Solar Power Plants in the North – final results

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Objective

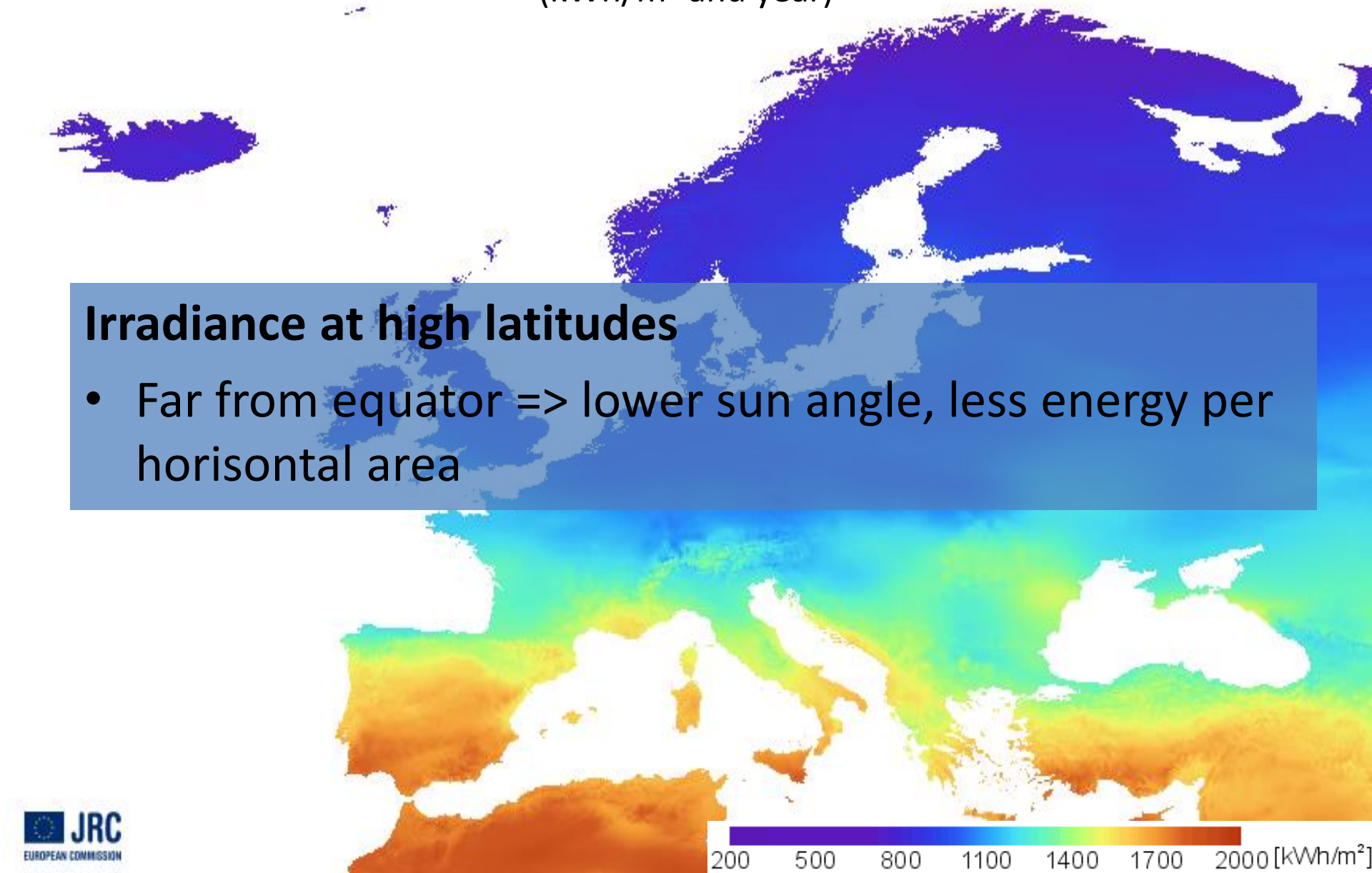
- To find out the feasibility of solar power in the north
  - Practically and economically
- Cooperation between PiteEnergi (SE), Norut (NO), LTU (SE) and Kemi Voctional College (FI)

Myth, Reality & Challenges about PV in the North

- Myth
  - It is too dark and cold in northern Scandinavia => solar energy cannot possibly be viable!
- Reality
  - Parts of Scandinavia receive lots of sunshine
  - Cold temperatures is an advantage => higher efficiencies
  - Reflection from snow in winter => higher yield
- Challenges
  - The solar irradiation is not evenly distributed over the year
  - We do not have a match between demand and supply
  - There is a great need for storage of energy

Irradiation on a horizontal surface

(kWh/m^2 and year)



