstück inkl. Umzäunung • Hydraulik • Wärmetauscher	350 €/m²
• Solarspeicher (ca. 700 €/m³) =	70 €/m²
• Abzgl. KfW-Förderung (0,495 € pro kWh Solar-Keymark-Ertrag)	– 276 €/m²
Gesamtkosten nach Förderung:	**145 €/m²**
• Spezifischer Solarertrag (regional verschieden!)	ca. 330 kWh/m²/a
• Wärmepreis aus Investition (25 Jahre, Zins: 1,85%)	2,2 Ct/kWh
• jährliche Betriebs- und sonstige Kosten	0,8-1,0 Ct/kWh
Vollkosten Solarthermie	**3,0–3,2 Ct/kWh**

Beispielkalkulation: Viessmann.

Example | DH Denmark



- Korsör, DK
- 12.512m² solar field size
- Biomass boiler
- 2.500m³ heat storage tank
- 5.000 households
- ~ 53.000 MWh/a heat demand
- 15% solar fraction

AALBORG CSP
- Changing Energy

"In order for us to offer our customers lower heating bills and at the same time contribute to the clean energy transition in the country, solar thermal was an obvious choice for us"

Example | DH Bioenergiedorf Germany

- Mengsberg, DE
- 2.950m² solar field size
- Biomass- & Biogas boiler
- 300m³ heat storage tank
- 150 households
- 4.900 MWh/a heat demand
- 9 km pipes
- 17% solar fraction

Example | DH Austria

MEGASTRONG

Together we can make climate change

This further milestone for climate protection, a biomass heating plant with a district heating system in combination with solar thermal energy, is being implemented together with "Unser Kraftwerk" and "KELAG Energie & Wärme GmbH".

under construction

FACTS

5.750 m²
Collector area

4.025 kW_{th}
Solar peak performance

2.500 $MWh/_{year}$
Solar energy feed-in

1.000.000 litres
Storage capacity

Intended use:
Solar support
District heating supply

FRIESACH becomes energy self-sufficient

SOLAR SUPPLY 2.500 MWh/year

Friesach: Middle Ages meet solar future and start construction of Austria's largest thermal solar plant.

A city steeped in history, known for its great past and history is now looking towards a solar future. GREENoneTEC and partners are now starting to implement this mega-project! Austria's largest thermal solar plant with a collector area of 5.750 m² will be built in the first half of 2021. The energy generated by the system (2.500 MWh/year) will subsequently be fed into the local district heating network! GREENoneTEC, the collector producer, "Unser Kraftwerk GmbH" the developer and later operator of the large-scale plant, have been working on this project with the municipality for some time. Now nothing stands in the way of the start of construction. The heat customer is KELAG Energie & Wärme GmbH. The energy generated supplies the local hospital, the Springer machine factory and 500 multi-storey residential buildings as well as single-family homes.

CEO, GREENoneTEC
Robert Kanduth

Thermal solar energy is the cheapest form of generating energy because the sun is available to us for free! "We are ready for a solar energy turnaround!"

GREENoneTEC 1 SOLAR COLLECTORS
Unser Kraftwerk
kelag Energie & Wärme

- Friesach, AT
- 5.750m² solar field size
- Biomass boiler
- 1.000m³ heat storage tank
- 500 households, hospital & commercial units
- Currently under construction finished in Summer 2021
- 15% solar fraction

