ENERGY TRANSFORMED FLAGSHIP
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Solar intermittency: Australia's clean energy challenge

Characterising the effect of high penetration solar intermittency on Australian electricity networks

Summary

Intermittency: is it really an issue?

Australia has abundant solar energy resources and many natural advantages when it comes to using renewable energy.

However, integrating renewable energy into the national grid presents some problems. The sun doesn't always shine, and the wind doesn't always blow to provide a constant source of renewable energy.

Because of this natural variability, using renewable energy places demands on the delicate balancing act of keeping the electricity grid operating.

Power grids have an intricate system of devices for managing surges and sudden troughs in supply and demand. Variable power supplies, for example from renewable energy sources, add another level of complexity.

The main problem isn't overcast days – it's possible to plan for them and adjust the power mix appropriately. Passing clouds are more difficult to manage.

Photovoltaic generation can drop by **60%** within seconds when solar panels are obscured by clouds. This effect is called **intermittency**.

What's the story?

current research

Until now there has been very little publicly available research or detailed data on how the variable nature of sunshine affects electricity networks, and research done in other countries is not entirely relevant to Australian conditions. Partly because stakeholders are unsure about potential network problems solar energy generation might cause, and what they will need to do to remedy them, the investment in solar has been cautious and conservative.

CSIRO has looked into the effects of solar intermittency on Australian electricity networks.

Combining data from studies in other countries and long term data from several Australian solar installations, our comprehensive study examines the effects of variations in sunlight on the output of solar installations and the wider power network.

What does CSIRO's research TELL US?

The study produced a number of important findings:

1. Intermittency could stop the adoption of renewable generation. In some Australian network areas, additional renewable generation is severely limited. This is because there is little information about what network problems intermittent renewable generation might cause or how to deal with them.

2. Existing information has conflicting conclusions, little quality data, and contains a lot of anecdotal evidence. Some studies predict significant cost savings from displacing conventional generation fuels with renewable energy sources. Others conclude upgrading conventional generation equipment required due to increased penetration of intermittent renewable generation will actually increase system costs.

3. In studies analysing wind and solar variability, some authors find that second-by-second wind is less variable than solar, while others show wind to be more variable.

4. The existing electricity system contains significant intermittency, managed through generator dispatch and ancillary services. Increased solar penetration levels may call for further measures. There is no consensus about when these will be needed, what they might be and how they can be put in place. These questions must be resolved.

5. The effect of solar intermittency is not uniform. At present, effects need to be considered in context on a case-by-case basis. Intermittency in different systems has different characteristics and effects on networks.

6. A more generalised approach to network assessment would alleviate the need for detailed modelling of individual systems. If solar generation is to be integrated into utility power systems it must not compromise power quality, stability and reliability. At present the amount that can be integrated safely varies widely, and depends on assumptions about how the system should operate, what measures are acceptable and what the wider system will look like in the future. Power quality standards need to be evaluated, to see if they are appropriate and adequate, and can be met cost-effectively.

7. Solar intermittency can be managed. Effective mechanisms include:
   - using short-term energy storage systems
   - strengthening the electricity network so effects are not as localised
   - controlling loads in response to network requirements
   - deploying additional ancillary services
   - curtailing the output of renewable generators.

   The choice of measures here will influence the economics of solar generation. Further investigation is needed, via modelling, experimental analysis and real-world Australian trials.

8. Accurate forecasting is vital for the successful integration of large amounts of solar generation. Intermittency can be planned for and managed most cost-effectively with forecasts over years, months/days and minutes/seconds. This is needed for network planning, and grid and market operation. To support this work, there is an immediate need for high-resolution solar data from both large-scale solar systems and large numbers of small-scale solar systems. Research and demonstration work is required in Australia.

9. To assess future high solar penetration scenarios, studies done in other countries must be performed in Australian conditions, to find out if extra ancillary services are needed and if existing mechanisms can cope with extra intermittency from intermittent renewable generation. This research should cover large-scale and small-scale solar systems.

Looking to the future

Future areas of research should include:

- **Developing evaluation tools** for assessing the effects of more solar power in the distribution network and developing appropriate coping strategies.
- **Reconciling conflicting information** in scientific literature on the impacts of intermittent renewable generation.
- **Undertaking a large-scale practical assessment** of the characteristics of generation, load and networks in Australia to establish whether international research results are applicable and the extent to which Australian networks might require special consideration.
- **Collection of high resolution temporal and spatial solar data** to support development of accurate solar forecasting tools, for long-term planning and short-term network management, and assessing different large and small scale solar architectures.
- **Making detailed case studies and investigations publicly available** that review specific intermittency issues and situations (both on actual networks and via modelling and experimental analysis).
- **Maintaining industry engagement** to ensure research is relevant and appropriate to Australian industry and context, its existing systems and regulatory environment, where a shared vision with greater renewable generation is fostered.

Our partners:

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FOR FURTHER INFORMATION

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