Irradiance at high latitudes

- Far from equator => lower sun angle, less energy per horisontal area

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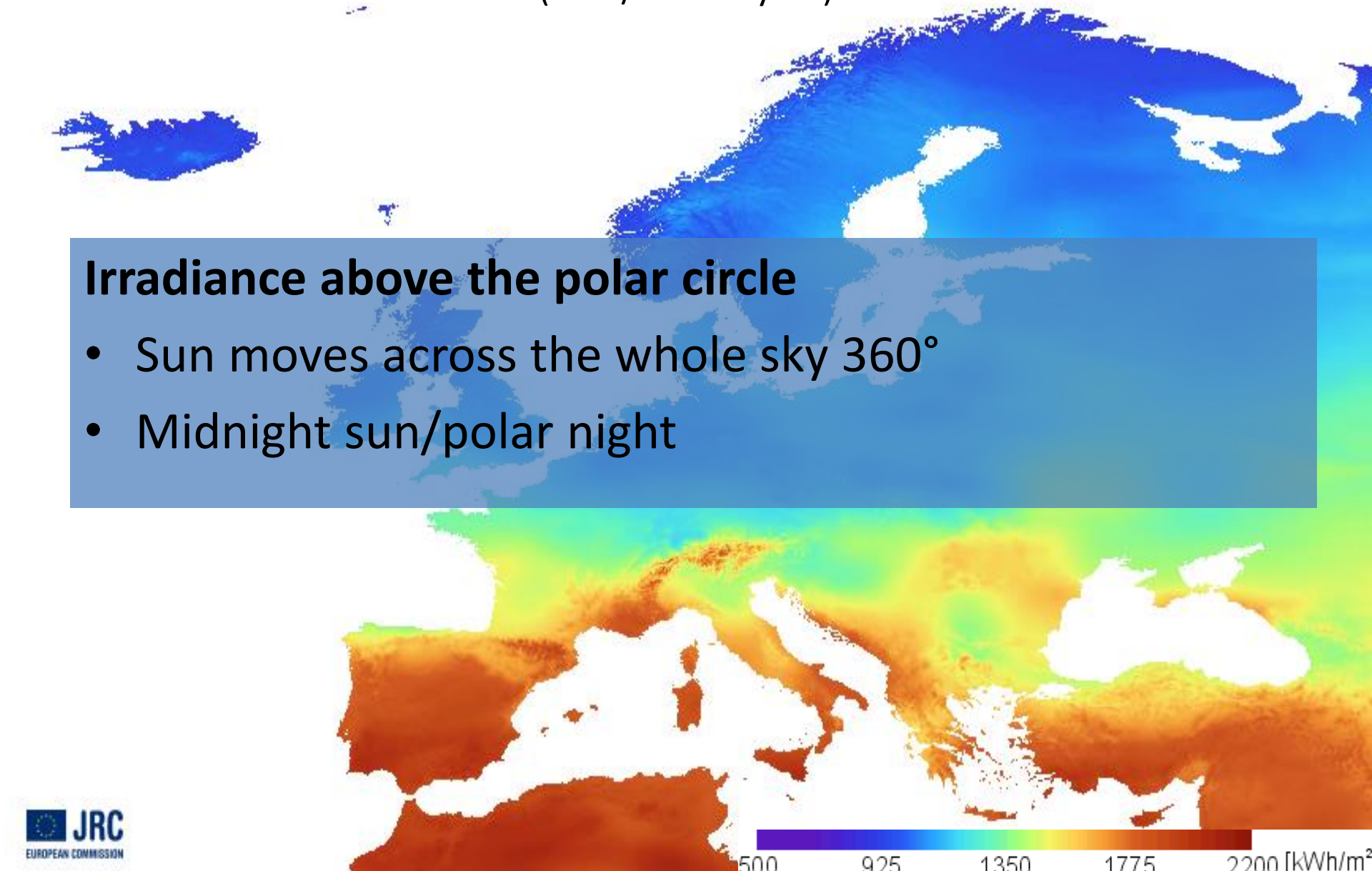
Irradiation on an optimally inclined surface

(kWh/m^2 and year)



Irradiance above the polar circle

- Sun moves across the whole sky 360°
- Midnight sun/polar night

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Irradiation on a 2 axis tracking surface

(kWh/m^2 and year)

Not dependent on the latitude, only the weather!

Piteå

400 1050 1700 2350 3000 [kWh/m^2]

