Interactive Australian PV Map

Supported by ARENA

Sept 2012 to September 2015

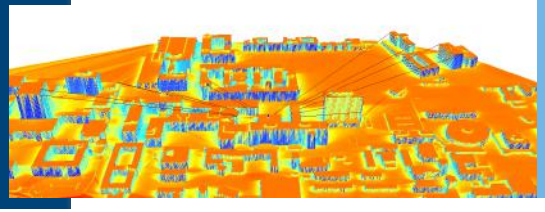
Participants:

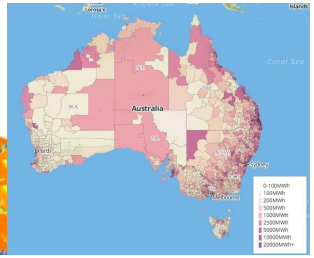
- University of NSW
- Sunwiz
- SMA
- CAT Projects
- CUNY

With support of Australian Government CER & OSP

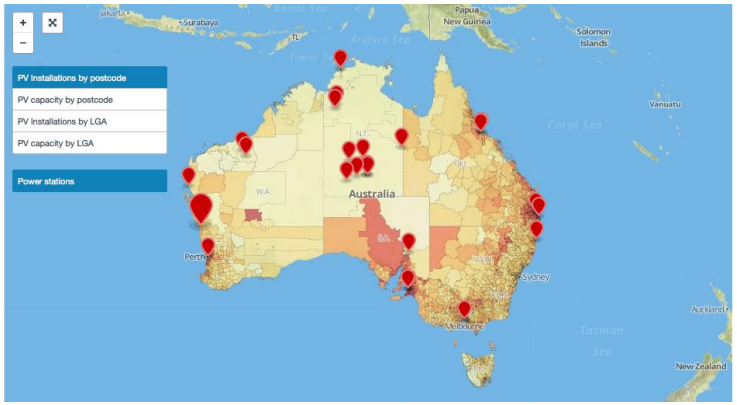
Overview

- **Interactive PV map for:**
  - **Tracking the uptake and impact of PV**
  - **Disseminating information to facilitate investment and research**
- Capacity installed and installation density estimates
- Historical and live performance data
- Tool for assessing PV potential in urban environments



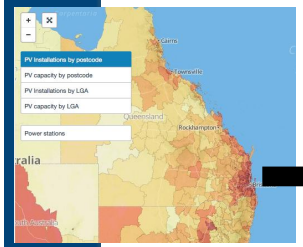


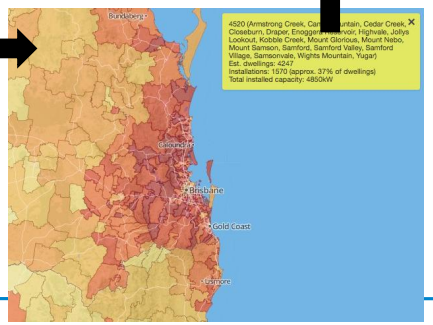
PV Status Map



- Will be able to improve estimates using historical generation data by postcode and LGCs for power stations (>100kW)

Postcode level statistics





4520 (Armstrong Creek, Camp Mountain, Cedar Creek, Closeburn, Draper, Enoggera Reservoir, Highvale, Jollys Lookout, Kobble Creek, Mount Glorious, Mount Nebo, Mount Samson, Samford, Samford Valley, Samford Village, Samsonvale, Wights Mountain, Yugar)
Est. dwellings: 4247
Installations: 1570 (approx. 37% of dwellings)
Total installed capacity: 4850kW

Postcode statistics

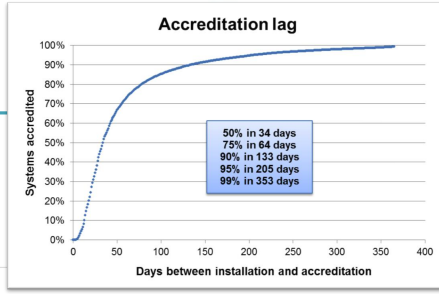
PV installations and capacity data from CER

