

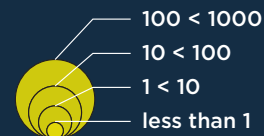
APPENDIX K MAP OF SOLAR RESOURCES

Renewable energy resources of New South Wales

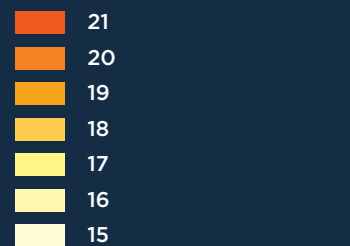
Solar

REFERENCE

Solar power generator capacity (megawatts)



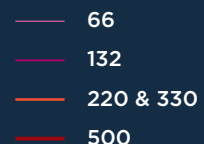
Average daily solar exposure (megajoules per square metre)



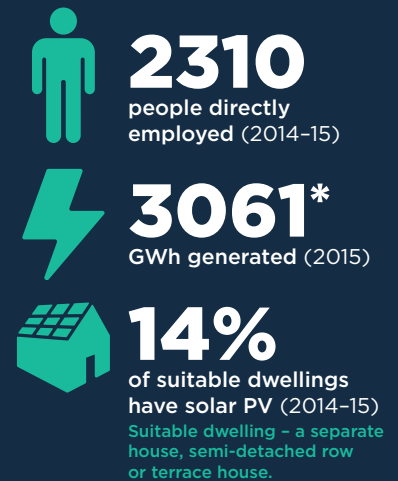
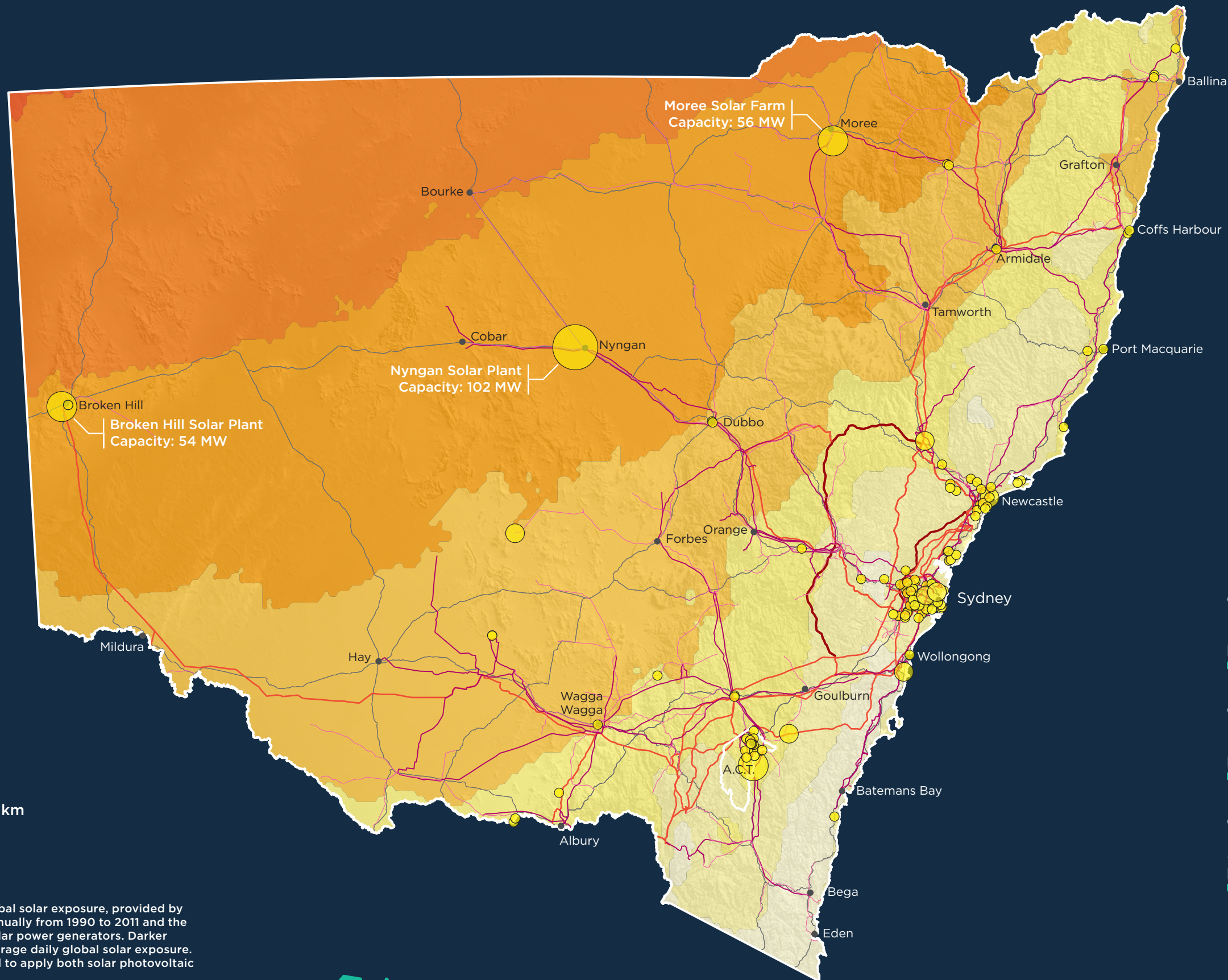
Topographic