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Real Case – Piteå System

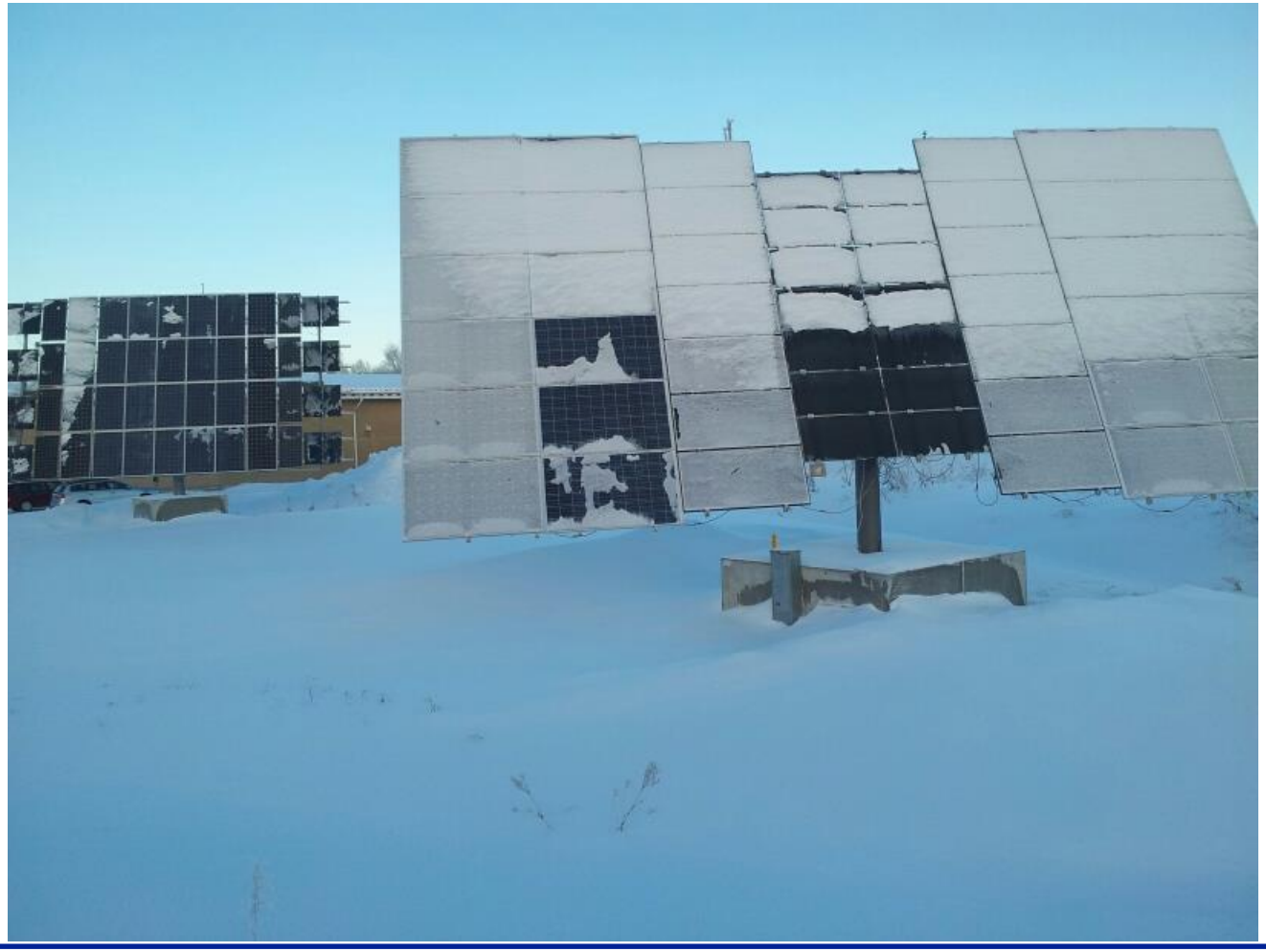
- 2 axis tracking system in Piteå, Sweden, 2 x 10kW$_p$
  - In operation from March 2012
  - Astronomical and optical tracking systems
  - Individual module monitoring
    - P and N-type mono, multi with and without textured glass and CIGS thin film
  - Weather station + pyranometers