Example | Bioenergiedorf Austria

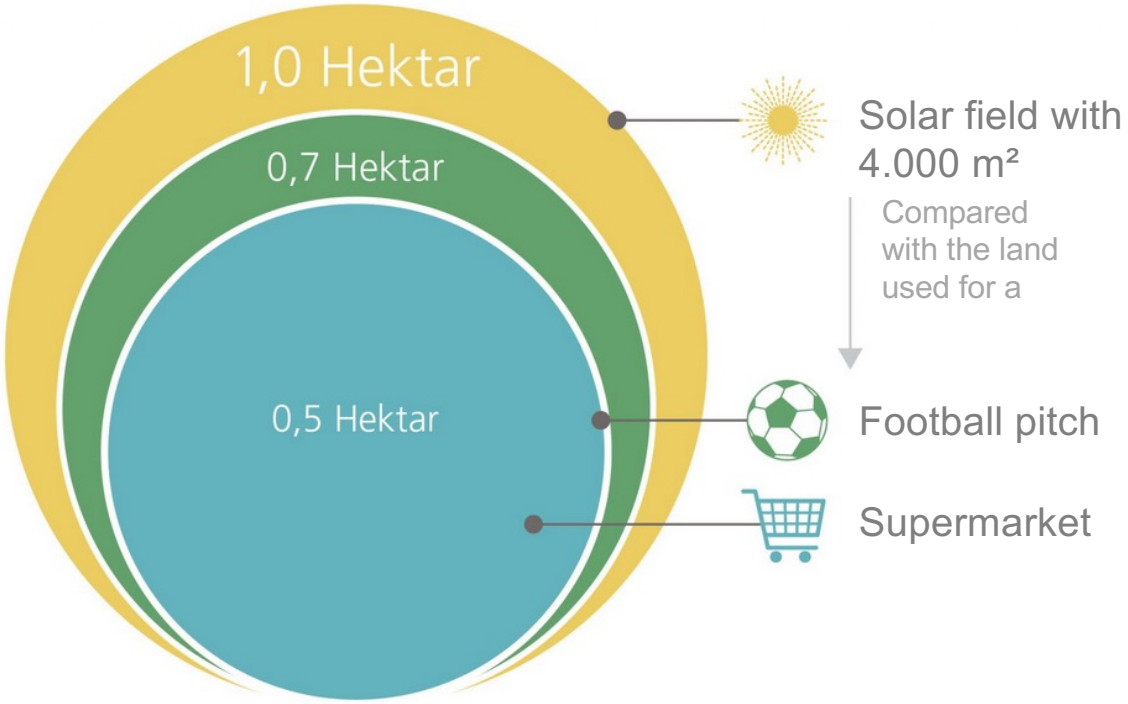
- Maria Gail, AT
- 175m² solar field size
- Biomass boiler
- 12m³ heat storage tank
- 54 households, goverment Buildings & care home
- 20% solar fraction

„[…], the biomass boiler designed for the high consumption in the winter months does start up much less often in the summer and transition months, or does not have to start up at all for several sunny days. This is also associated with a reduction in the usual start-up losses […]. This advantage will certainly extend the life of the boiler.*“*

Example | DH Bioenergiedorf Austria - roof

- Krumpendorf, AT
- 191m² solar field size
- 2 Biomass & 1 Öl boiler + HP
- 62m³ heat storge tank
- 1600 households
- 10.500 MWh/a heat demand
- 10 km Nahwärmenetz
- 1% solar fraction

Land usage



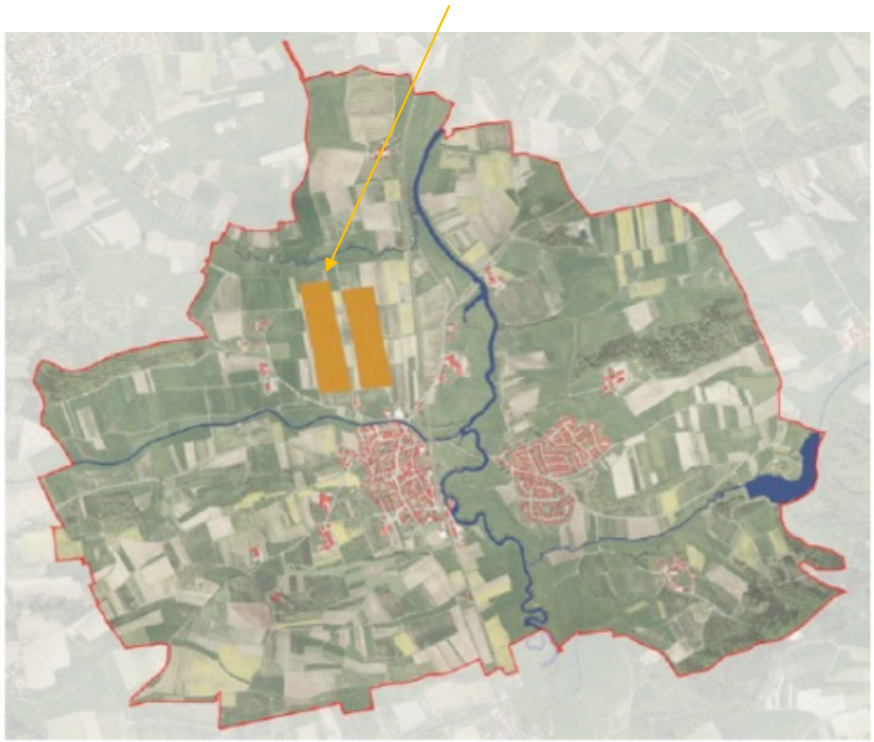
Source: *IEA SHC TASK 55*

Land usage | Biomass vs. Solar Thermal

Direct comparison of Biomasse vs. Solar Thermal in a community with complete heat coverage from renewables