Dwellings from ABS

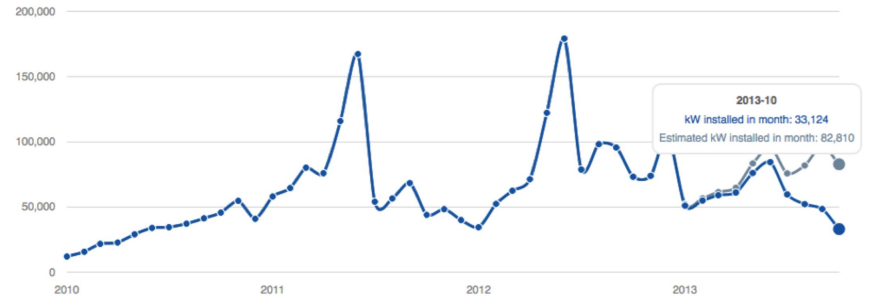
Annual energy based on REC multiplier regions

Market Statistics

- Total installations, installed capacity, and estimated annual generation
- Graphs of per month and cumulative installations
- Estimation to account for lag between installation and CER accreditation



Australian PV installations since January 2010: kW installed per calendar month

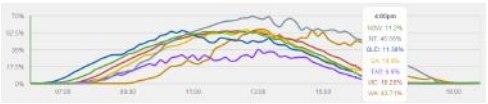


Monthly, per-postcode aggregated PV installation data is updated quarterly and available for download from the Clean Energy Regulator.

Live PV performance map

Real-time performance data

- PV system output data
- Electricity market demand data

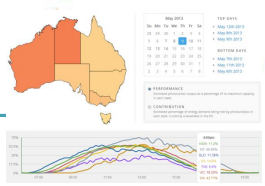


Live PV performance and contribution to load

- PV data at 10 min resolution
- National Electricity Market (NEM) data for NSW, QLD, SA, TAS, VIC. 5 min resolution
- SWIS (IMO) data for WA (90% of the Western Australian power market)
- Demand is not recorded for ACT, so is included in the NSW 'performance' %
- Currently aggregated by state

Performance = PV output / Installed capacity (%)
Contribution to load = Scaled PV output / (demand + Scaled PV output)

Live PV performance



PVOutput

- Live map current uses data from PVOutput.org
  - Data uploaded by individuals and businesses
  - 1300 to1400 live systems
  - 10 minute intervals
  - Aggregation on state level
  - Easily accessible
  - Small sample size

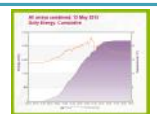
State / Territory	No. of CER database systems	No. of live PVOutput systems	%
NSW	222200	160	**0.07%**
Vic	173684	220	**0.13%**
Qld	296311	560	**0.19%**
Tas	12532	42	**0.34%**
SA	136739	145	**0.11%**
ACT	11784	110	**0.93%**
WA	131303	90	**0.07%**
NT	1975	5	**0.25%**

SMA

- To be replaced with SMA data
  - Approx 300,000 SMA inverters in Australia, majority web-enabled
  - Sunny Portal (publicly available) has 115,342 kW
  - Postcode level data to be aggregated on LGA or postcode groups e.g. 203X or 20XX level

Individual System Data

- Individual data for in-depth analysis



- Current linked live sites:
  - UQ
  - DKA Solar Centre

Solar Centre DESERT KNOWLEDGE AUSTRALIA

- Working to compile dataset of representative systems
  - To include basic information such as system size, tilt, orientation, module technology
  - Working to access NSSP schools data via SMA
  - To be paired with weather data
  - To be mapped by climate zone

