Performance of the 27000 m² Parabolic Trough Collector Field,
Combined with Biomass, ORC Cogeneration of Electricity, in Brønderslev Denmark
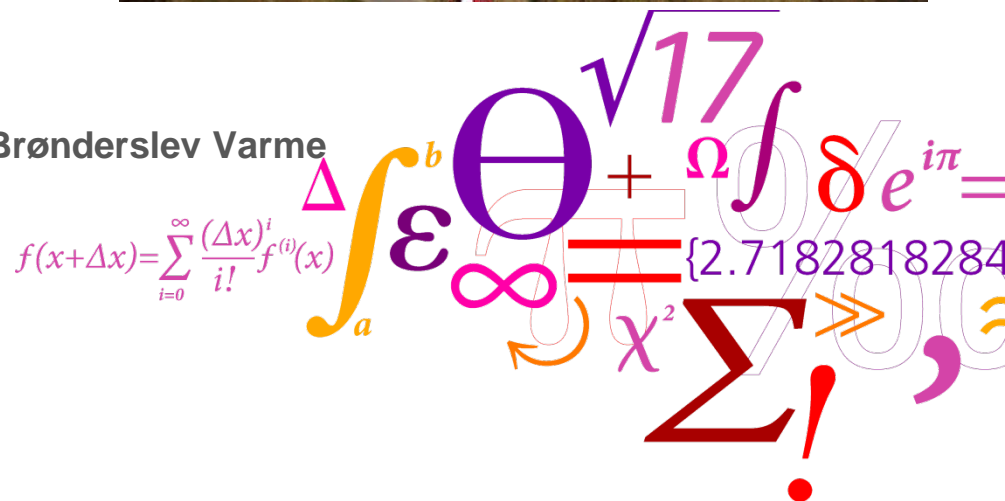
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$$f(x+\Delta x)=\sum_{i=0}^{\infty}\frac{(\Delta x)^i}{i!}f^{(i)}(x)$$

DTU Civil Engineering
Department of Civil Engineering

The Brønderslev CSP, Biomass, ORC plant

ORC= Organic Rankine Cycle
CSP= Concentrated Solar Power
PTC = Parabolic Trough Collector

