
# NATIONAL BULLETIN

Bulletin 4 | 2022

## Improving Network Performance

By Jeff Allen, National President of the Electric Energy Society of Australia | 20 April 2022

On the 7th of March 2022, Energy Networks Australia (ENA) issued a report that explores Australia's changing climate and how this is likely to affect future planning and investment by network businesses. The report, "Electricity Networks: A guide to climate change and its likely effects" makes for interesting reading.

My personal view is that I can see more frequent and extreme events compared to say 40 or 50 years ago. My observations are based on my experience gained from my role as System Control Engineer at Prospect Electricity (now part of Endeavor Energy's supply area) where I was responsible for the day-to-day control and operation of the electricity network in Western Sydney and beyond from 1972 to 1984. The Control Centre was based in Parramatta and my responsibilities included managing the call centre and the control room for the for the safe and reliable operation of the electricity network for our customers and the community.

We experienced strong winds, floods, bushfires, snow, and major lightning storms across our diverse network. These events impacted the network in various areas and with variable severity. Thus, the challenge was to understand the likely direction and severity of the weather event and to plan and respond appropriately to manage the continuity and restoration of electricity supply efficiently, effectively, and safely for the best overall outcomes.

As a result of my experience in System Control, I presented a paper at the Electricity Supply Engineers Association of NSW (the predecessor organisation to EESA) Conference in 1979. The paper was about "System Fault Statistics," and it described the (very basic) computer-based System Fault Recording and Reporting scheme developed within the System Operations Branch of the Prospect County Council in the mid 1970's. The following are extracts from the paper.


Jeff Allen, National President of the Electric Energy Society of Australia

"During 1978 there were a total of 1,404 system supply failures having an average duration of 89 minutes (weighted) and a total loss of 707 MVA hours. This time is for all possible

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restoration of supply by switching. When Branch/District repair times are added the average duration for supply failures (until complete restoration of supply) was 99 minutes (weighted) and the total loss is 780 MVA hours. These figures are further broken down as follows to assess system performance under normal weather conditions and extreme weather conditions.

"Extreme" weather is difficult to completely define but basically it would include faults occurring due to gale force winds and severe electrical storms, i.e., weather conditions that the system cannot reasonably be expected to cope with, without some fault operations,

1. Normal Weather Conditions - during 1978 there were a total of 979 failures having an average duration of 71 minutes (weighted). When Branch/District repair times are added the average duration for the supply failure is 79 minutes,
2. Extreme Weather Conditions - During 1978 the system was affected by 35 electrical storms, 8 windstorms, 1 gale and 1 major flood. There were 44 days when it is considered that the system was exposed to extreme weather conditions. There was a total of 425 failures having an average duration of 131 minutes (weighted). When Branch/District repair times are added the average duration for the supply failures is 145 minutes.

The paper goes on to undertake considerable analysis on the types of fault and the equipment involved and I have listed some of the content below.

"Having presented information on the general performance of the Prospect County Council system for the year 1978, the other aspect of system performance is the question of system reliability. This requires a knowledge of the reliability of each of the individual network elements.

Electrical storms cause the biggest number of fault trips on the sub transmission and 11kV systems. The relative fault rates are approximately

- Sub transmission system – 2 faults per 100km per annum
- 11kV System - 5 faults per 100 km per annum
- Low Voltage System - Less than 1 fault per 100 km per annum

Gales, wind etc, are also a major cause of fault on the overhead systems, accounting for approximately 3 fault trips per 100 kilometres per annum on the overhead 11kV and low voltage system. The sub transmission system fares better at a fault rate of approximately half this."

Note that in the mid 1970's there was little use of underground cables, and the feeder protection was very basic with overcurrent and earth fault at the Zone substation and dropout fuses used on a relatively small number of spur lines. Since then, of course there has been significant change in the composition of the sub transmission, medium voltage and low voltage networks with underground cabling replacing much of the overhead system. In addition, sophisticated protection systems together with SCADA and automated switching have improved the overall resilience of the system to faults, particularly during extreme weather events. Asset management processes and systems have been regularly reviewed over the years to ensure that appropriate resilience levels are being achieved with all the changes that are occurring across all aspects of a network business.