SMA

Network Areas

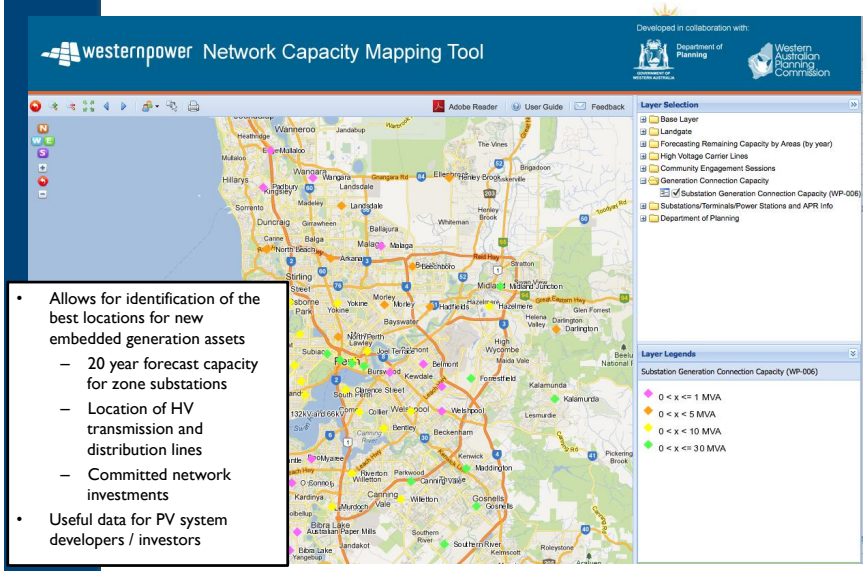
Planned: Mapping network areas to assist PV customers finding relevant information about connecting to the network

- DNSP guidelines for small PV customers
- Processes for larger PV customers
- Summary of relevant policies

Possible: Integration of electricity network data

- Rule changes under consideration by AEC may make network capacity and load forecasts available
- PV systems could potentially be mapped to network via NMI

AER 2012



- Allows for identification of the best locations for new embedded generation assets
  - 20 year forecast capacity for zone substations
  - Location of HV transmission and distribution lines
  - Committed network investments
- Useful data for PV system developers / investors