ORC
and
Biomass Boiler

27000 m² 16 MW CSP Field

South direction

The PTC large area collectors

PTC=Parabolic Though Collector

Vacuum Tube Absorber

Parabolic Glass Mirror

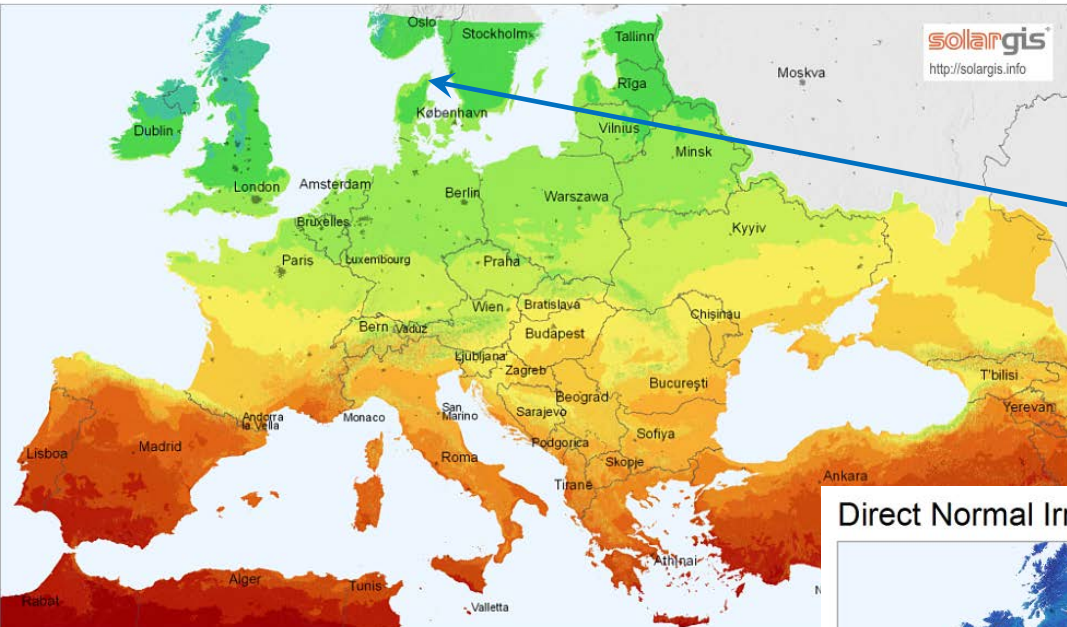# CSP-ORC direct thermal cycle principle

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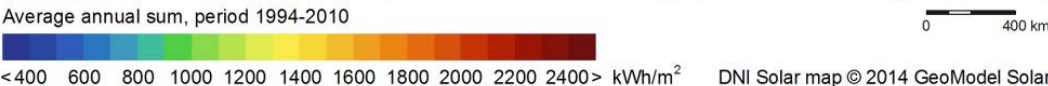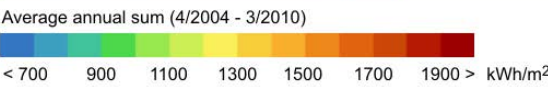# Location of the Brønderslev Plant

Global horizontal irradiation — Europe

Brønderslev Denmark

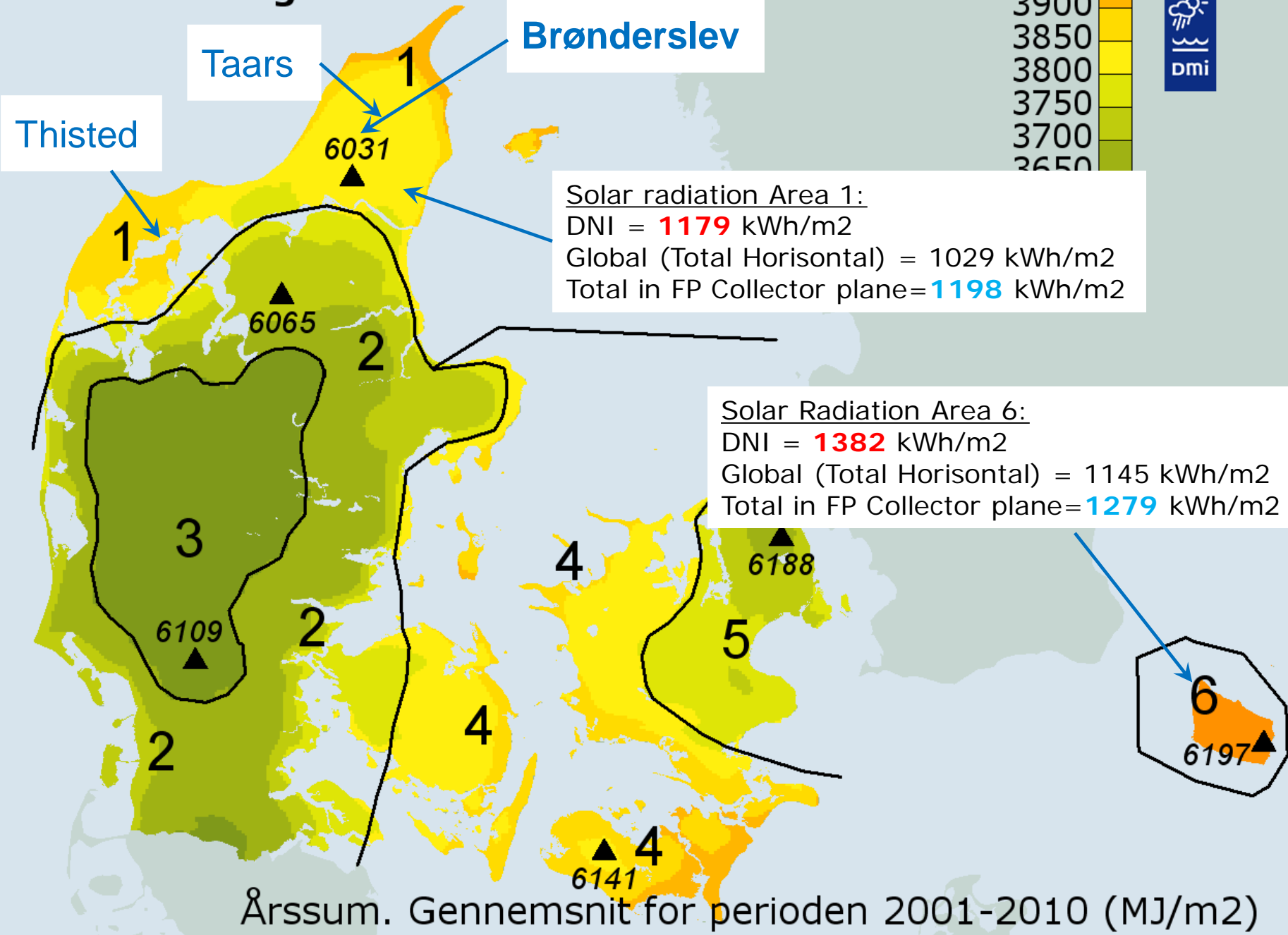Average annual sum (4/2004 - 3/2010)

