# Methodology for Assessment of Australian Rooftop Solar Potential Aggregated by POA and Planning Zone

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The method for estimation of rooftop PV potential used an adaptation of the method developed for the APVI Solar Potential Tool (SunSPoT), as described below and in [1, 2].

## SunSPoT Tool

The APVI Solar Potential Tool is an online tool to allow electricity consumers, solar businesses, planners and policymakers to estimate the potential for electricity generation from PV on building roofs. The tool accounts for solar radiation and weather at the site; PV system area, tilt, orientation; and shading from nearby buildings and vegetation.

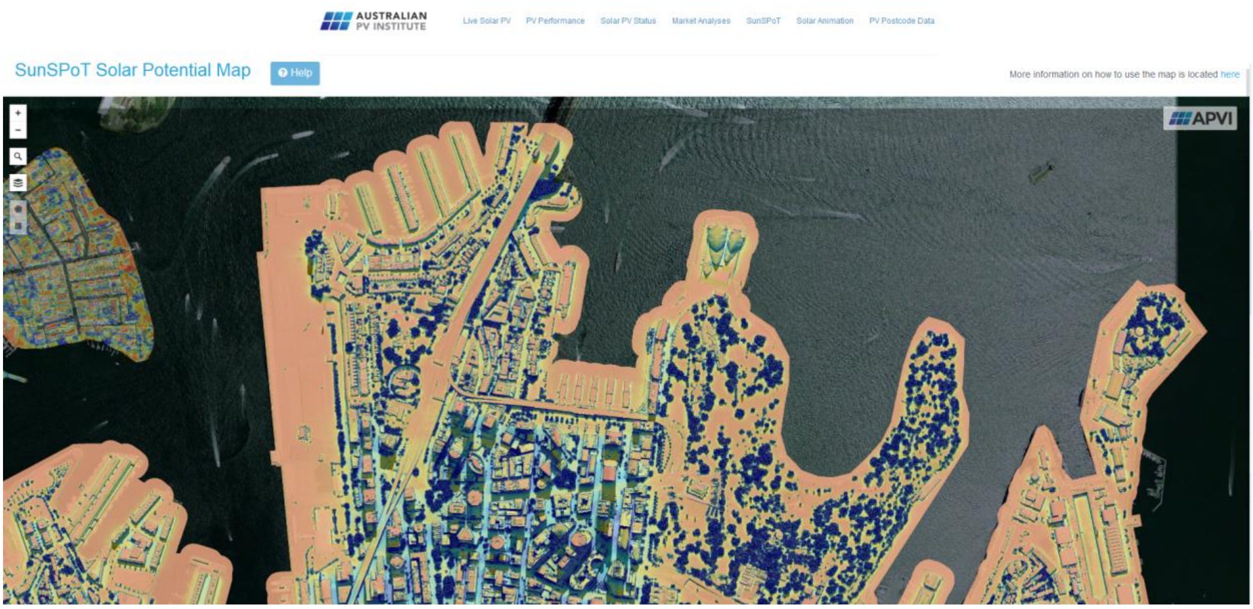


**Figure 1: Screenshot from the SunSPoT Tool**

Users can select any building within the mapped area, outline a specific roof area and automatically generate an estimate of potential annual electricity generation, financial savings and emissions offset from installing solar PV. The data and methodology behind SunSPoT is detailed in [1, 2].

The data behind the APVI SPT were generated as follows:

1. Three types of digital surfaces models (DSMs)[1] (3D building models, XYZ vegetation points and 1m ESRI Grids), supplied by geospatial company AAM, were used to model the buildings and vegetation in the areas covered by the map.
2. These DSMs were used as input to ESRI's ArcGIS tool to evaluate surface tilt, orientation and the annual and monthly levels of solar insolation falling on each 1m$^2$ unit of surface.

[1] Digital surface models provide information about the earth's surface and the height of objects. 3D building models and vegetation surface models have been used in this work. The ESRI Grid is a GIS raster file format developed by ESRI, used to define geographic grid space.

3. Insolation values output by the ArcGIS model were calibrated[2] to Typical Meteorological Year (TMY) weather files for each of the capital cities and against estimates of insolation at every 1 degree tilt and orientation from NREL's System Advisor Model (SAM).

## Solar Potential of Major Australian Cities

The SunSPoT methodology was developed further to assess the solar potential of building rooftops in five Australian cities.

The areas mapped are City of Sydney LGA, City of Melbourne LGA, Adelaide CBD, Canberra CBD, Brisbane CBD. The general steps in the methodology are illustrated in Figure 2.

For this analysis, two input data sources and two rooftop suitability methods were assessed for each city and the results combined. The data sources are:

1. The three sources of input DSMs data from AAM; and
2. LiDAR data sourced from (a) City Councils for Melbourne and Adelaide; (b) NSW LPI for Sydney (now also available on ELVIS); (c) ELVIS[3], the Elevation – Foundation Spatial Data portal for Canberra; and (d) the National Elevation Data Framework (NEDF) for Brisbane (now also available on ELVIS)

And the methods used to select suitable roof planes were:

1. Selection of areas receiving 80% of the expected annual insolation incident on an unshaded, horizontal surface and
2. NREL's PV rooftop suitability method based on hillshade and surface orientation.

