



[www.csiro.au](http://www.csiro.au)

# Solar Energy Forecasting

## An introduction

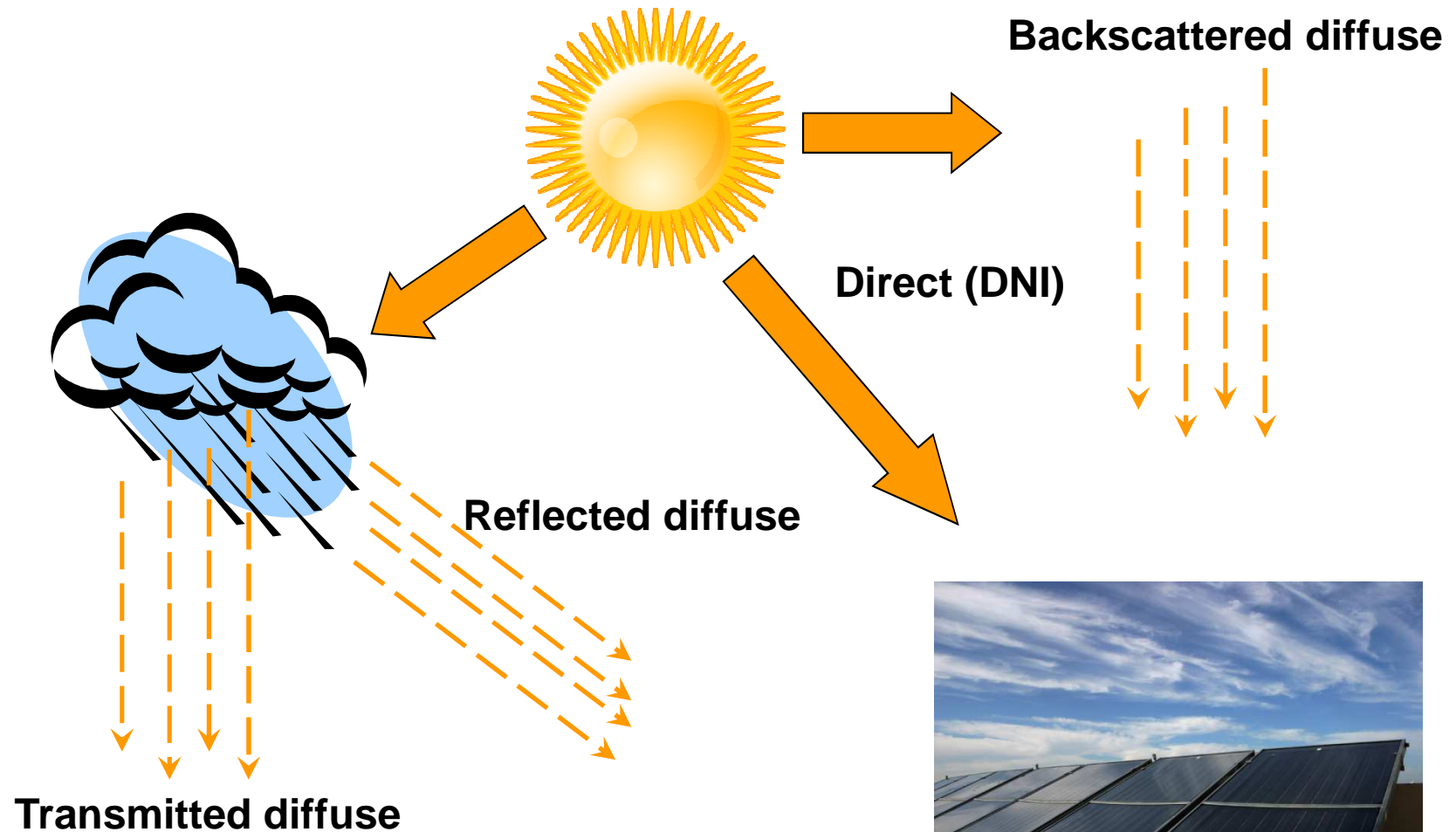
**Peter Coppin**  
**Energy Transformed Flagship**