< 700   900   1100   1300   1500   1700   1900 >   kWh/m²

Direct Normal Irradiation (DNI) — Europe

Average annual sum, period 1994-2010

0   400 km

<400   600   800   1000   1200   1400   1600   1800   2000   2200   2400>   kWh/m²

DNI Solar map © 2014 GeoModel Solar

Globalstråling

Taars

Brønderslev

Thisted

6031

1

1

6065

2

3

6109

2

2

4

6188

5

6

6197

4

6141
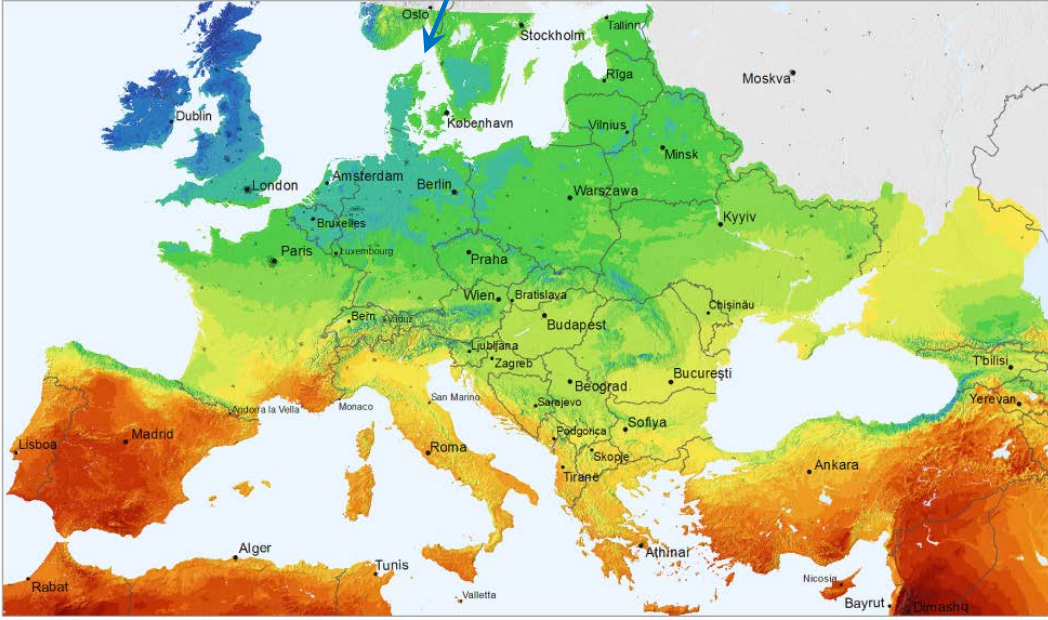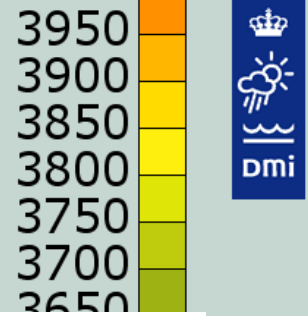
Solar radiation Area 1:
DNI = **1179** kWh/m2
Global (Total Horisontal) = 1029 kWh/m2
Total in FP Collector plane=**1198** kWh/m2