PITE ENERGI

Timelapse May 9th 2012

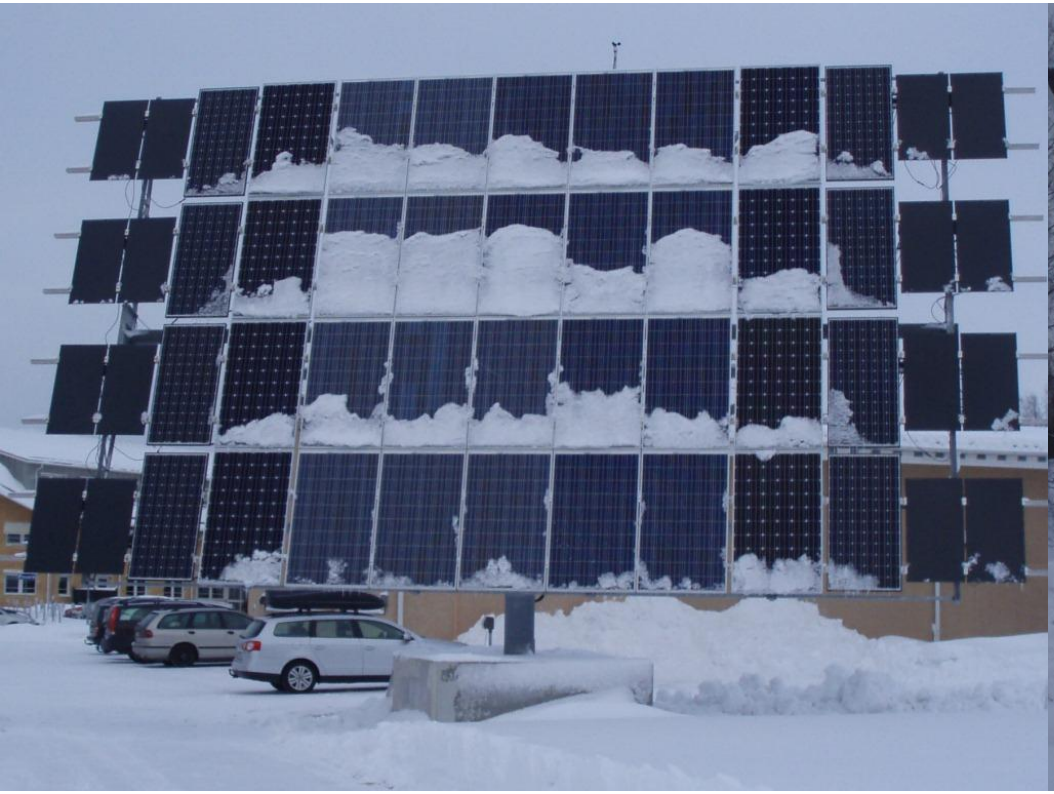
Cold climate effects

January 14th 2013

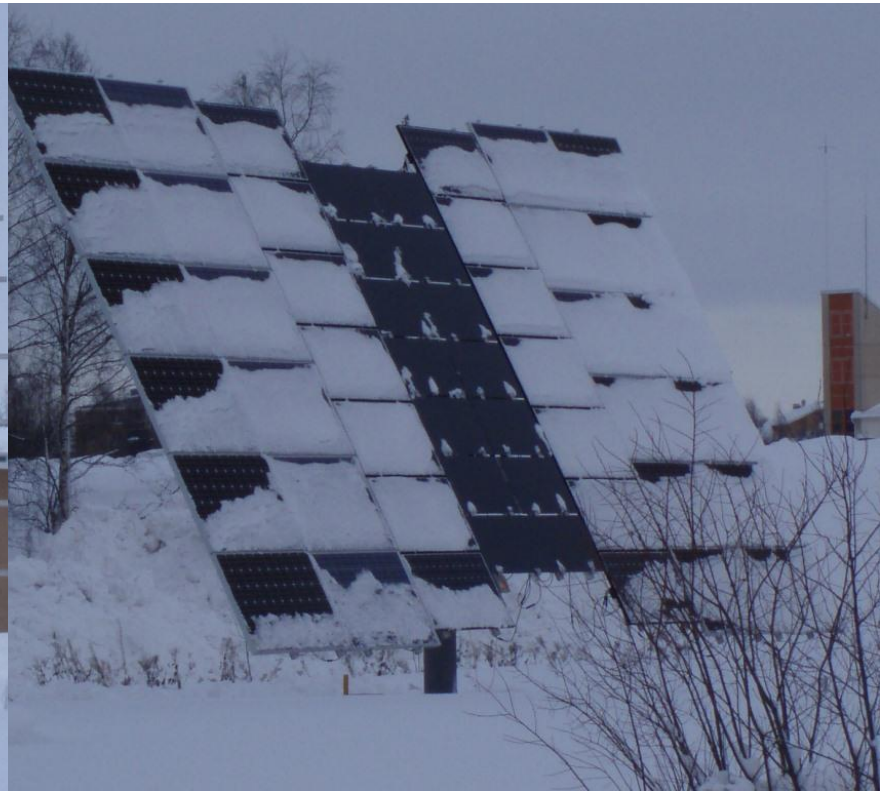


February 8th 2013

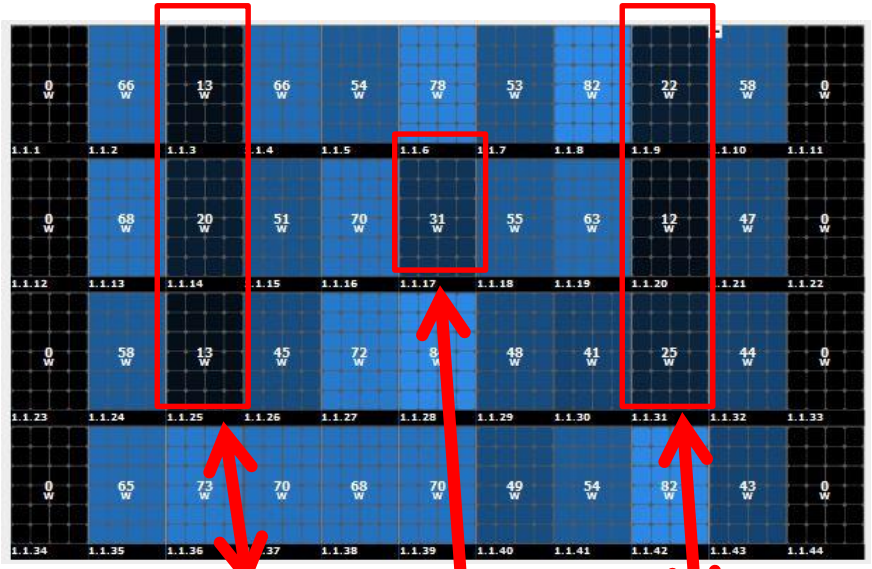
Kemper



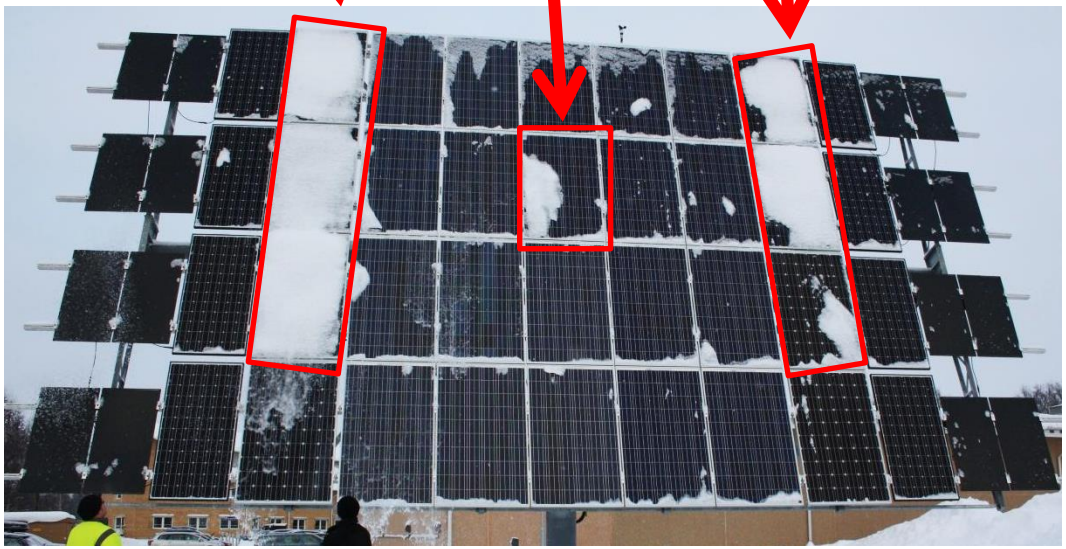