- City, town
- Highway
- State border

Key transmission lines (kilovolts)



0 200 km



Broken Hill Solar Plant capacity to power

21 k homes **670+ k** PV panels

Moree Solar Farm capacity to power

24+ k homes **222.8 k** PV panels

Nyngan Solar Plant capacity to power

34+ k homes **1.3+ m** PV panels

This map shows the average daily global solar exposure, provided by Australian Bureau of Meteorology, annually from 1990 to 2011 and the location and capacity of operating solar power generators. Darker colours indicate areas with higher average daily global solar exposure. These are areas with greater potential to apply both solar photovoltaic (PV) and solar thermal technologies.

Global solar exposure is the total amount of solar energy reaching the Earth's surface. It depends on many factors, such as the position of the sun and the extent of cloud cover, and consists of direct and diffuse solar energies. Direct solar energy comes directly from the Sun's beam and is used in solar thermal technologies. Diffuse solar energy comes from the part of the Sun's beam which is weakened and redirected, or scattered, as it travels through the Earth's atmosphere. Solar PV and solar hot water technologies use both direct and diffuse solar energy, whereas concentrating solar thermal mostly uses direct solar energy.



Department of Industry
Resources & Energy

Geological Survey of New South Wales 

Solar energy

What is solar energy?

Solar energy is generated by using two properties of sunlight – particle and wave.

The first property is the energy inside the sunlight – the particle or photon. Sunlight is directly converted into electricity using solar photovoltaic (PV) cells. A number of cells make up a panel. These panels can be as small as wristwatches and handheld devices or as big as large-scale solar power plants.

The second property is the wave-like nature of sunlight and is used to create thermal energy (heat). Solar thermal technologies are used when sunlight is converted into heat energy. Thermal energy can be immediately converted into electricity by focussing sunlight to a single point using concentrated solar thermal power (CSP) systems, or stored in water, air or molten salts then converted to electricity as required.

What can solar energy be used for?

Solar energy is mainly used to generate electricity. It has the potential to be an important source of off-grid electricity in remote areas, and is increasingly used in homes and businesses. Solar thermal energy can be used for heating and cooling. Hot gases or fluids can be used to heat buildings or hot water systems. Heat energy can be used to drive a refrigeration cycle.

Are there solar resources in NSW?

NSW has some of the best solar resources in the world. The drier regions have high average global solar exposure providing an ideal environment for large-scale solar systems.

How is solar energy used in NSW?

Solar PV use in NSW has increased over six-fold since 2010. In 2015, 3.1% of the total electricity generated in NSW (including ACT) was from solar PV systems (residential and commercial) and 1.4% from solar water heaters and heat pumps. According to Clean Energy Regulator, over 34 000 solar PV installations and almost 6 800 solar hot water heaters were installed in 2015.

The three largest solar PV plants in Australia are in NSW. The largest plant, in Nyngan (102 MW), was opened in 2016 and has the capacity to deliver electricity to power over 34 000 homes. The second and third largest plants are in Moree and Broken Hill. All three solar generators supply their electricity to the national electricity grid to help meet the state's energy needs.

While solar hot water systems are a common use of solar thermal energy, electricity production from concentrated solar thermal energy is still in a preliminary stage in Australia. The Jemalong Solar Thermal Station (6 MW), which includes molten salt thermal storage, is under construction near Forbes, and the CSIRO's solar thermal research hub, built in Newcastle in 2010, is Australia's largest solar thermal research facility.

What is the future of solar energy in NSW?

The central, northern and western regions of NSW have low population densities, abundant open space and high average global solar exposure, which are ideal for expanding the state's large-scale solar electricity industry.