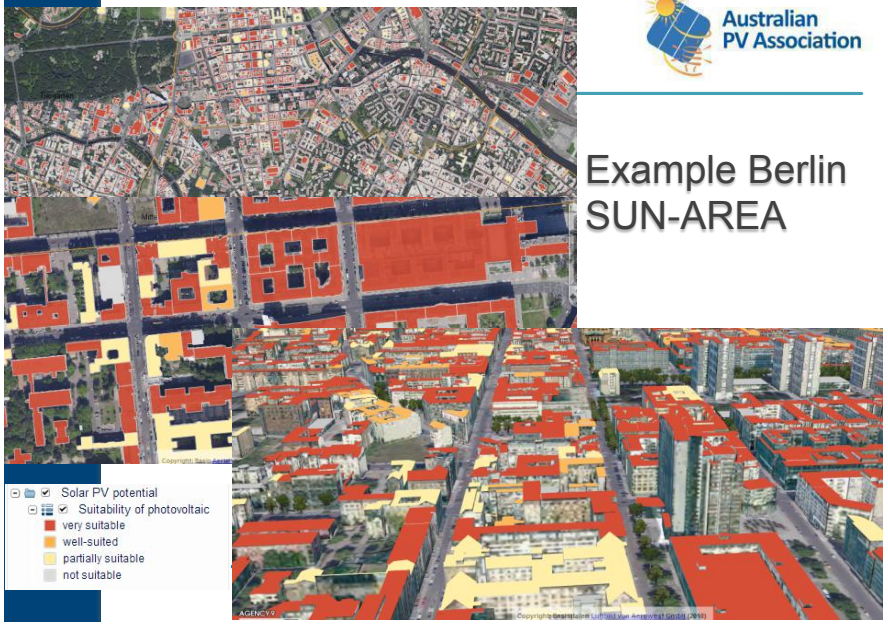
Review of 3D Solar Maps

Australian PV Association

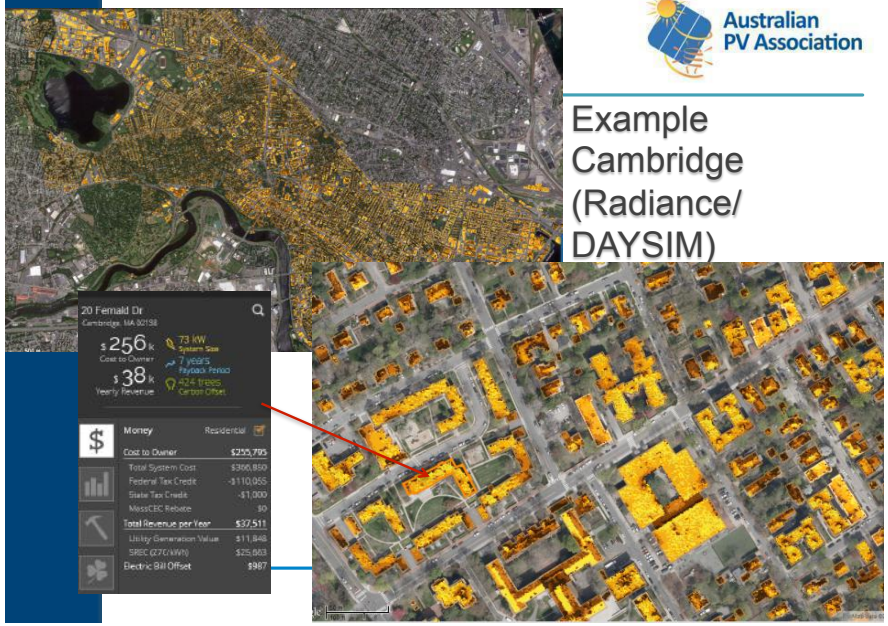
- North America
  - Esri Solar Analyst Method
    - Anaheim[1], Boston[2], LA County[3], NYC[4], Salt Lake City[5]
  - RADIANCE / DAYSIM Method
    - Cambridge[6], Washington (in development)
  - Flat Roof Constant Method
    - Berkeley[7], San Francisco[8]
  - Unknown Method
    - Denver[9], Madison[10], San Diego[11]
- Europe – SUN-AREA tool[12]
  - Bristol[13]
  - Germany
    - Berlin[14], Cities of Osnabrueck, Gelsenkirchen and Braunschweig

Australian PV Association

Example Berlin SUN-AREA



Example Cambridge (Radiance/ DAYSIM)



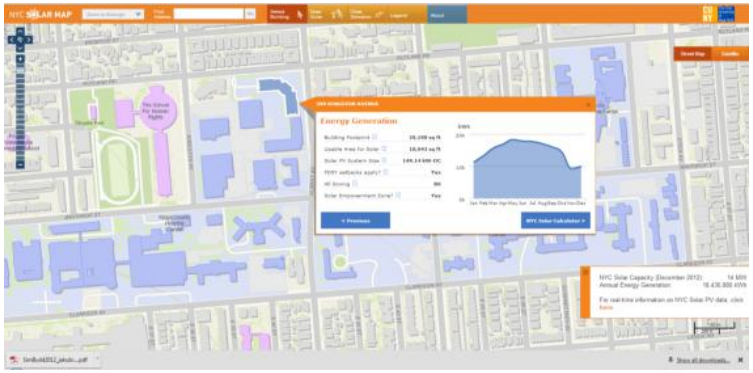
Typical Features of Existing Maps

- Roof Area – Total and/or area determined to be suitable for PV
- Slope and orientation of roof or roof surfaces
- Annual Insolation Wh/m^2
- Annual and monthly electrical production from a PV System calculated from either:
  - Total or suitable roof area
  - User specified polygon drawn area
  - User specified dc PV system size
- Carbon savings
- System costs
- System payback period
- Local rebates and incentive programs