# Key Messages for solar power generators and financiers

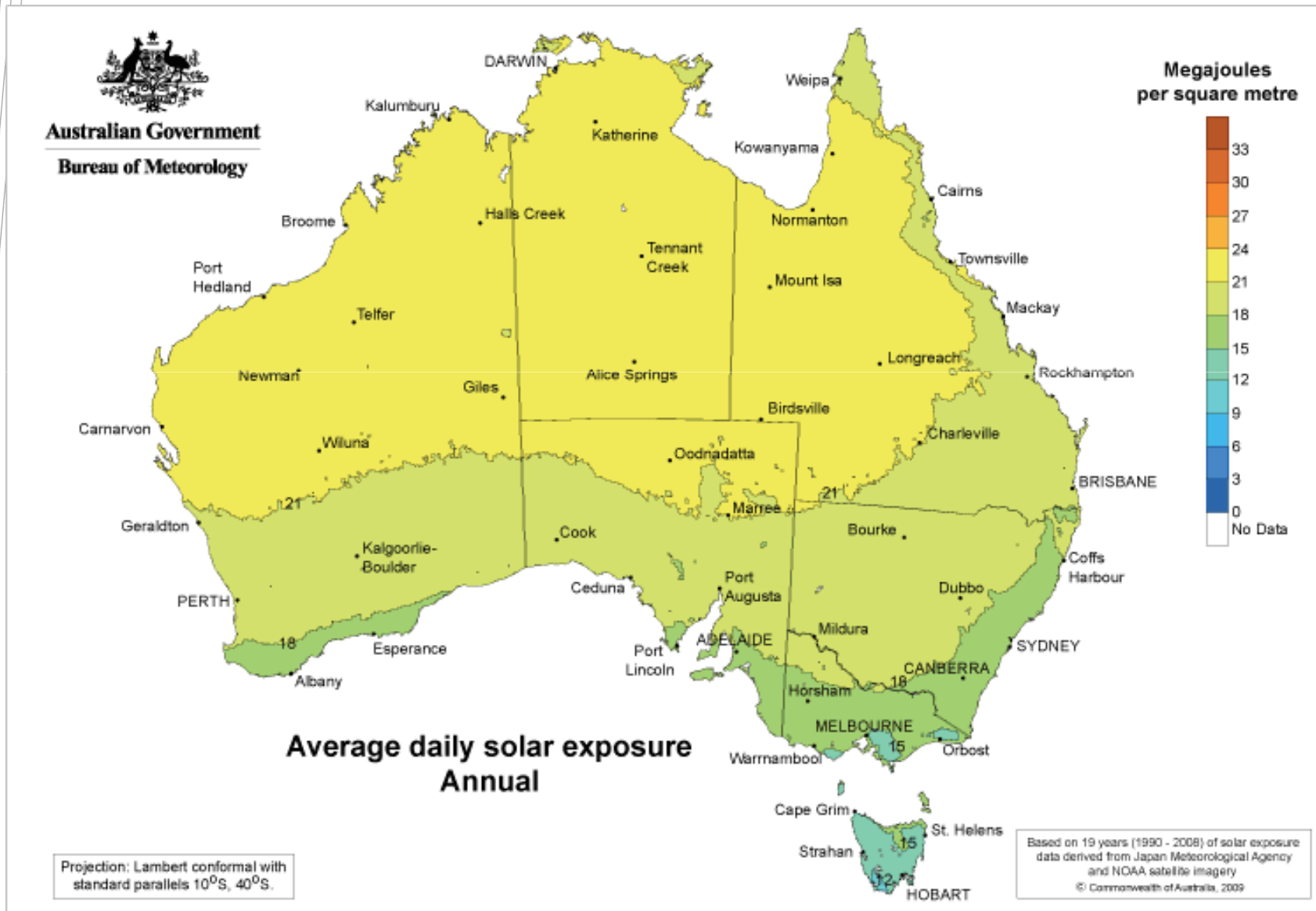
- “Forecasting” is both understanding the potential lifetime power production and ensuring efficient grid and market operation - covering timescales from 5 mins to 20 years
- The main game is reducing uncertainty
- There are many tools available but we need to understand the limitations
- Good measurements are essential