System fault statistics will have changed over the years – although it would be interesting to see the analysis of the response to severe weather events in our modern networks compared to those of say 40 or 50 years ago.
I am sure that a paper on System Fault Statistics showing fault performance under both normal and severe weather events and how this compares with the performance of the system of say 40 or 50 years ago would be of great interest to attendees of EECON 2022 to be held in Brisbane in October.

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# CLEAN ENERGY INVESTORS CALL FOR "TRANSMISSION QUEUE" TO MANAGE GRID ACCESS

By Michael Mazengarb | 8 April 2022 | Source: Renew Economy

Crudine Ridge wind farm. Photo: CWP.

Leading investors in Australia's clean energy sector have pitched a set of energy market reforms to establish a "transmission queue" for renewables projects accessing the grid, to mitigate the impacts of network congestion. The proposal has been put forward by the Clean Energy Investor Group (CEIG), which represents some of Australia's largest independent investors and developers of renewable energy projects.

The group's CEO, Simon Corbell, said that establishing certainty in expected revenues generated by new projects was key to maintaining confidence amongst investors, and this required the introduction of new reforms to actively manage how projects accessed the grid.

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"A key factor for investors when considering whether to invest in a clean energy project is the relative certainty of future revenue streams associated with the project over the life of the proposed asset," Corbell said.

"The higher revenue certainty investors will gain from our reform will reduce the risks clean energy projects currently face in the Australian market, lowering the cost of capital and overall costs for consumers."

On Friday, the CEIG submitted its proposal for grid access reform to the Energy Security Board. The group proposes to establish a "transmission queue" for electricity generators, which would guide how and when generators projects can send power into congested parts of the grid.

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In its submission, the CEIG said the transmission queue arrangement would prioritise projects on a 'first come, first served' basis and would allow new project developers to understand the capacity of the network to accept generation – and whether a new project will be guaranteed access – before an investment decision is made.

"We propose introducing a transmission queue that will result in moving away from Australia's extreme version of open access to protect incumbency rights of generators by creating a dispatch queue in times of transmission constraints that will provide a firm and stable access right to local transmission capacity," the CIEG's submission says.

"The queue will protect incumbents' dispatch rights by curtailing new entrants that locate in areas that do not have spare transmission capacity before curtailing incumbents.

"Thus, the queue will encourage investors to build generation capacity in locations that either a) will not have a negative impact on congestion or b) where they are willing to accept that their higher number in the queue means that they will be constrained off during periods of high generation by generators with a lower number in the transmission queue.

"Places in the queue will be assigned based on existing incumbency, first-come, first-serve when there is spare transmission capacity, and through auctions when multiple investors are interested in the same existing or planned transmission capacity."

This arrangement, the group says, would provide a "long-term" market signal to new projects about network capacity that would allow the location of new wind, solar, and storage projects to be optimised without creating undue risks for investors.

The alternative plan is in response to a proposal being considered by the Energy Security Board that would impose added costs on new renewable energy projects that happen to be constructed in areas where the grid faces congestion challenges.

The Energy Security Board's "congestion management model" proposal has been criticised by clean energy developers for potentially punishing new projects for network challenges they did not cause and for pushing the costs burden onto new projects at a time when new zero emissions capacity is desperately needed.

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The congestion management model would provide rebates to incumbent generators and new projects fortunate enough to be selected to participate in Renewable Energy Zones being created by state governments but would effectively punish any new projects being built outside those zones.

Corbell acknowledged that the current "open access" regime for managing the connection of renewable energy projects to the grid – which has seen parts of the network become congested when multiple wind and solar projects have been clustered within the same geographical region – had become untenable.

But Corbell added that he did not think the model being considered by the Energy Security Board would provide a suitable solution.

"The current open access regime is not fit for the future NEM as it does not provide sufficient long-term revenue certainty," Corbell said.

"The Clean Energy Investor Group's grid access reform addresses these issues by sending a stronger locational signal to generators and by providing better information on their risk of being curtailed.

"The reform also proposes that a generator can fund transmission investment to improve their dispatch position, where there is no existing or planned transmission capacity available."