Review of 3D Solar Maps

- Existing maps vary considerably in their methods to estimate the following parameters:
  - Insolation on building surfaces (intensity of solar energy over a defined period of time and area in kWh/m^2) and how shading is incorporated into the estimate
  - Surface area suitable for PV deployment
  - DC PV system size and the associated de-rating factor to convert to AC power
  - Annual electricity generated
  - System costs, annual savings and other financial indicators
- We are conducting a rigorous review aimed at peer-reviewed publication

NYC Solar Map



CUNY Method

Australian PV Association

LiDAR Data
Resolution: 8-20 points/m²

Digital Surface Model (DSM) generated at 0.5ft and 1ft resolutions

ESRI Solar Analyst (1m resolution - trade off between resolution and processing speed)

Shading Factor Calculation
Ratio of modelled solar radiation to TMY3 reference solar radiation

SAM
- Monthly outputs of a 1kW system
- Default derating parameters
- Output calculated for every combination of tilt angle and orientation
- Tilt angle in 5° increments between 0° and 90°
- Orientation in 22.5° increments between East and West

Post GIS Database
- Monthly Insolation
- Monthly Shading Factors
- Useable roof area
- Monthly PVWatt output

DC System Size Calculation
Useable roof area or user drawn polygon multiplied by system size factor
If tilt < 10° - 8 Wdc/ft²
If tilt ≥ 10° - 11 Wdc/ft²
If user defined polygon – 9.5 Wdc/ft²

Useable Roof Area Calculation
1ft (0.3m resolution) - defined useable if 10m² of contiguous area with minimum of 1030 kWh.pa/m²

System size × PVWatt Output × Shading Factor = Final Output

Australian Map Approach

Australian PV Association

- Based on CUNY (Esri Solar Analyst -> NREL SAM) methodology
  - Applying lessons learned & within limitations of available data
  - Analysis conducted with Esri ArcGIS Solar Analyst presented on a 2D map

3D Building Model or Digital Surface Model (DSM) → shading → System Advisor Model
- Climate data input
- System parameters
- Geometry – shading, surface area

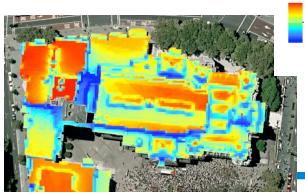
→ User output
- Simple results
- Parameter input based

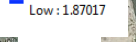
Graphic User Interface – visualisation & reporting

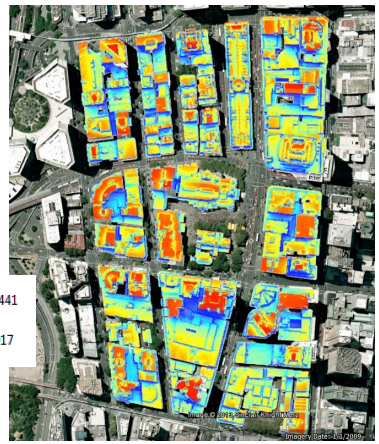
3D Map – Example 1

Australian PV Association

- Example 1 – Section of Sydney CBD built using AAM 3D building model.
- Map Layers
  - Visual Irradiance layer: annual daily average irradiance (kWh/m² per day)





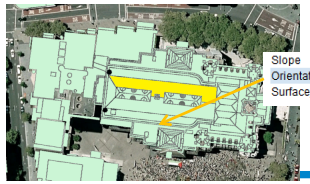


Scale units: (kWh/m² per day)