# Radiation components

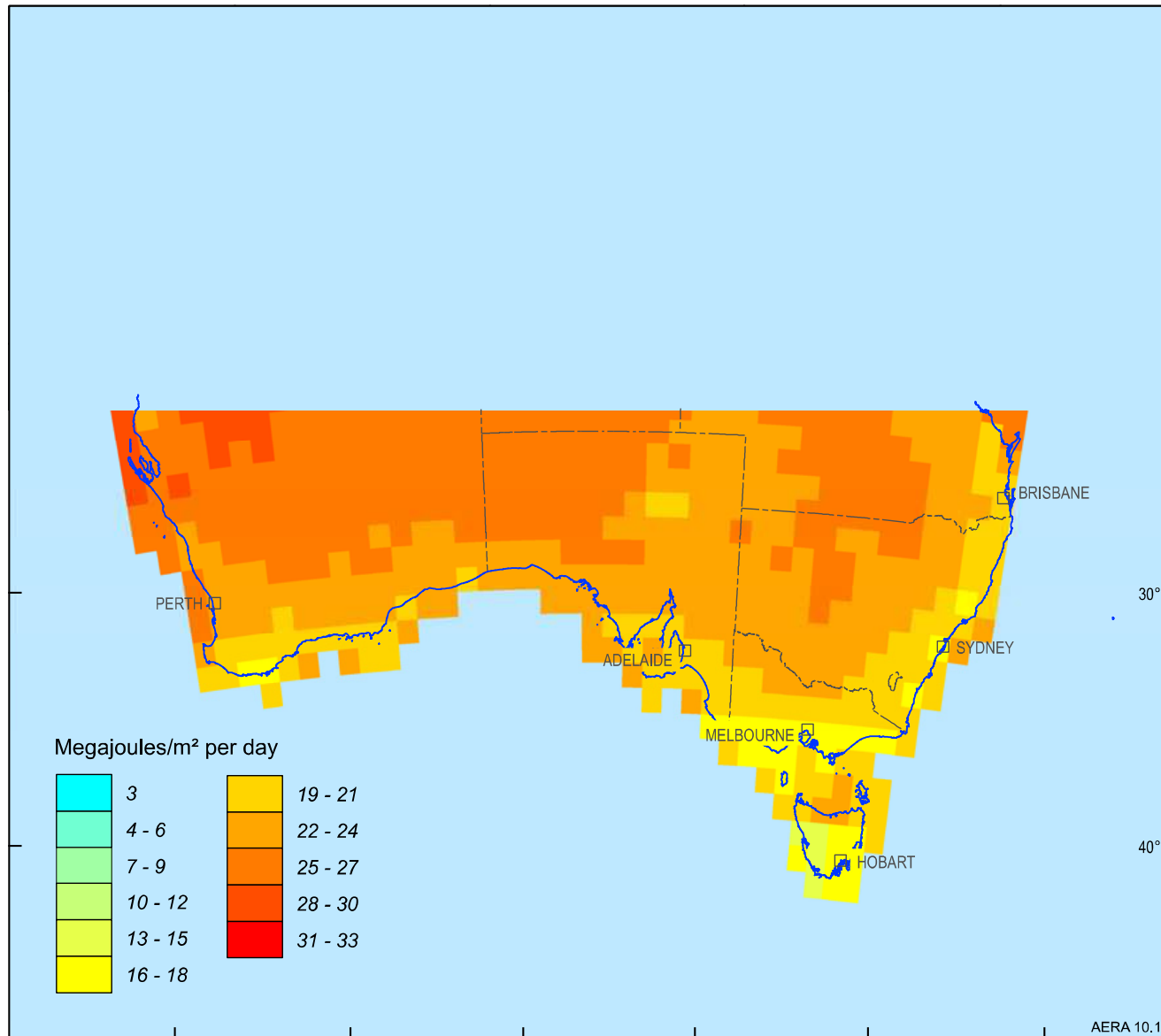


The various radiation paths sources have different spatial distribution and spectral characteristics

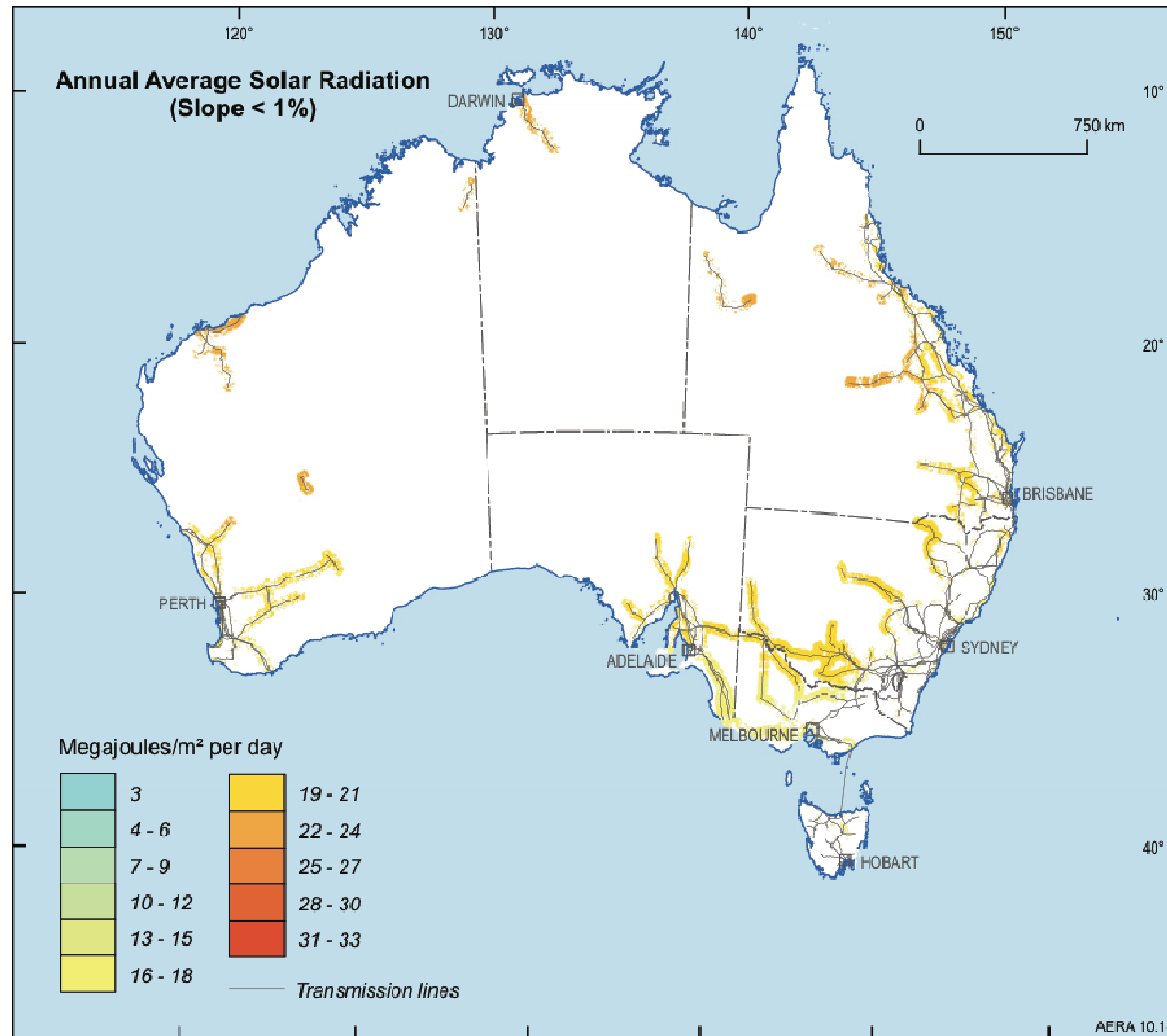
# Total annual average solar resource horizontal surface – satellite derived