Deger



Power production from the system 2012-02-03



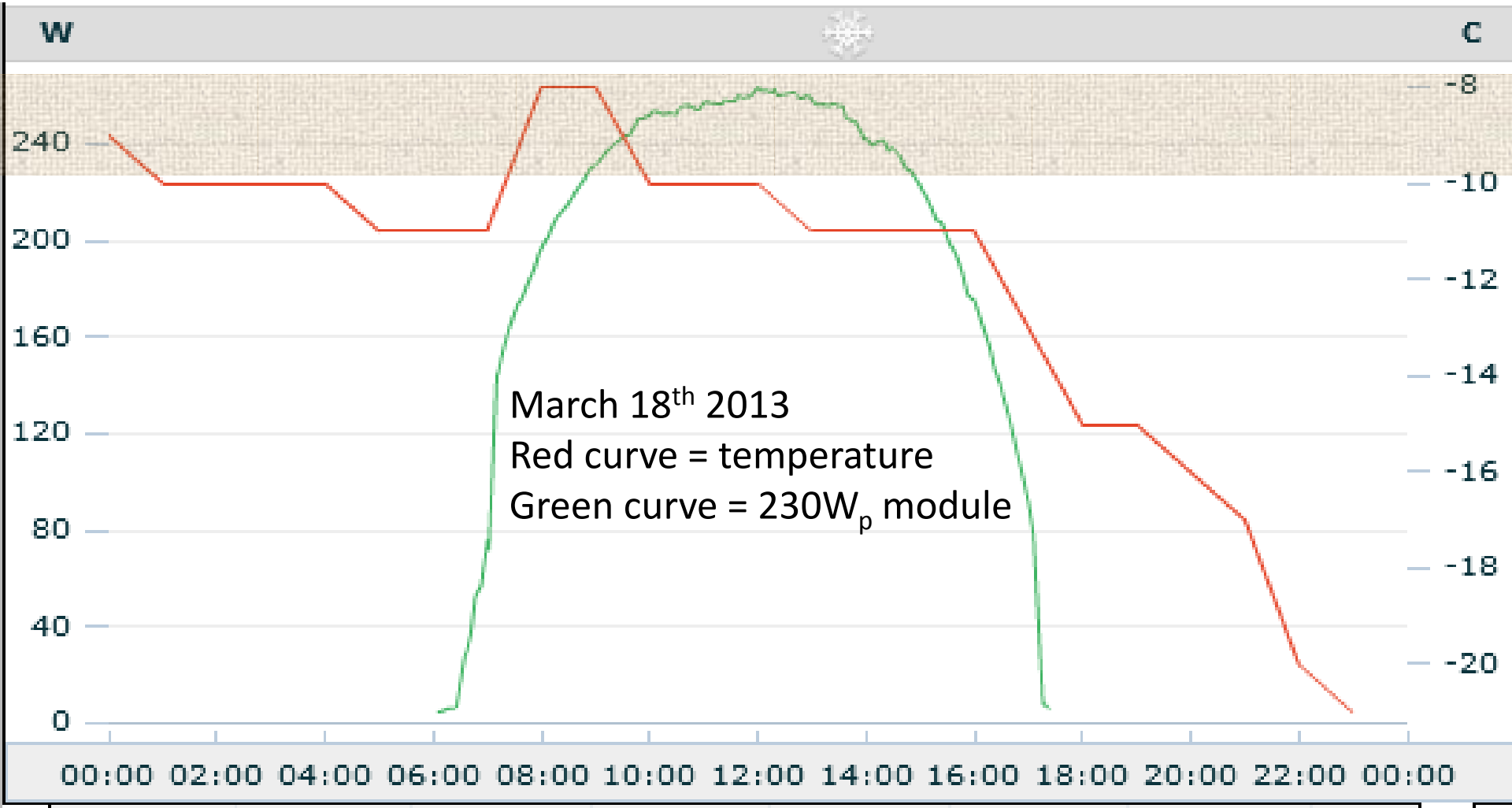
Picture of the system taken 2012-02-01



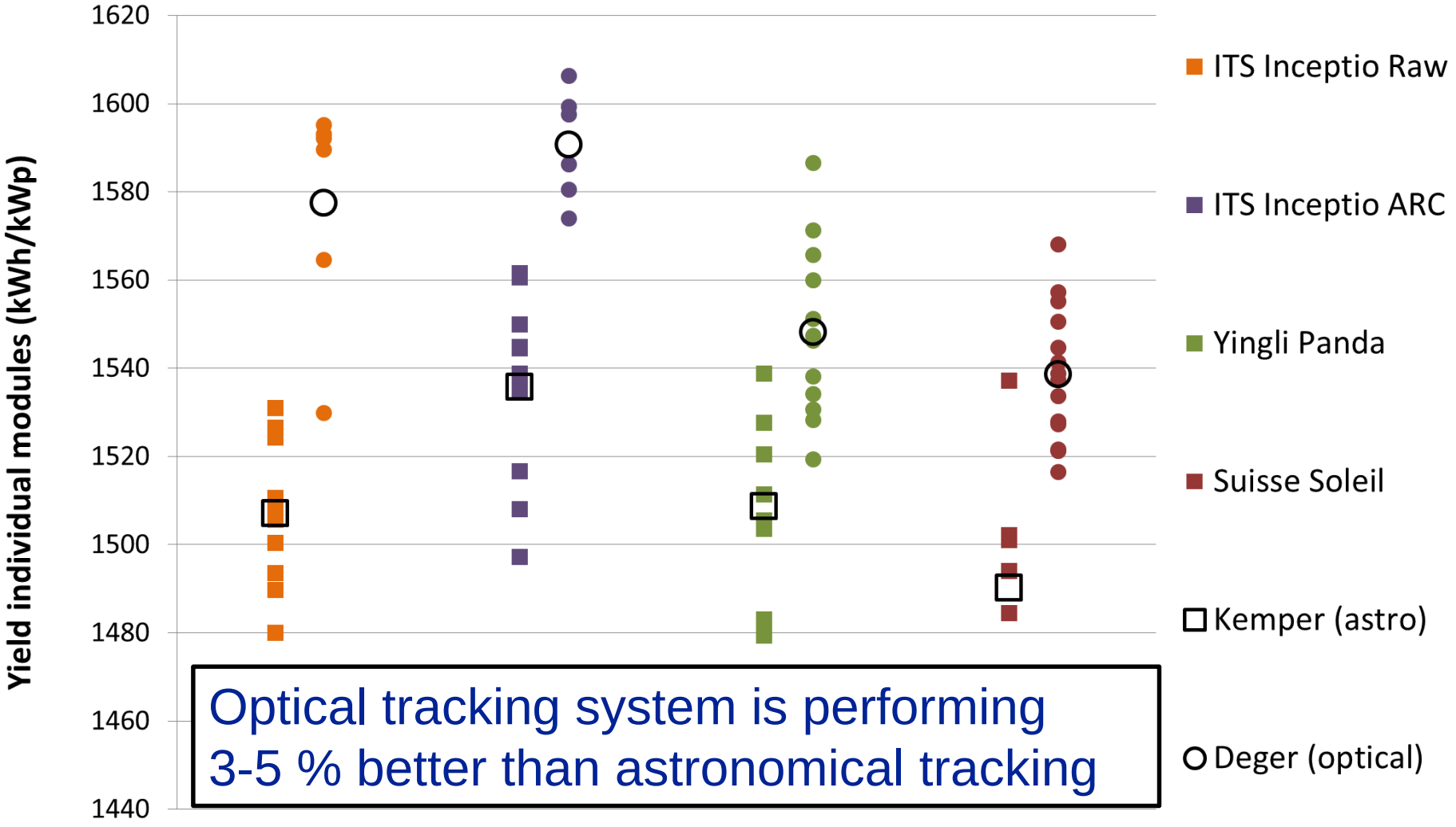
Performance results

Peak Power Production