The Australian Energy Market Operator (AEMO) projected that the total installed capacity of PV systems in NSW will be 3300 MW in the residential sector (less than 10 kW capacity) and 2123 MW in the commercial sector (greater than 10 kW capacity) by 2035. Solar PV systems have become significantly cheaper in recent years, resulting in an increase in the popularity of small-scale (home rooftop), medium-scale (rural, industrial and commercial) and large-scale solar projects. Concentrated solar thermal systems can be used in NSW as they can be installed with energy storage systems.

The development of battery storage technologies is expected to play an important role in further growth in the solar energy industry. AEMO has predicted that NSW will have the highest integration of rooftop solar systems and battery storage technology in the next 20 years compared to other Australian states.

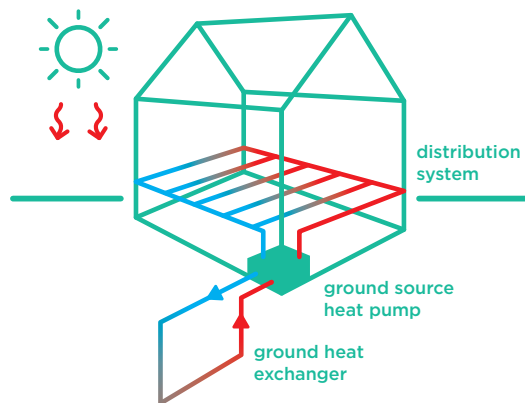
Where solar meets geothermal

Approximately 48% of solar radiation that enters the Earth's atmosphere is absorbed by the Earth's surface. As a result, the ground and bodies of water store heat as thermal energy.

This renewable thermal energy is most commonly used for heating and cooling buildings or heating swimming pools. It can also be used to heat hot water systems. Heating is achieved by extracting thermal energy from the ground or water through a ground heat exchanger. Alternatively, cooling is achieved by extracting heat from the air inside the building and injecting it to a hot water system, a pool, or returning it to the ground heat exchanger. After the heat is removed, the air is used for cooling. This process is controlled through a ground source heat pump.

Heat exchange systems are becoming more common and have been installed at the NSW National Parks and Wildlife Service office in Jindabyne, Wagga Wagga City Council building, Macquarie University buildings and the Sustainable Buildings Research Centre in Wollongong.

Geoexchange system



Glossary

capacity

the amount of energy generated for any length of time. This map indicates capacity as a megawatt (MW).

energy

the ability to do 'work' or to 'make something happen'. It can exist in different forms, such as thermal (heat), kinetic, electrical, chemical and potential (stored). Energy is measured in joules (J).

direct employment

fulltime equivalent of employment hours (FTE)

global solar exposure

the total amount of solar energy reaching the Earth's surface

kilowatt (kW)

one kW = one thousand (1000) watts

megawatt (MW)

one MW = one million (1 000 000) watts

transmission

the movement of electricity along transmission lines once it leaves the power station

watt

a measure of the flow rate of electricity, equivalent to one joule of energy per second. One joule is the internationally recognised unit for measuring energy of all types.

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Credits

Bibliographic reference

Wade S.L., Barry C.M. & Nelson M.D. (compilers) 2016. *Renewable energy map of New South Wales: solar resource fact sheet*. Geological Survey of New South Wales, Maitland.

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Data sources

Note: All numbers have been rounded to whole numbers or one decimal point where possible.

Generator capacity data Compiled by NSW Division of Resources and Energy from Australian Energy Market Operator (AEMO) *Current Registration and Exemption lists* where available and various company data sources.

Note: The resource maps show call outs for large renewable energy generators with greater than 30 MW capacity. These are maximum capacity values as listed by the Australian Energy Market Operator (AEMO) registration list 11 April 2016.

Solar Derived from Bureau of Meteorology *Mean monthly, season and annual solar exposure data*.



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Infographics and figure data sources

Broken Hill and Nyngan solar plants <https://www.agl.com.au/about-agl/how-we-source-energy/renewable-energy>

Economic Capacity and generation data compiled by NSW Division of Resources and Energy includes data for Australian Capital Territory (ACT). This is shown using an asterisk (*).

Note: The capacity data represents maximum capacity where available.

Employment Data derived from Australian Bureau of Statistics *4631.0 – Employment in Renewable Energy Activities, Australia, 2014–15*.

Moree Solar Farm <http://www.moreesolarfarm.com.au/>

Solar PV <http://www.cleanenergyregulator.gov.au>

Project data are stored in the DiGS catalogue search geoscience.nsw.gov.au

Topographic base

© Land and Property Information, Panorama Avenue, Bathurst NSW 2795. www.lpi.nsw.gov.au

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