# Annual average direct solar resource DNI – satellite derived

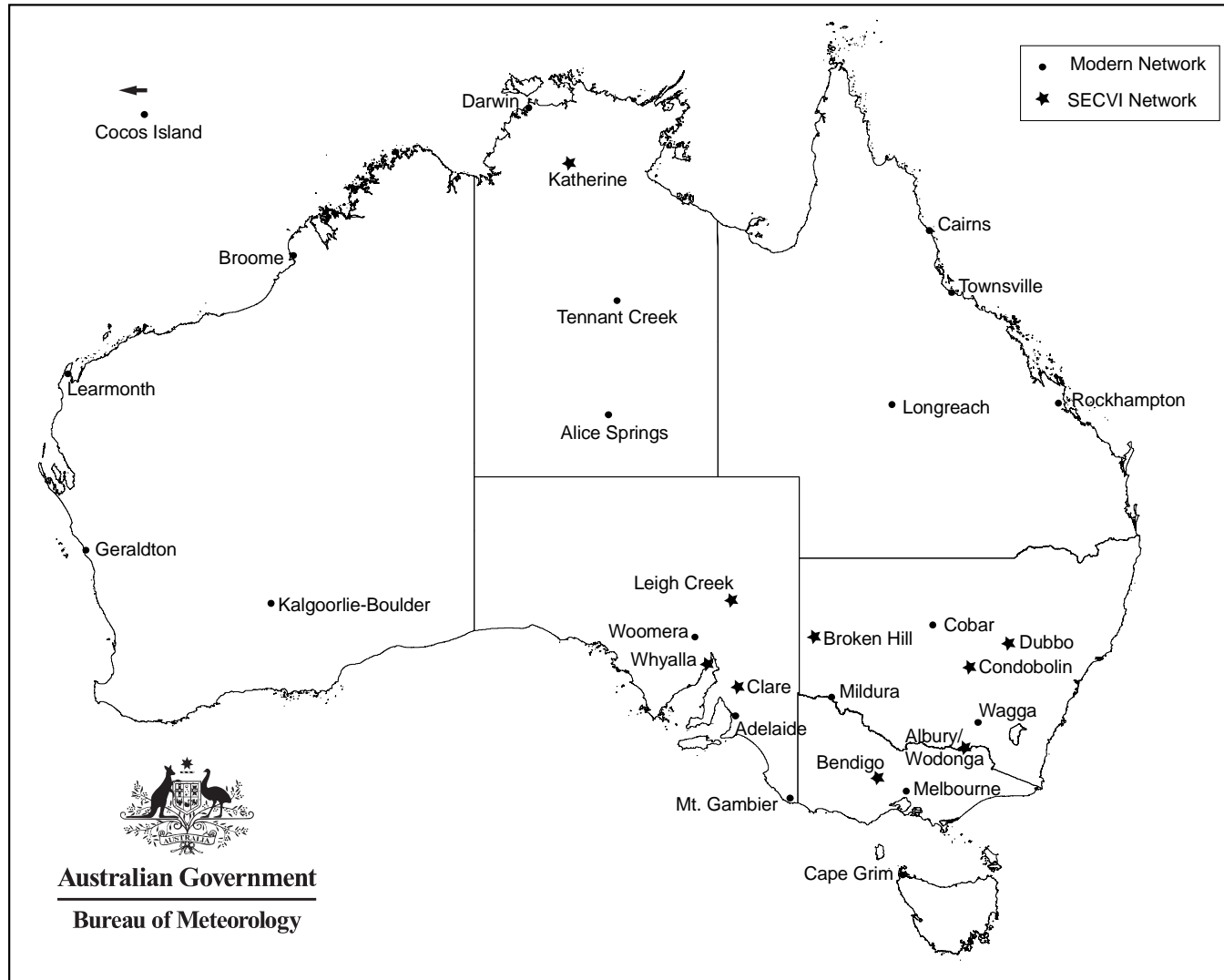


# Total annual average solar resource within 25km of major power lines



**Figure 10.14** Annual solar radiation, excluding land with a slope of greater than 1 per cent and areas further than 25 km from existing transmission lines

# Bureau of Meteorology Solar Radiation Stations



# BoM Precision solar radiation measurements

Shading disk



Total and Diffuse component measurements

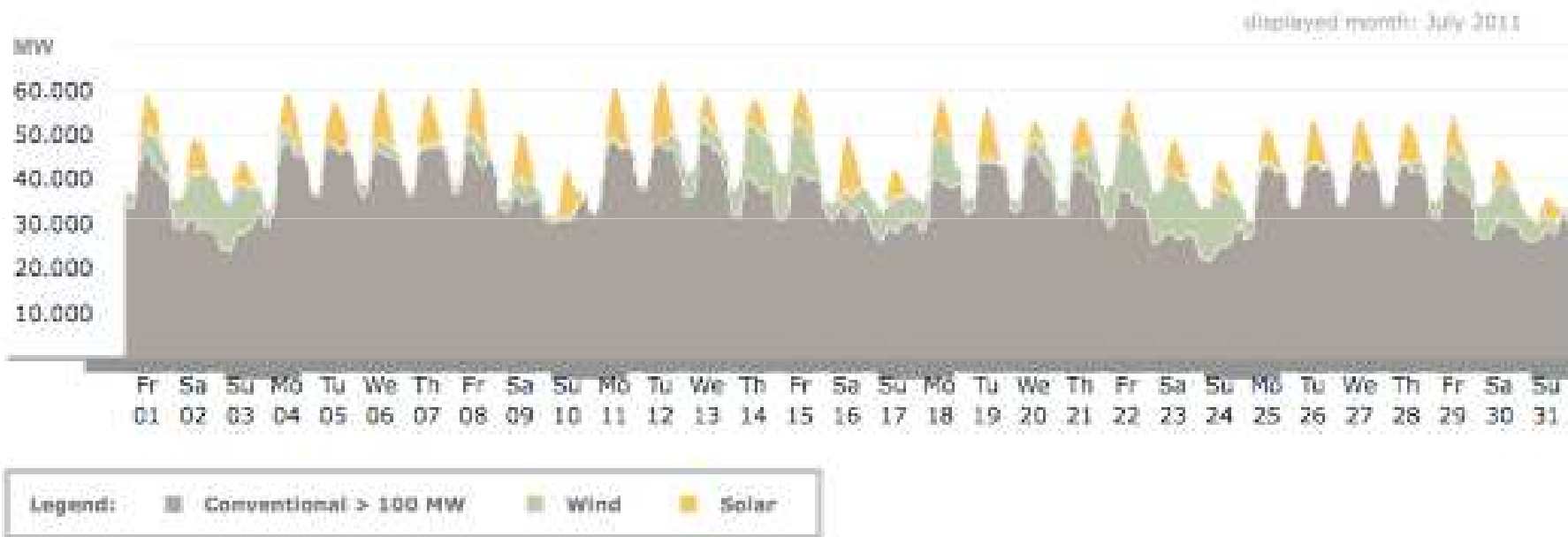
Direct component measurement (DNI)