3D Map – Example 1

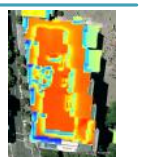
Australian PV Association

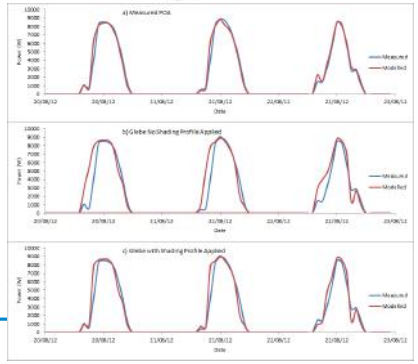
- Example 1 – Section of Sydney CBD built using AAM 3D building model.
- Map Layers
  - Polygon Building surface layer with following information:
    - Slope, Orientation, Surface Area
    - Useable PV surface area (calculated)
    - Annual and Monthly PV output (from NREL SAM, using local TMY weather and ArcGIS skyline as inputs)



SAM/ArcGIS vs Measured PV

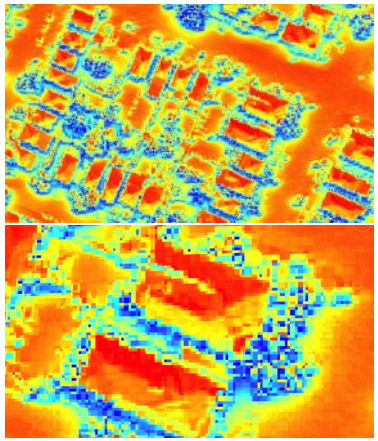
- 12.6 kWp PV System in Sydney CBD.
- Performance modelled in SAM using:
  - Measured plane of array (POA) irradiance. Irradiance sensor suffers from the same shading as the PV array
  - Irradiance measured at a nearby location in Glebe modelled with and without the shading profile generated by ArcGIS
- ArcGIS and a 3D building model of the CBD from AAM used to generate the equidistance shading profile





3D Map – Example 2

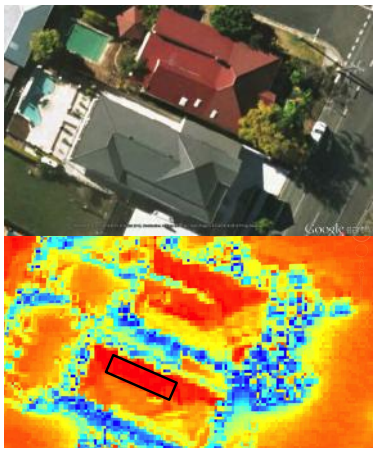
- Example 2 – Brisbane Residential
- Map Layers
  - Visual Irradiance layer
  - Annual daily average of irradiance in kWh/m² per day
- Layer developed using ArcGIS and Geoscience Brisbane City Council LAS dataset
- This method can be applied to any region with Lidar data



Scale units: (kWh/m² per day)

3D Map – Example 2

- Example 2 – Section of Brisbane Residential
- Expected Map Functions
  - User drawn PV surface area
  - Automatic calculation:
    - PV system size
    - Average Irradiance
    - Average Tilt
    - Average Orientation
    - PV output
- Existing maps using this method:
  - http://solarsimplified.org/solar-resources/solar-map
  - http://solarmap.cityofmadison.com/Madisun/



Scale units: (kWh/m² per day)

Future Work

- Network areas
- Improved spatial resolution with live data
- Individual system data mapped to climate zones
- Implement 3D Map for Capital Cities
  - Currently engaging with key stakeholders, particularly planners
- Assess opportunities for mapping PV output forecasting
- Would like to include network constraint and demand data and map PV capacity to networks

References

[1] City of Anaheim Solar Map, http://anaheim.solarmap.org/

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[4] New York City Solar Map, http://nycsolarmap.com

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[7] Berkely Solar Map, http://berkeley.solarmap.org

[8] San Francisco Solar Map, http://sfenergymap.org

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[12] Sun Area tool, http://www.sun-area.net/index.php?id=103

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