Understanding the cost of Australia's energy transition

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Final report

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Credit: CSIRO

Electricity generation accounts for about a third of Australia's greenhouse gas emissions.

It's commonly accepted that we need to transition towards sustainable, low-carbon, energy sources to address the urgent challenge of climate change. It is considered one of the single most important levers for Australia to achieve net zero emissions by 2050. Developing sustainable electricity generation technologies is key.

So, it follows that understanding the costs of different new-build electricity generation technologies—whether for renewables, nuclear or gas—is central to help guide planning and decisions to support Australia's energy transition and the management of our energy system.

The GenCost report is one of several economic analysis documents that contribute to this planning. It's a specific, policy agnostic and—for most readers—a pretty dry annual window on costs associated with Australia's future energy planning.

Its authors and contributors work to match the information it provides with the needs of industry and other stakeholders. As a result, it has become an anticipated and important information source—albeit one that can be used to support different, and often polarizing, assertions about our energy future.

GenCost is a complex report and our previous aticle covered its general themes. This year, public interest has also focused on understanding the

report's use of industry standard modeling on costs, which we will look at here.

What is the GenCost report?

GenCost is a collaboration between CSIRO, Australia's national science agency, and the Australian Energy Market Operator (AEMO) to update the costs of electricity generation, energy storage and hydrogen production. GenCost reports are developed over an annual cycle and includes opportunities for government, industry, the private sector, and economic specialists to ask questions and provide input. Each year more than 100 different organizations do.

Gencost was first published in 2018 to create a common data set that could be used across the energy sector to enable standardized electricity system modeling. GenCost responds to the question: what will it cost to build different electricity generation technologies now and in the future?

New cost projections are released to government and industry via a draft consultation report in December each year. The capital costs of technologies are updated each year with input from an engineering firm. The final report, released mid-year, reflects the feedback and input received.

As well as referencing a range of relevant national and international energy reports, stakeholder consultation and input is a critical part of the process to analyze and update GenCost's data and projections.

How GenCost calculates costs

GenCost responds to the question: what will it cost to build different electricity generation technologies now and in the future? To do this,

GenCost provides two sets of data for current and projected costs:

- Capital cost data
- Levelized cost of electricity (LCOE)

GenCost's current and projected capital costs for electricity generation and storage technology are a necessary and highly impactful input into electricity market modeling studies, such as those conducted by AEMO. Governments, regulators, and private industry use capital cost data for a range of planning and forecasting purposes, such as evaluating new investments and consideration of alternative policies.

LCOE, on the other hand, is a simple and widely used metric that provides a quick way of comparing the competitiveness of alternative sources of electricity generation.

What can levelized cost of electricity (LCOE) tell us?

LCOE helps us understand how much it costs, on average, to generate electricity from a range of technologies that could be built now or at a future time.

It's like calculating the average cost of making any product from a combination of capital, labor, and material inputs. If you're running a business and considering a new production line, you would need to add up all the costs of producing your product, then divide by how much of that product you can make.

LCOE does the same for electricity, helping us compare different ways of making it, like solar, wind, coal or gas. It shows us which method is cheaper for producing electricity.

On a technical level, LCOE tells us the average price of electricity an

investor would need to receive over the design life of their investment to recover both their capital and operating costs of building and running the technology. The technology with the lowest LCOE is the most competitive.

Because the LCOE is the price of electricity that new investors would need to break-even, LCOE data is also itself one indicator of future electricity prices required to ensure sufficient supply capacity is built to meet demand.

Are renewables the 'cheapest' form of energy?

Yes. The 2022/23 GenCost report found renewables have the lowest LCOE of any new-build electricity generation technology when we consider them as stand-alone technologies without any additional costs.

However, we know variable renewable energy (VRE), like wind and solar, generates electricity intermittently. It requires significant extra costs to firm and integrate their supply into our electricity system.

So, to make a fair comparison of the competitiveness of VRE with other technologies that do not need firming or integration, we include these extra VRE costs in our analysis. These costs vary depending on what percentage VRE represents of the electricity system.

For example, these extra VRE costs are low when VRE represents less than 50%. This is because irregular power generation can be smoothed out through the flexibility of the existing generators such as gas, coal, and hydro. Most new solar and wind farms at this level can also be placed on existing transmission routes.

However, extra VRE costs increase when VRE represents more than 50% of the electricity system. This is because we need to construct

purpose-built renewable firming technologies and new transmission infrastructure to access the significant additional renewable energy farms needed. Our Renewable Energy Storage Roadmap is a helpful reference about these technologies.

The importance of the percentage of VRE in determining its firming and integration costs also explains why GenCost currently only provides firming and integration costs for 2030. CSIRO has forecast that Australia's energy grid would reach 55% VRE share by then. So, GenCost chose 2030 as the date to explore the LCOE for investors facing the prospect of increasing Australia's VRE share from 55% to between 60% and 90% in 2030.

Even with this extra VRE cost in 2030, the answer to whether renewables are the cheapest form of energy is still yes. And it remains so when VRE is at 90% of the energy system.

What about sunk costs? Or the cumulative costs to reach 2030?

Because we are evaluating the cost of variable renewables from the perspective of an investor in 2030, the costs incurred before 2030 are not relevant to the decision an investor needs to make.

However, we recognize people would like to know how previous investments, which take place before 2030, contribute to the competitiveness of variable renewables. The GenCost project is committed to a continual cycle of seeking stakeholder feedback and making incremental improvements to the information included in the report. We will determine what additional information we can add to consider pre-2030 costs in the next version of GenCost.

What is the Integrated System Plan? How can it help understand costs and benefits to 2050?

AEMO's Integrated System Plan uses capital cost data to produce a whole-of-system plan for the least cost way to supply reliable electricity to homes and businesses while supporting Australia's net zero transition.

The Integrated System Plan uses capital and operating costs for generation, firming (batteries, hydro and gas) and transmission to determine the least cost pathway to meet an evolving consumer electricity load.

Consistent with our LCOE analysis, AEMO's modeling finds renewables to be the cheapest form of energy production when connected with transmission, firmed with storage and backed up by gas. It does this by comparing alternative generation technologies and the impact that they have on the scale of required supporting infrastructure (transmission and firming investments).

All resource mixes explored by AEMO's Integrated System Plan, developed over a two-year period with hundreds of stakeholders, are required to meet the reliability standard for the electricity system.

What about nuclear energy?

A review of the available evidence makes it clear that nuclear power does not currently provide an economically competitive solution in Australia. Here's more on the question of nuclear in Australia's energy sector.

From developing low-emissions technologies to supporting the transition to renewables and improving energy efficiency, our research is helping

tackle the challenge of decarbonization.

Provided by CSIRO