- 100% of peak power obtained in end of February
- 115% of peak power obtained in mid March!



Yield in kWh/kW$_p$
July 2012 to June 2013



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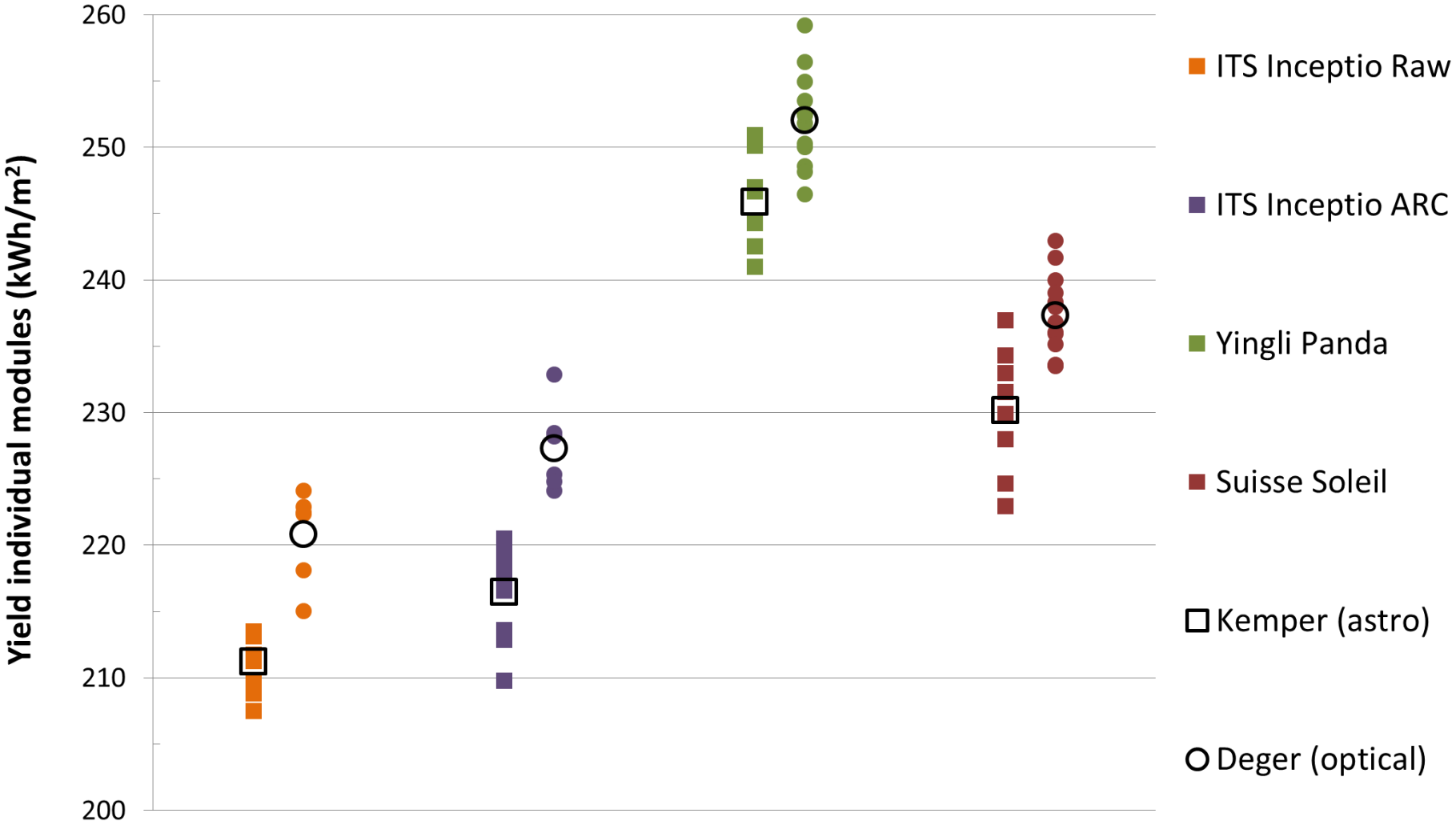
Yield in kWh/m^2
July 2012 to June 2013