1-min data available



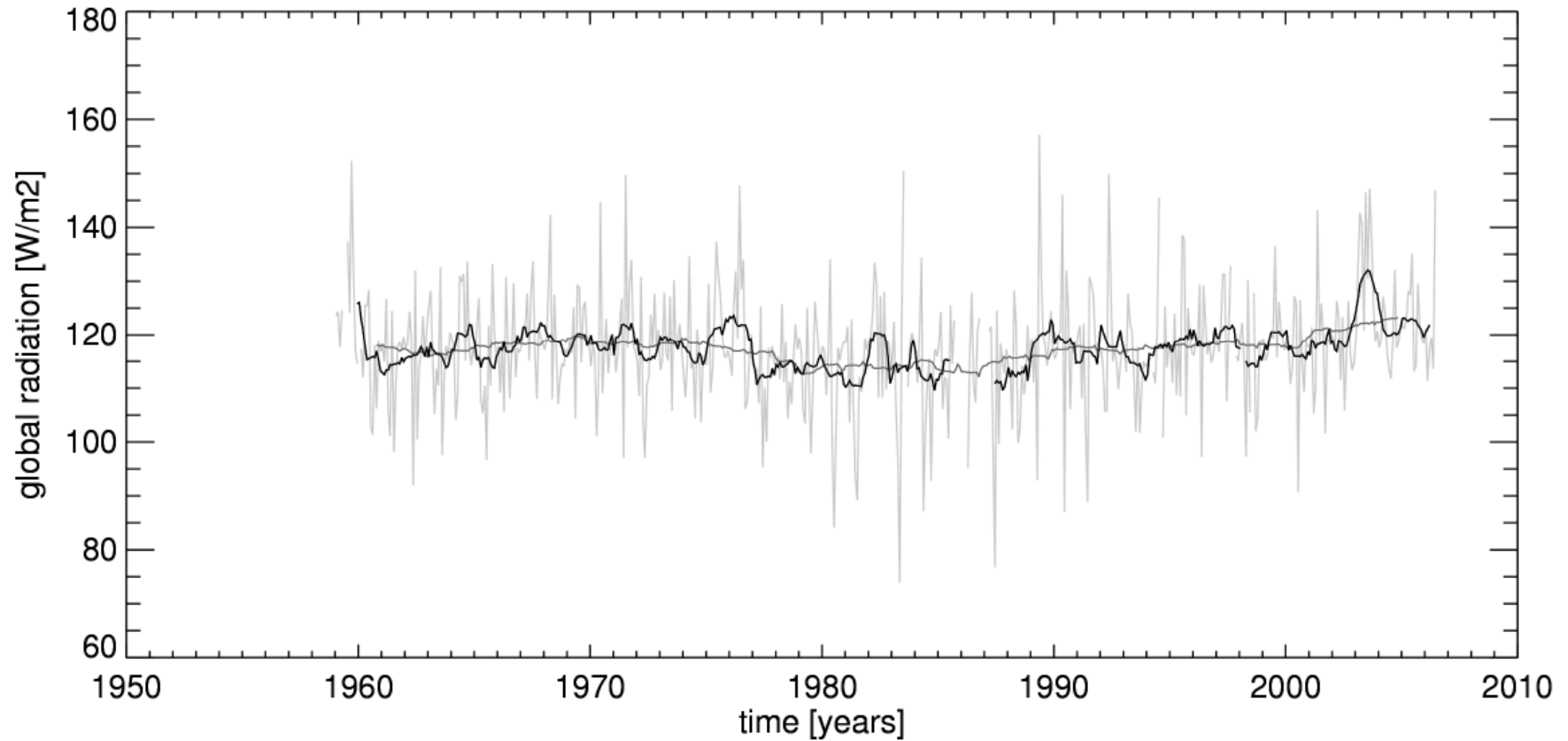
# PV and Wind contribution to power generation – Germany in Summer