Solar Radiation Area 6:
DNI = **1382** kWh/m2
Global (Total Horisontal) = 1145 kWh/m2
Total in FP Collector plane=**1279** kWh/m2

3950
3900
3850
3800
3750
3700
3650

dmi

Årssum. Gennemsnit for perioden 2001-2010 (MJ/m2)

26,929 m²
CSP collectors

Heating
primary energy

Electricity
periodically produced

DTU

CSP parabolic troughs

▬ ▬ ▬ = Heat Transfer Oil

ORC

Biomass boiler

Heat pumps

Heat storage tank

The city of Bronderslev

CHP gas engine
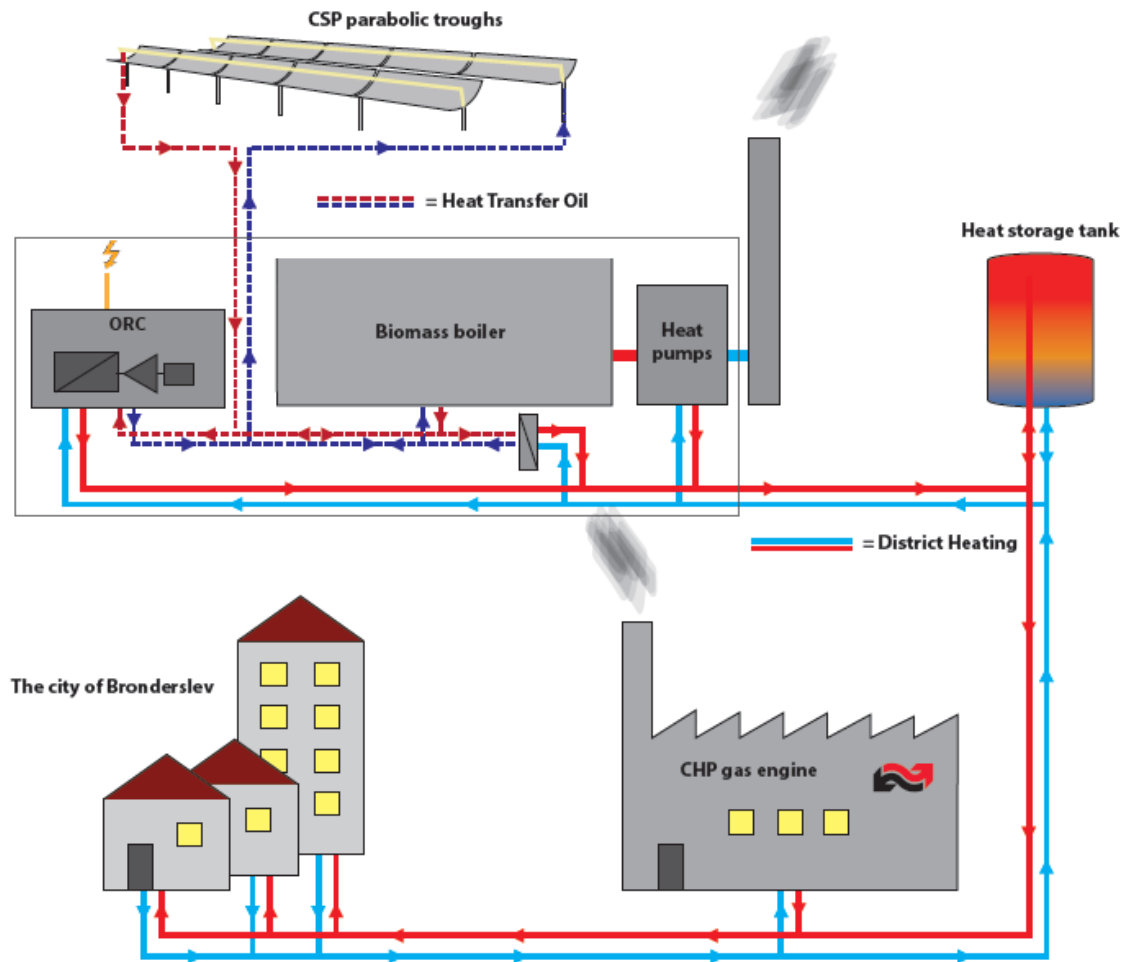
▬ ▬ = District Heating

The DNI Solar Sensor and Weather Station
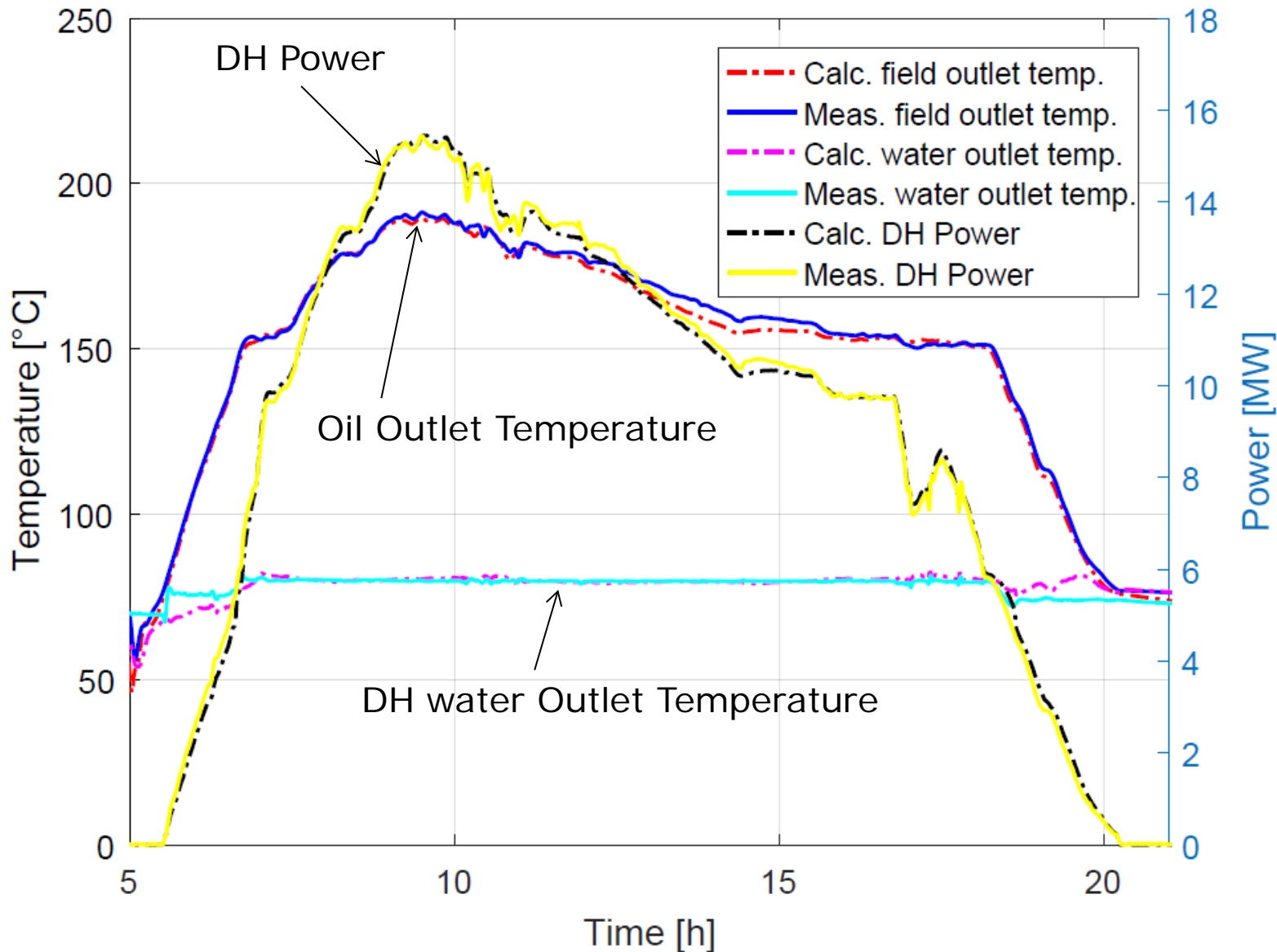
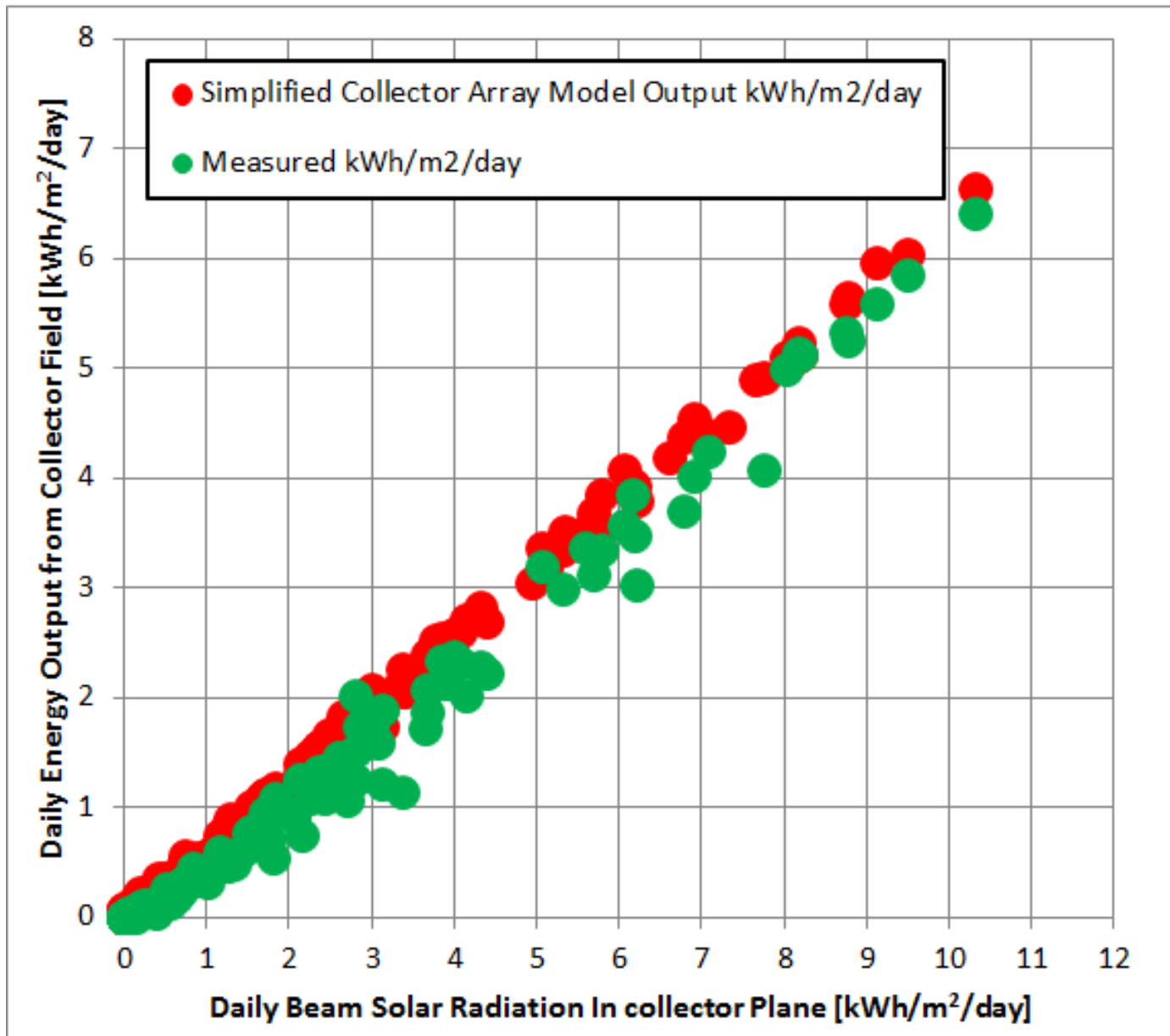**DNI = Direct Normal Irradiance**