# AEMC TO REVIEW REGULATORY FRAMEWORK FOR METERING SERVICES

By AEMC Media | 14 April 2022 | Source: AEMC

The AEMC has today announced that work will recommence on its review of the regulatory framework for metering services. The review was paused in November 2021 as part of an adjustment to the AEMC's sequencing of work.

Following the recommencement, the AEMC will work with stakeholders to progress a package of measures to accelerate the roll out of smart meters, improving the efficiency of installations and enabling appropriate access to data from meters in the National Electricity Market.

Prior to the review pause, the Commission received over 60, well-considered submissions from stakeholders. The AEMC recognises the high level of stakeholder interest and enthusiasm in this review and remains committed to reforms to the regulatory framework for metering services.

AEMC Chair, Anna Collyer, thanked the many stakeholders who had contributed to the metering review so far, saying the quality of their contributions confirmed the benefits of smart meters for both individuals and the community.
"Smart meters, providing greater access to real time data and facilitating innovation, will play a crucial part in Australia's smarter networks of the future." Ms Collyer said.

The Commission invites stakeholders to engage with the AEMC to share their ideas and feedback as work begins to develop the draft report.

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## POWER STATION CLOSURE RULES NOT AS SIMPLE AS THEY SOUND

By Ben Skinner | 14 April 2022 | Source: Australian Energy Council

Last week, just before the federal election date was announced, the Federal Energy Minister submitted a **rule change** to the Australian Energy Market Commission (AEMC) to extend the existing National Electricity Rule (NER) that obliges scheduled and semi-scheduled generators to provide 3 ½ years notice of closure to five years.

The Australian Energy Council responded with **caution**. Early market information is certainly beneficial, but attempting to mandate fixed dates in this way introduces complexities, is not readily enforceable and is potentially counter-productive. Importantly, the thinking behind such proposals appear to confuse forecasts and commitments.

We thought it useful to take a look at the history of notice of closure rules and the issues they raise.

**Hazelwood and Finkel**

Prior to 2018 there were no obligation to provide an "official notice of closure" apart from the non-binding forecasts that the Australian Energy Market Operator (AEMO) requested from generators in order to prepare its planning outlooks, such as the Electricity Statement of Opportunities (ESOO). A number of significant plants had closed through the 2010s, including Northern, Playford B, Anglesea, Morwell, Munmorah, Wallerawang and Swanbank B. Many of these gave accurate, long-term forecasts, whilst in some cases, such as Northern, operational circumstances changed unexpectedly quickly.

Everything altered, of course, following the Hazelwood closure with a 5 month official forecast of its closure at the end of the 2016-17 summer. That was followed by a period of tight reliability in Victoria and South Australia and raised wholesale prices across the National Electricity Market (NEM).

Hazelwood's plant circumstances had been challenging for some time. In early 2016 it was still hoped these issues could be economically rectified, in which case the station could have kept running. It is not clear that had an official "notice to close" obligation existed, that the outcome would have been any different.

Nevertheless this event coincided with the **Finkel Review**, which recommended an obligation to provide at least 3 years notice of closure be placed on large generators. The Finkel Review's recommendation seized on the obvious advantages of providing more predictable forecasts. Although it is not clear the Review adequately worked through its practicalities.

Given the political desire to support the Finkel Review at the time, the recommendation was immediately endorsed by governments, and the Energy Security Board (ESB) put forward a successful **rule change**. The result is that all scheduled and semi-scheduled generators**[1]** have to provide an indicative closure date to AEMO, which is **published**. It is non-binding until the last three years, subsequently extended to 3 ½ years.

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### How the existing rule works

Under NER 2.10.1(c3), generators must list their proposed closure dates, and are allowed to extend them at any time, but may not bring them forward in the last 42 months unless granted an Australian Energy Regulator (AER) **exemption**. There is an obvious asymmetry, in that a near-term plant closure can be deferred, but not brought forward. This was intentional: Finkel's objective was to create an "overlap" in new capacity ahead of a closure. There was never an intention to inhibit the economic deferral of a planned closure.