Both methods also required a minimum contiguous surface area of 10m$^2$ for a roof plane to be determined suitable, to ensure a minimum 1.5kW PV system for any plane. More details of this methodology can be found in [1] and [2] and in the APVI Solar Potential Reports [3-7]. For each suitable roof plane, the shading factor (SF) was calculated as

$$SF = Annual\ Insolation/Insolation\ on\ unshaded\ surface\ of\ same\ tilt\ and\ orientation$$

## Analysis of Solar Potential by Planning Zone

The solar potential maps for each city were overlaid with LGA and State planning zones. These zones were mapped to the generic zones used by Omnilink to categorise buildings across Australia. This mapping is shown in Table 1.

For each city, dataset and method, the flat and pitched usable roof surfaces were aggregated within each Omnilink planning zone and the % usable area and median shading factor were calculated. Mean values for these figures were then calculated for the two methods and two datasets, and across the five mapped cities. Omnilink Zone 0 (Unknown) and Zone 8 (Rural / Primary Production) which were not found in the mapped areas were assigned the same values as Zone 5 (Mixed).

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[2] Calibration was required in order to obtain good agreement NREL's well-tested SAM model and measured PV data.

[3] ELVIS: Elevation Foundation Spatial Data from Geoscience Australia, available at http://elevation.fsdf.org.au/

**Table 1: Mapping Omnilink zones to state planning zones**

| OZ | Omnilink Zone Name | Melbourne | Sydney | Brisbane | Adelaide | Canberra |
|---|---|---|---|---|---|---|
| **0** | Unknown | | | | | |
| **1** | Commercial / Business | 706; 711; 712; 6871; 6891 | B5; B6; B7; B3 | PC; MC | I2; MS(A); MS(H) | 6 |
| **2** | Community Use | 6926; 7161; 7162; 7165; 7166 | | NC; CF | Rb; I3; CiL; I1 | 9 |
| **3** | Conservation / National Park | | DM | | AH(C) | |
| **4** | Industrial / Utilities | 1644; 1646; 7160 | IN2; IN1 | | | 19 |
| **5** | Mixed Use | 209; 6872; 6890; 6892; 6894; 6895; 6896; 6920; 6921; 6922; 6923; 6924; 6925 | B4; B1; B2; B8 | DC; MU; PDA; SBCA | CC | 12 |
| **6** | Recreational / Open Space | 6050 | RE1; RE2 | OS; SR | PL; CF | 8; 15; 21 |
| **7** | Residential | 206; 400; 401; 402; 403; 420; 421; 440; 441; 6873; 6893 | R4; R2; R3; R1 | HDR; LMR; CR; MDR; EC | | 1; 2; 13; 20 |
| **8** | Rural / Primary Production | | | | | |
| **9** | Special Use | 6851; 6852; 6853; 7070 | SP1 | SC; SP | | 3 |
| **10** | Transport / Infrastructure | 820; 7163; 8020 | SP2 | | | 5 |
| **11** | Water | | | | | |