## Actual production



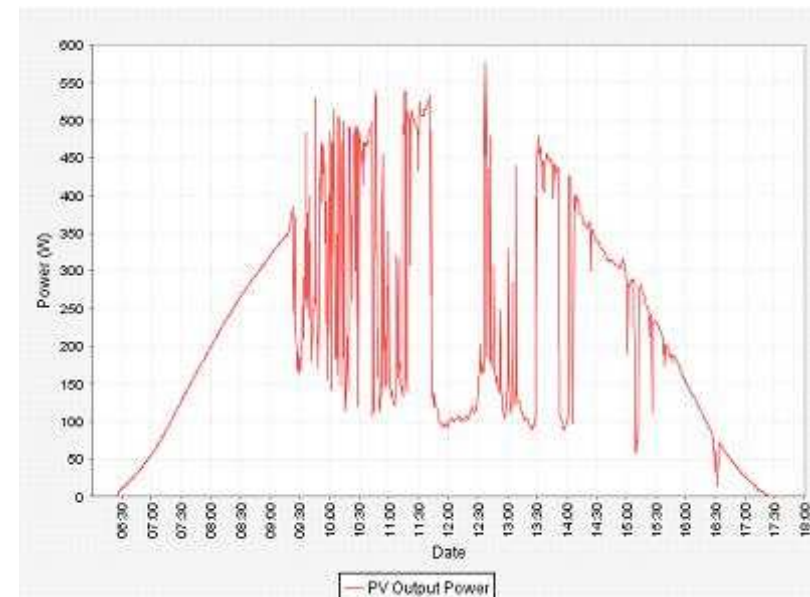
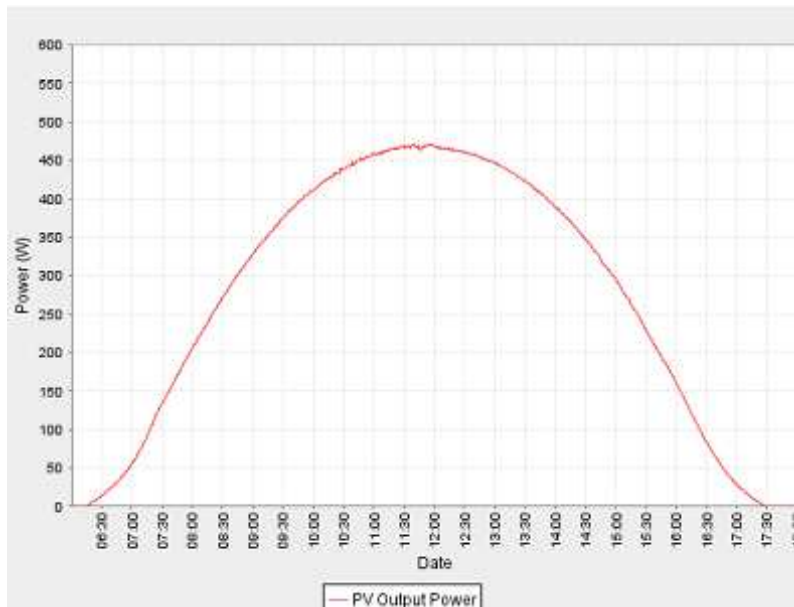
# Solar Radiation Variations

## Average for northern hemisphere measurements



**Monthly data, 1 year and 5 year running means**

# Operational issues solar radiation – can be very variable



# PV Power conversion complexities

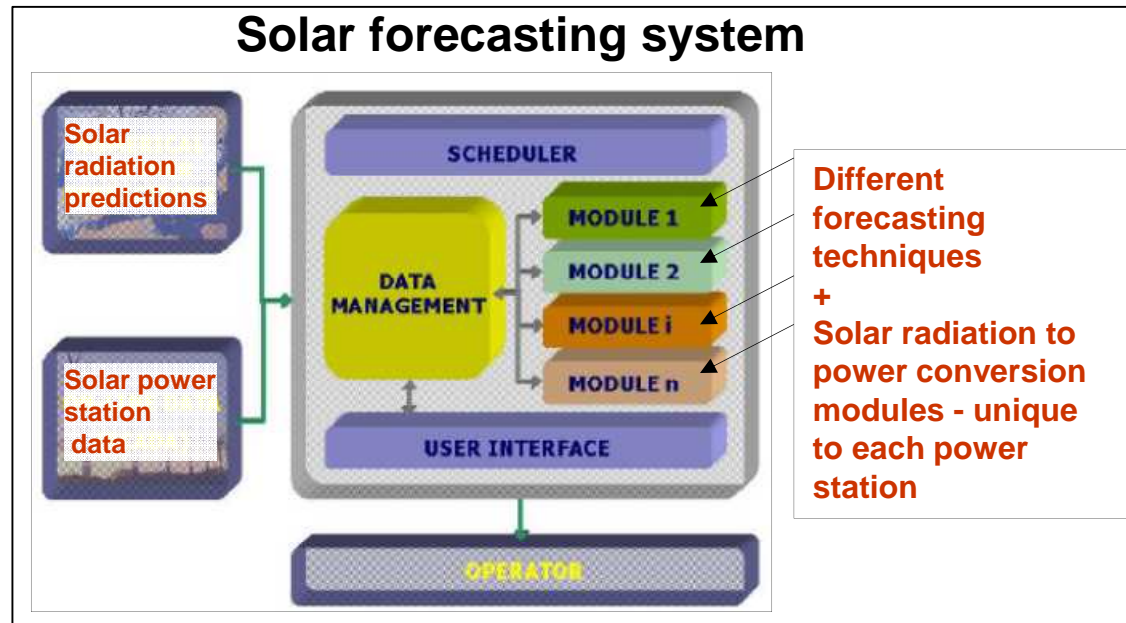


Sharp cloud boundaries can cause inverter voltage collapse  
– creating large, very rapid changes in output

# Issues

- Variability at all time-scales
- Making quality measurements - Solar instruments are specialized and need a lot of maintenance
- Relating single-site measurements to whole of plant power production
- Relating short measurements to 20+-year energy production
- Ensuring grid stability and adequacy at all time-scales