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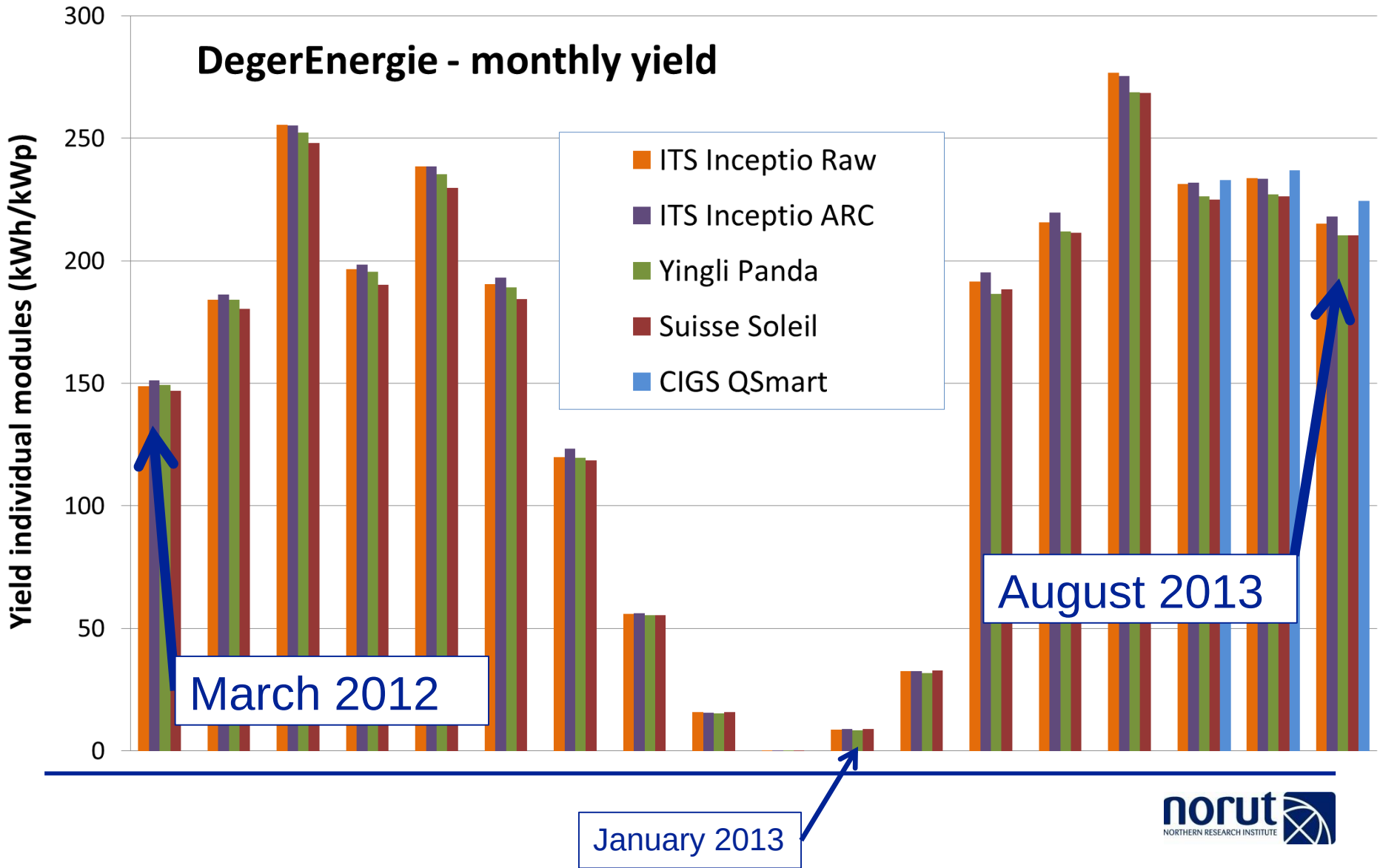
Deger - Monthly yield for ind. module type