Sun position sensor

Detailed TRNSYS model validation
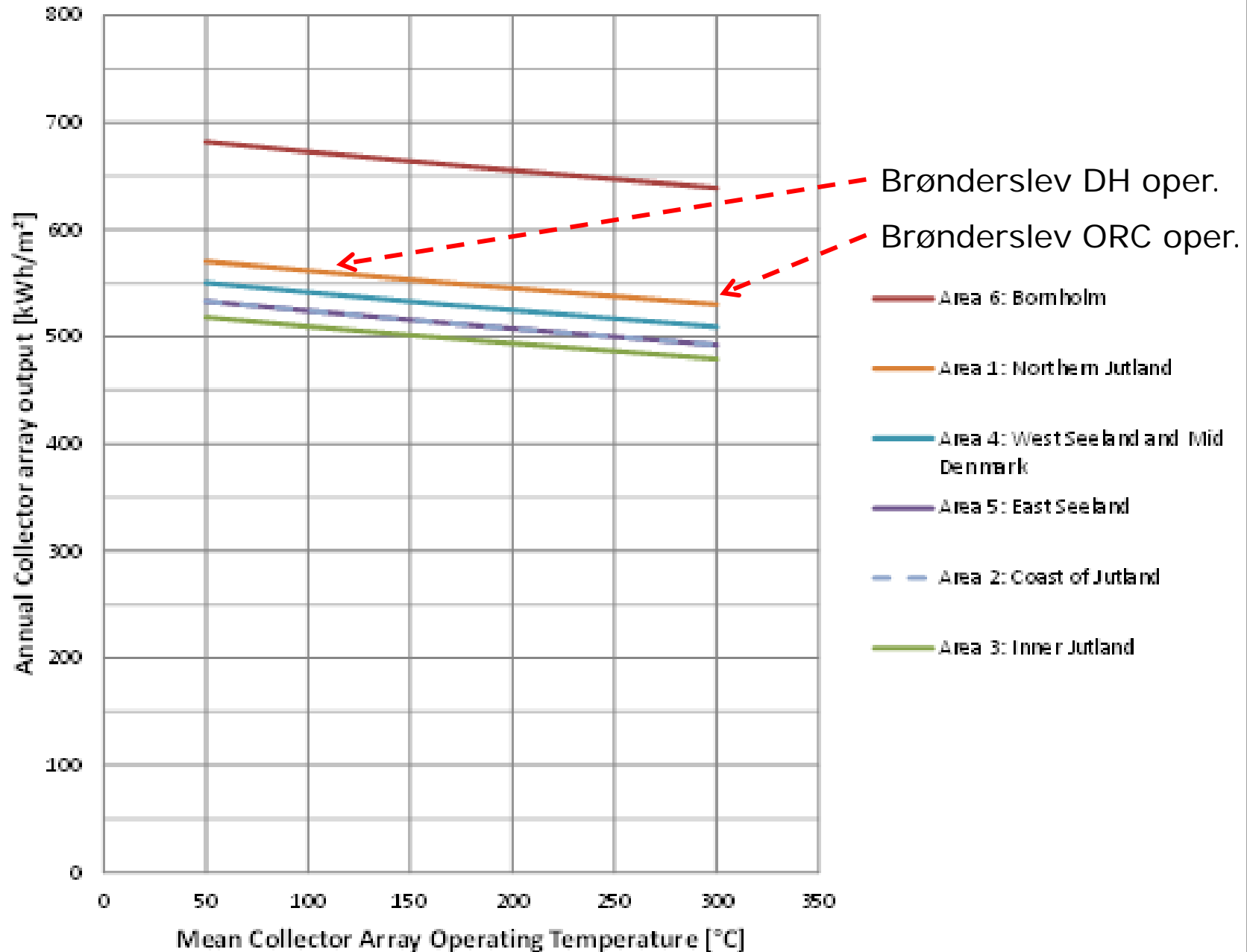## CSP Collector field performance
DH= District Heating

Simplified Daily Input Output Performance Check May-September 2017 (Preliminary ongoing work)

ACSP Array Performance for different locations in Denmark

DTU

Conclusions:

The CSP collector array performance is close to expectations.

It is possible to produce solar heat above 300C with good efficiency

An accurate performance check of a solar plant requires an analysis taking local weather and operating conditions into account.

Enough optical precision and tracking accuracy is very important

Accurate solar radiation measurements and especially DNI requires regular cleaning of the sensors

The construction and operation of a CSP plant needs expertice to be sucessful

Thank you for your attention