# AWEFS – building a solar extension – ASEFS to be installed at AEMO



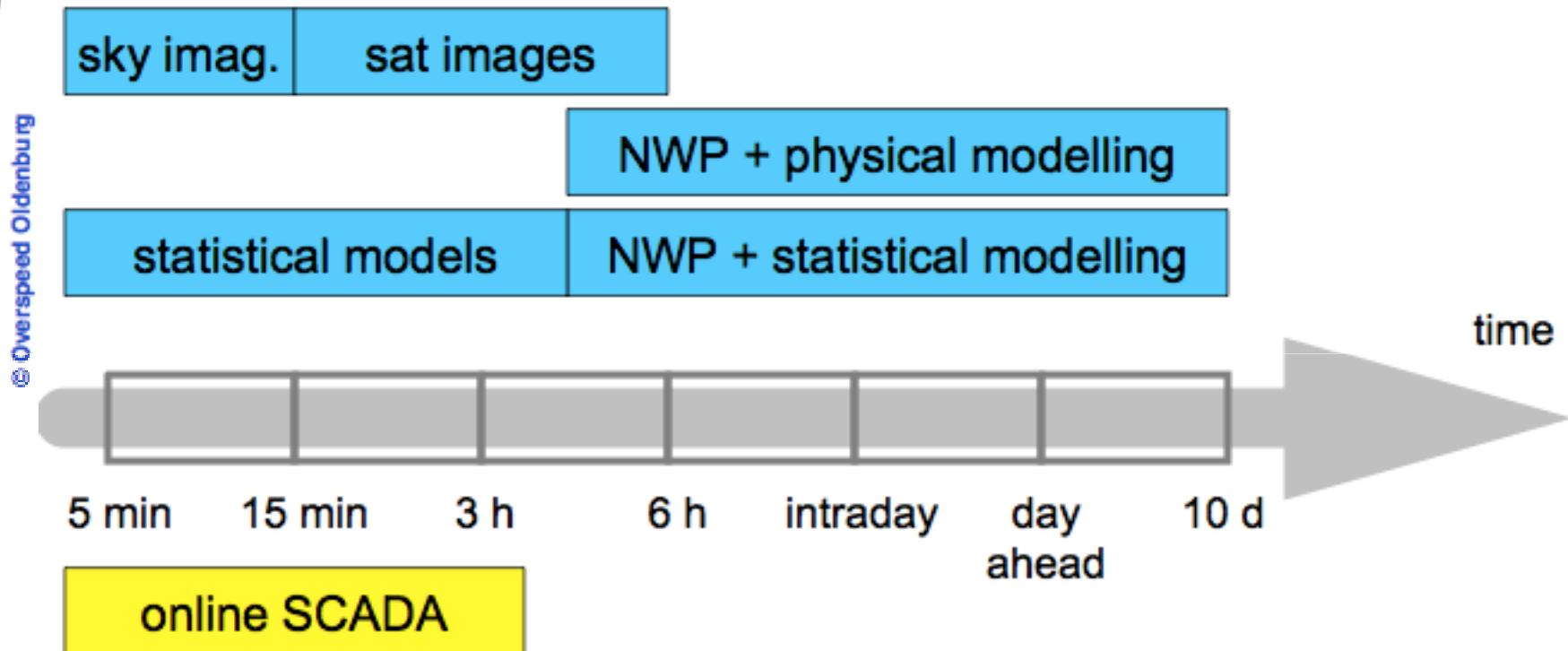
**Modelled Wind Speed @location...** →

**Wind farm standing data eg. power curve** →

**Modelled Solar Radiation input components (direct, diffuse) @location, physical distribution, time, date, other dependent data (panel temp)**

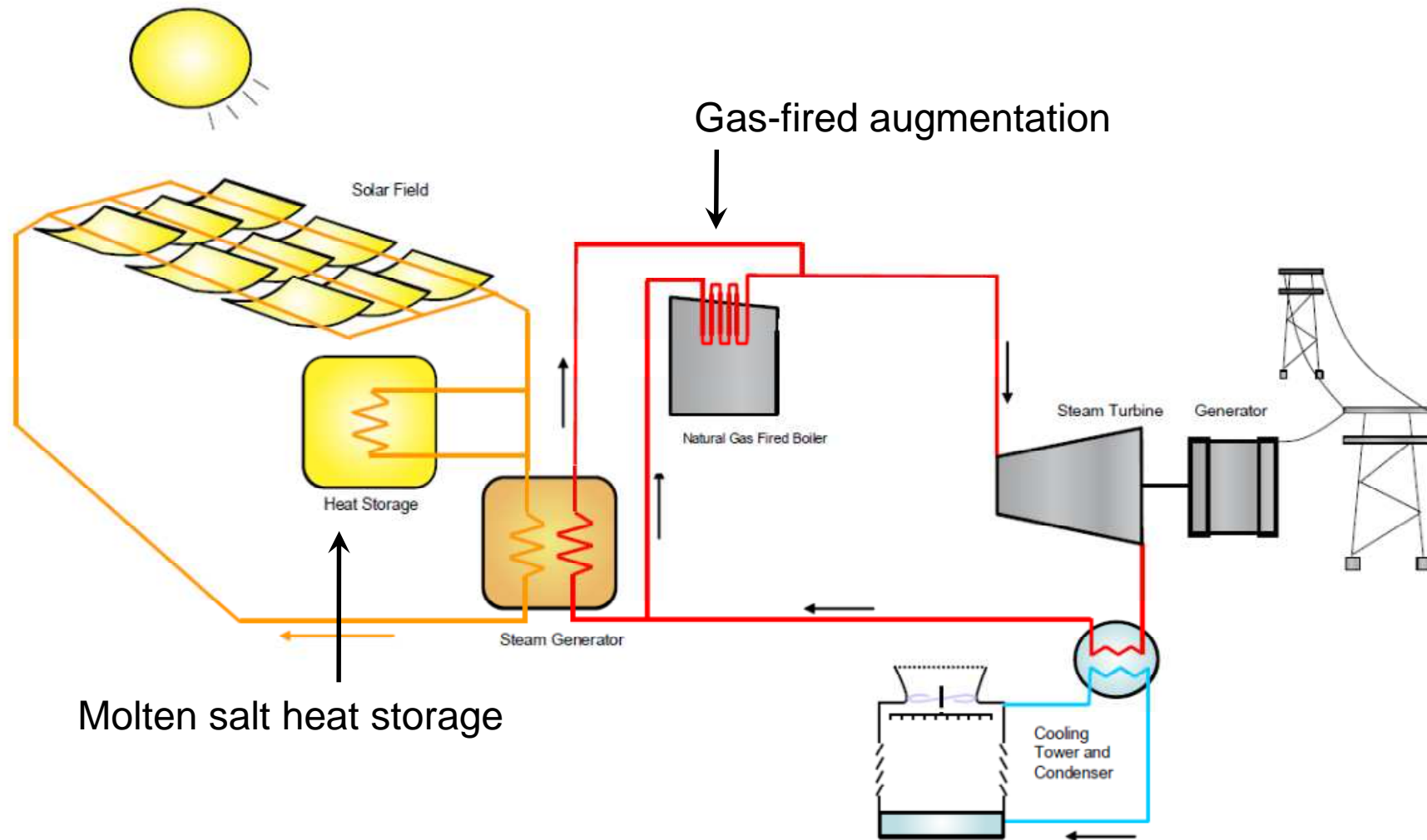
**Solar farm standing data eg. power curve + any fuel conversion, storage**