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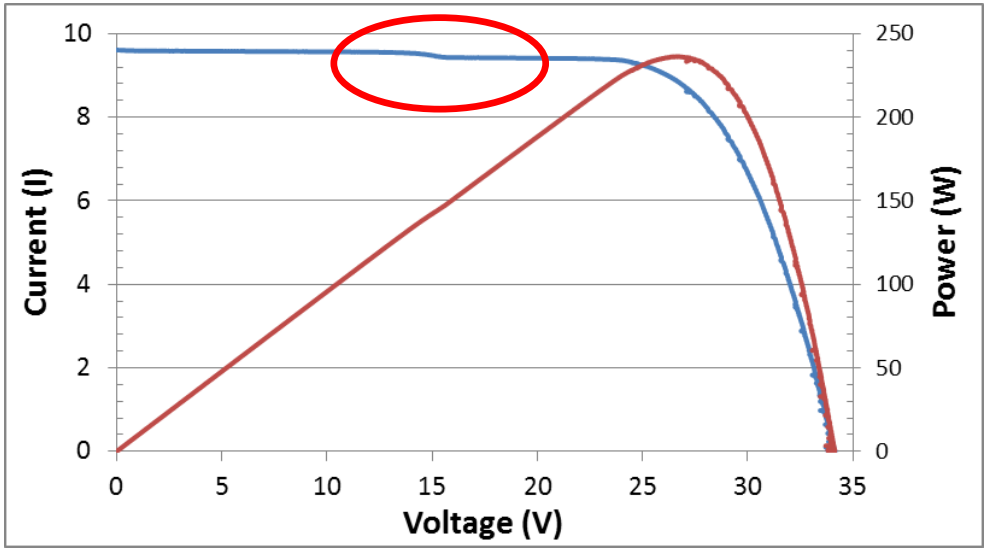
Irradiation in Piteå and effect on Yield

- 2012 was the rainiest year since the measurements started 150 years ago!
- 2013 is so far very sunny
- Effect on yearly yield for silicon modules:

	Yield (kWh/kW_p)
2012	1400
2013	1600
Average Year	1500

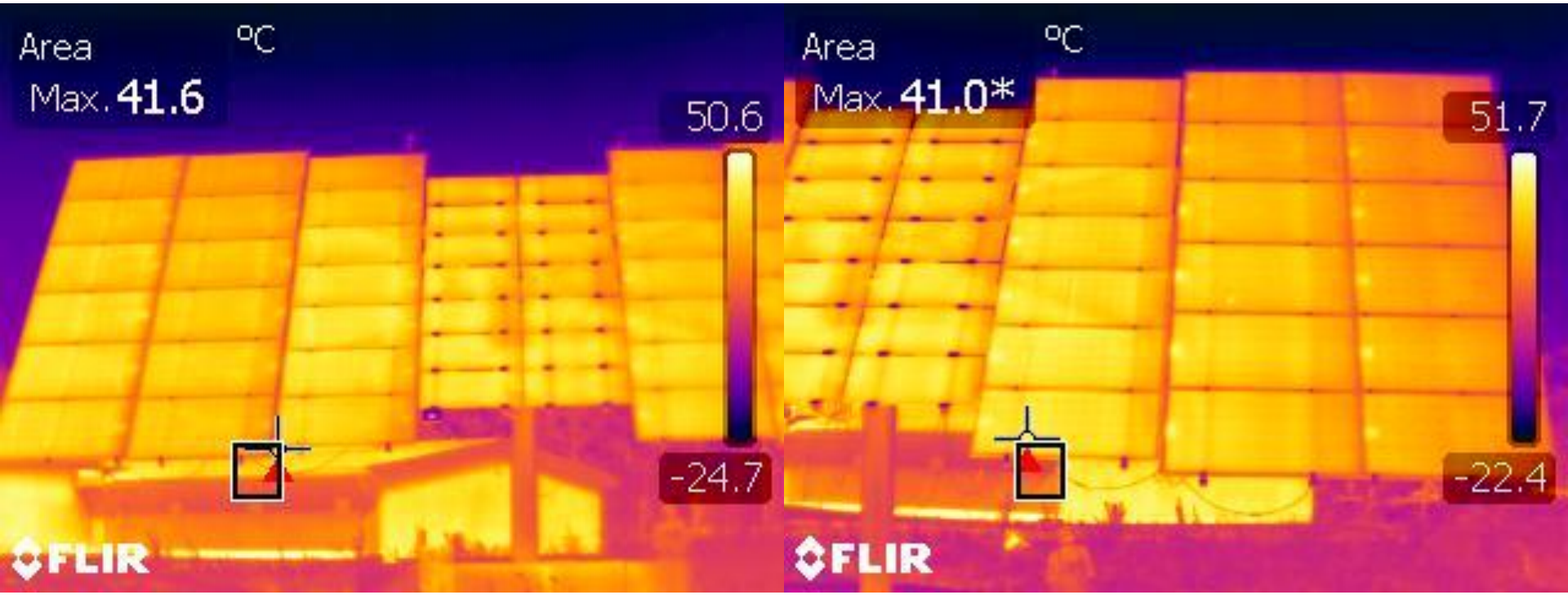
IV experiment

- Effect on power
  - dirt due to low rainfall
  - bird droppings
- The loss is equal to ~ 1-2%



IR experiment

- IR imaging of panels on the Deger system



Conclusions – solar energy in the north

- A myth that we have little sunlight in the north
  - But unevenly spread over the year
  - Energy storage is essential
- Cold temperatures and snow is only positive
- A tracking system in Piteå obtains 1500 kWh/kW per year
  - 40-50% more than a fixed system in Piteå
  - 1500 kWh/kW is the same yield as for a fixed system in southern Europe!
- Yearly yield in Piteå per km_2 land area
  - Wind power ~ 22 GWh
  - Solar Power ~ 60 GWh!

Conclusions – solar energy in the north

- PV can become an important part of the energy stystem in Scandinavia!
- Guarantee = 25 years
  - Lifetime = 50 years?
- Information and polictical support is still needed to support PV
  - Much lower energy price in Scandinavia
- Do you know that the fossil energy industry recieves 8 times more subsidies than renewable energy!
- We need to start the transition now!
  - Climate change is no longer a debatable future, it is here and it is man made

Thank you for your attention!