- Biomass

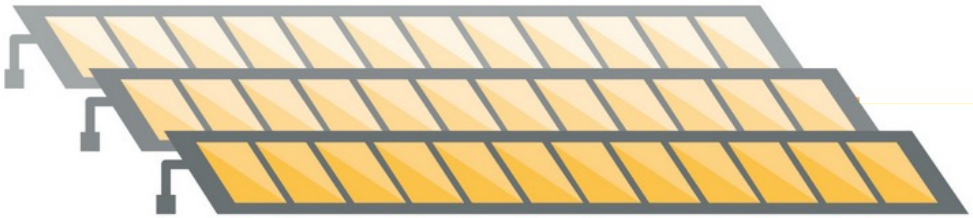
- Solar thermal field

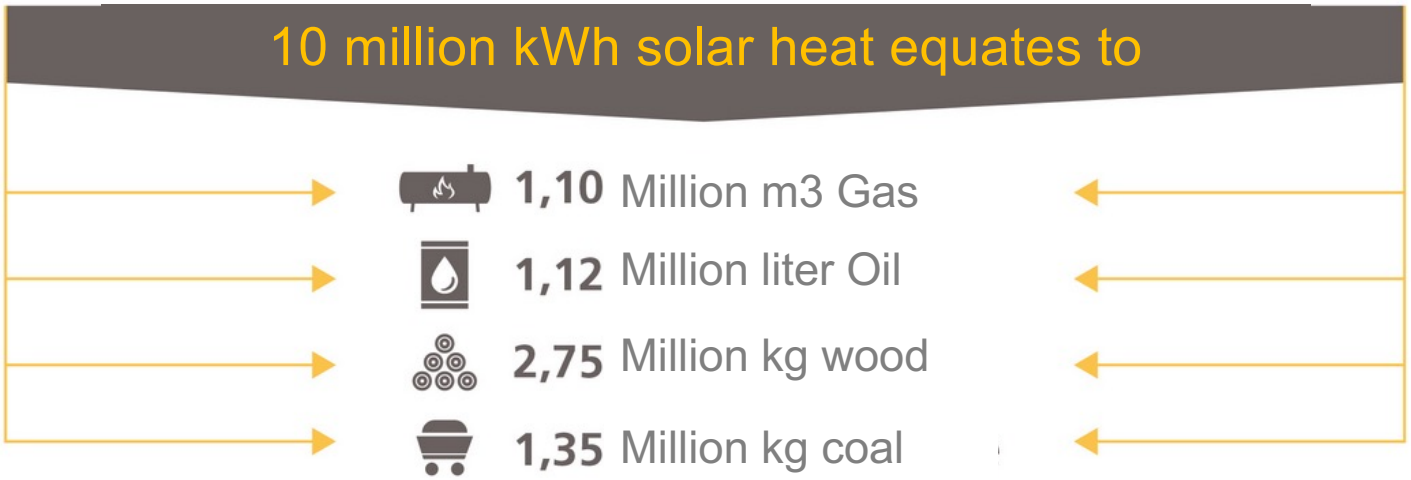


Source: Solites

How much energy can solar district heating save?

A 1.000 m² solar thermal system produces 10 million kWh over 20 years in central Europe





Quelle: IEA SHC TASK 55

Solar thermal systems | ecologically preciouse

- Solar thermal plants help to develope diverse sanctuaries for flora & fauna and support the biodiversity
  - Proven by a recent study of Pechel, R. et.al. (2019); Solarparks – Gewinne für die Biodiversität
- No permanent building / simple renaturazation
- Ground / soil regeneration after intensive agricultural usage

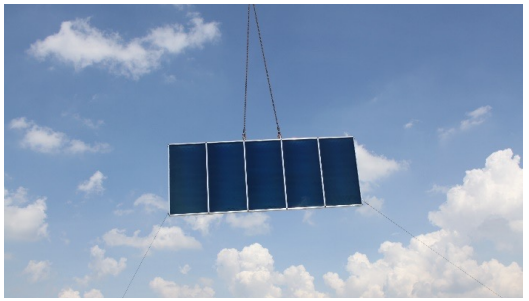








GREENoneTEC | visit us & convince yourself




Thank you!
Please do not hesitate to contact us! We are very happy to discuss your next project.
Ing. Klaus Kucher
Key Account Manager International
GREENoneTEC Solarindustrie GmbH
Dr.-Ing. Sebastian Schramm
Business Development Manager
GREENoneTEC Solarindustrie GmbH