# Solar forecasting techniques for different timescales



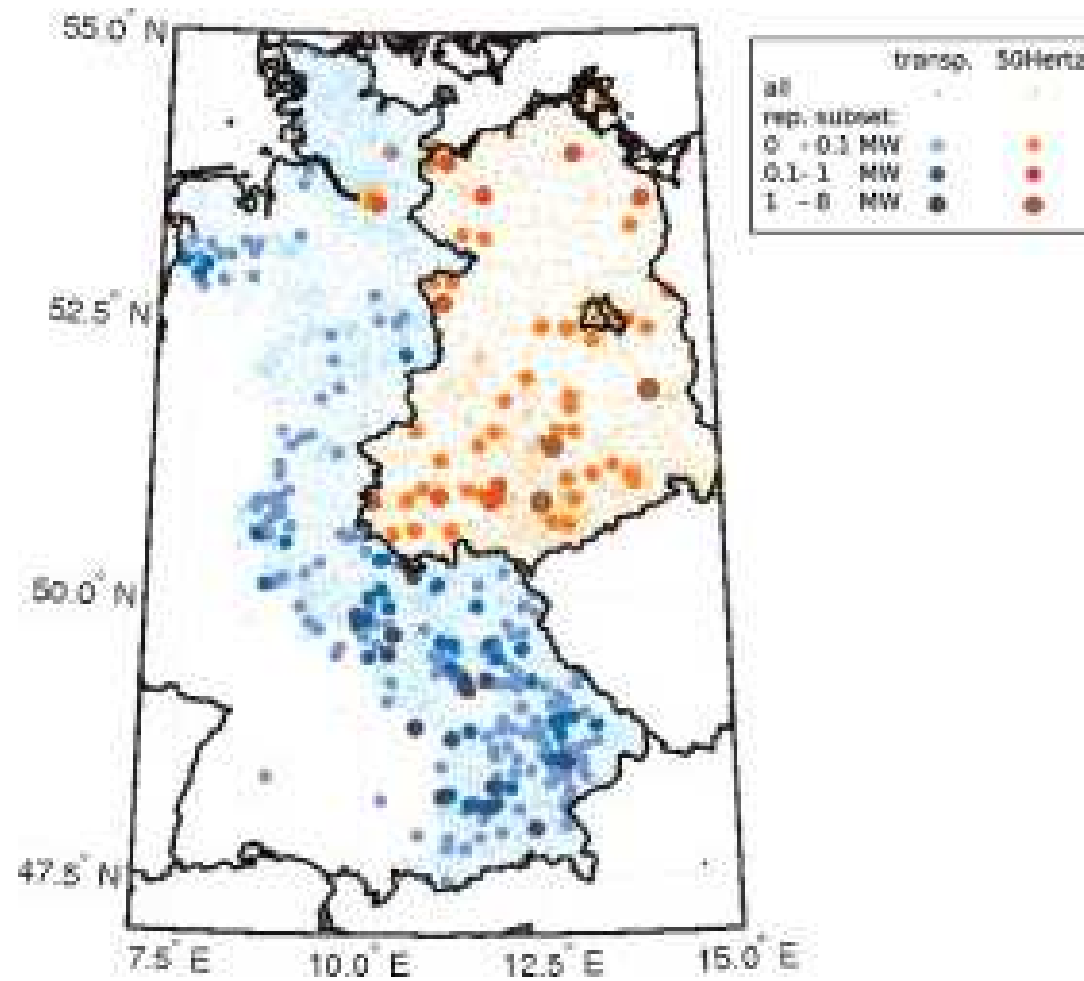
**NMP – Numerical Weather prediction**

# Challenges: Solar Trough system with storage and gas augmentation





# Challenges: City/Regional Up-scaling - PV



**CSIRO Marine and  
Atmospheric Research**

Dr Peter Coppin

Phone: 02 6246 5576

Email: [peter.coppin@csiro.au](mailto:peter.coppin@csiro.au)

[www.csiro.au](http://www.csiro.au)

**Thank you**

**Contact Us**

Phone: 1300 363 400 or +61 3 9545 2176

Email: [enquiries@csiro.au](mailto:enquiries@csiro.au) Web: [www.csiro.au](http://www.csiro.au)