Under what circumstances may the AER provide an exemption? The most obvious is a plant failure: it's pretty hard to keep a plant running after it has blown up. But less extreme cases exist. For example a plant may receive a corrective order from a safety or environmental regulator. If money were no object then such things can be fixed, but clearly it makes no sense if the plant is scheduled to close in the near future anyway.

The AER's guideline acknowledges that changes in circumstances will require both a technical and economic assessment of the closure plan, which recognises that contemporary market conditions will be taken into account. Whilst few would disagree with such common-sense, it raises an obvious question of what the original rule is trying to achieve.

Under Corporations Law, company directors have obligations to not operate insolvent businesses. As the AEMC acknowledged in its final determination on the rule, Corporations, Environmental and Safety laws would, if they were in conflict, necessarily over-ride the NER.

Finally, generators make their own day-to-day decisions on how they run and price their operation. If a plant is incurring losses when operating, then the owner will not run it. It will remain registered, and therefore not "closed", but the substantive effect on the market is the same. Whilst some stronger transparency rules are being proposed in this area, there will always be ways to cease operating rather than to continue operating at a loss. Attempting to prohibit such rational behaviour seems unlikely to succeed.

As one works through hypothetical examples, it becomes apparent that many stakeholders have placed far too much faith in the ability of notice of closure rules to provide certainty. Outlawing change seems as likely to succeed as outlawing gravity.

Ultimately, the only way to make sure that a generator will do its best to keep a plant operational is for it to be profitable. If customers genuinely need its physical capacity, then the market should be paying for it. If there is a fear that such genuinely needed capacity won't voluntarily run, then this can only be fixed through the market design itself, not by creating rules that try to hold back the tide of the market's signals.

### Alternative proposals

The Grattan Institute previously investigated these issues and:

- Took the view that closure notices should be symmetrical, in that new entrants should feel confident that when they enter the market they will not have to face unexpected competition from deferred closure; and
- Recognised the unenforceable nature of a mandatory notice of closure rule.

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Their **alternative proposal** was fixed closure dates (i.e. no advancements nor deferrals) enforced by large bonds forfeited upon changes to plans.

Immediately there is a logical problem: if a needed generator is receiving insufficient revenue to stay operational, it is not clear how it would also manage to stump up a bond.

But more fundamentally, such proposals intentionally discard something of great value: optionality. The ability to change business plans, in response to the emergence of clearer information, is obviously beneficial to owners, but also to society. For example, Germany has just completed its staged nuclear power station shutdown which was originally lauded for the certainty it provided.

However, this is now regretted in a context of European gas crises. It would have been very useful right now to have been able to extend the operation of some of the last nuclear plants.

**Eraring notice**

On 17 February 2022, Origin announced that it had alerted AEMO in relation to the "potential early retirement" of Eraring in 42 months. They also noted "We will continue to assess the market over time, and this will help inform any final decisions on the timing for closure of all four units."

Origin's approach seems consistent with the intent of the rule, in that it is alerting the market to the possibility of closing the plant in mid-2025, which AEMO will now plan around, but leaving open an option to extend. What was surprising however is how **media commentary** subsequently overlooked the intentional and beneficial optionality provided by the rule and in Origin's announcement. Thus the date was widely **misinterpreted as fixed**.

**Proposed 5-year rule**

The minister's rule proposal expressly responds to the Eraring notice. The rule has proposed three features:

1. Extending the 42 months to five years;
2. Creating a new concept of "longer term mothballing" which would be subject to the same notice requirements as closure; and
3. Introducing a rule for the AER to oversee and prevent "gaming" of the notice period in relation to closure deferrals.

The second and third features above unavoidably draw the AER into subjective judgement about internal business practices. Such arrangements generally lead to unproductive games of cat and mouse between the regulator and businesses..

**Forecasts versus Commitments**

Reflecting on this series of events, it appears that over the last five years policy makers have confused the idea of a "good faith forecast" with that of a "commitment".

Forecasts have always been provided in the NEM and are highly beneficial to its functioning. However, it is entirely appropriate that they remain subject to change.