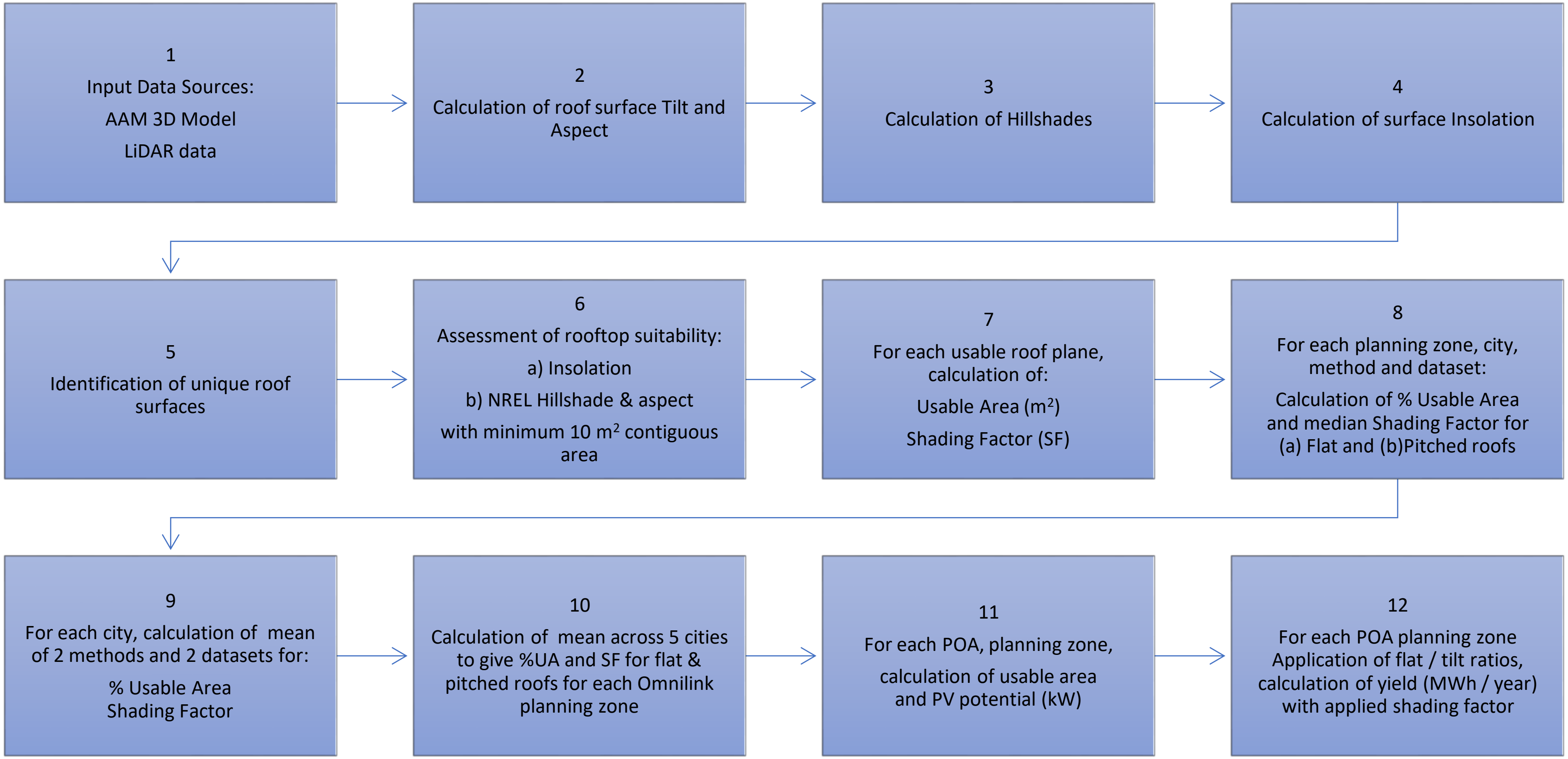


**Figure 2 - Outline of methodology**

## Application to all Australian Postcodes

For application to all Australian postcodes, PSMA's Geoscape data was used to extract data on number of buildings and roof area, by local government planning zone. Note that the zone allocations are aligned with state and city planning zones, rather than building types, so that not all Zone 7 buildings are residential, while residential buildings also exist in other zones. The dataset includes total roof area (assumed to be horizontal roof area) for each planning zone in each POA. These areas were multiplied by the % usable area for each zone to determine the amount of usable roof space in each zone in each POA. Note, however, that as individual building areas were not available the minimum 10m$^2$ contiguous roof area criteria could not be applied. The tilt and orientation of the usable area was allocated as follows:

- Zone 7 (Residential):
  - 10% is flat (<10°)
  - 90% is pitched at 25°, evenly distributed between -270° and 90°
- All other zones:
  - 90% is flat (<10°)
  - 10% is pitched at 25°, evenly distributed between -270° and 90°

A PV intensity of 156.25W/m$^2$ (based on generic 250W modules sized 1.6m x 1.0m) was applied to the pitched and flat usable areas to determine PV capacity for each zone and POA. NREL's System Advisor Model (SAM)[8] was used to calculate the annual yield of the potential PV capacity for each tilt and orientation at each POA using a reference meteorological year (RMY) weather file created from weather data collected at the nearest of 196 BOM weather stations. The unshaded SAM output was multiplied by the shading factor for the zone and POA to provide an estimate of the potential annual yield.

## Note on the Results

The results give an estimate for the total potential rooftop PV capacity of Australian buildings of 179 GW with an expected annual output of 245 TWh. Of this, 96 GW (with an output of 130 TWh/year) is on buildings in zone 7 (residential).

The figure for residential zones is significantly higher than the estimate of rooftop potential on residential buildings of 43-61 GW (with a midpoint of 52 GW) given by a previous study [9], which combined the average per-dwelling capacity of residential buildings in the City of Melbourne with Australian Bureau of Statistics (ABS) data for the number of dwellings in each state.

The study presented here may *over*estimate the residential potential for a number of reasons:

- The calculation of total roof area for zone 7 includes the roofs of commercial properties within the residential zone as well as residential buildings.
- The number of residential buildings in each POA and state derived from the Geoscape data is significantly higher than the dwelling numbers derived from the ABS census data. This may be explained by the inclusion of outbuildings (sheds, garages, etc.) sited on residential property in the Geoscape data as well as the primary residence. It is reasonable to include this in the residential potential.
- There is no published validation of the roof area derived from the Geoscape data, and this may be an overestimate.

Conversely, the previous study may *under*estimate the residential potential for the following reasons:

- The per-dwelling potential PV capacity is based on residential buildings in the City of Melbourne LGA, where average roof sizes are likely to be lower than in suburban and rural areas.
- The ABS dwelling figures may not include all empty dwellings.

It is therefore likely that the actual residential solar potential lies between the 52 GW of the previous study and 96 GW derived from the analysis above.

## References


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