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Any business owner knows that the real world is probabilistic not deterministic, and that forecast returns of an asset are spread across a wide distribution curve which depend on variables that cannot be known in advance. More profitable parts of the distribution curve would imply a later closure, others an earlier closure. A very sophisticated approach would be to provide such a probabilistic distribution to AEMO, however that would be excessively complex. Instead a "most likely" single date forecast is provided, with all parties understanding that the "most likely" can or will change over time.

Such forecasts can fairly provide the full market with the best available information, without unnecessarily restricting the optionality that is so valuable to the entire market community. Two things can go wrong with such forecasting however:

- Forecasts can get out of date as parties that have altered their plans omit to update the information to AEMO. This is remarkably easy to do: plans tend to change very gradually, and, like a boiling frog, it is easy to overlook the obligation to continuously update information.
- Much more rarely, if it occurs at all, is a more nefarious behaviour: deliberately providing misleading information in order to confuse competitors. Such behaviour is arguably illegal under many laws, and the NER has a specific rule, 3.8.22A, in relation to pre-dispatch bidding.

Rules can play a part in the first of these, and, if only to maintain confidence in the information's integrity, potentially in the second.

Commitments are however a different matter. This is where, as per the Grattan proposal, actions are locked in without an ability to update. For the reasons described previously, these are problematic.

An excellent example of the difference exists in the short-term pre-dispatch timeframe. Numerous proposals for bidding "gate closures" have been raised and rejected in the NEM's history. Gate closures lock generators' bids several hours ahead of time, which, prima facie, would appear to reduce uncertainty. However when these proposals are considered in detail, it is soon realised that they are counter-productive, as they inhibit the market's ability to efficiently respond to natural changes. In doing so they actually increase rather than reduce volatility and uncertainty.

This reasoning formed the basis of the AEC's detailed 2020 **consultancy** into Ahead Markets.

**Conclusion**

Since the Finkel Review, the NEM has implemented firm closure rules which sound initially attractive, but when thought through problems are evident. This is because they attempt something unnatural – the prohibition of change.

Their existence has led to a misplaced trust in their effectiveness. When the inevitable happens and the rule fails to operate as expected, the appropriate course should be to review and reconsider the fundamental merit in such rules.

However, this latest development instead appears to double-down on the false belief that such things can be regulated.

[1] This is effectively any generator, including solar and wind farms, over 30MW capacity.

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# DOES ASIA NEED AUSTRALIA'S GREEN HYDROGEN?

By Andrew Blakers | 4 April 2022 | Source: Renew Economy

In its latest budget, the federal government has promised hundreds of millions of dollars to expand Australia's green hydrogen capabilities.

Green hydrogen is made by electrolysis of water, powered by solar and wind electricity, and it's key to the government's "technology not taxes" approach to meeting its climate target of net-zero emissions by 2050.

The government aims to create a major green hydrogen export industry, particularly to Japan, for which Australia signed an export deal in January. But as our latest research suggests, the likely scale may well be overstated.

We show Japan has more than enough solar and wind energy to be self-sufficient in energy, and does not need to import either fossil fuels or Australian green hydrogen. Indeed, Australia as a "renewable energy superpower" is far from a sure thing.

"Green" hydrogen could be used to generate electricity and also to form chemicals such as ammonia and synthetic jet fuel.

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In the federal budget, hydrogen fuel is among the low-emissions technologies that will share over A$1 billion. This includes $300 million for producing clean hydrogen, along with liquefied natural gas, in Darwin.

Australia plans to be a top-three exporter of hydrogen to Asian markets by 2030. The idea is that green hydrogen will help replace Australia's declining coal and gas exports as countries make good on their promises to bring national greenhouse gas emissions down to zero.

Underlying much of this discussion is the notion that crowded jurisdictions such as Japan and Europe have insufficient solar and wind resources of their own, which is wrong.

Our recent study investigated the future role of renewable energy in Japan, and we modelled a hypothetical scenario where Japan had a 100% renewable electricity system.

We found Japan has 14 times more solar and offshore wind energy potential than needed to supply all its current electricity demand.

Electrifying nearly everything – transport, heating, industry and aviation – doubles or triples demand for electricity, but this still leaves Japan with five to seven times more solar and offshore wind energy potential than it needs.

After building enough solar and wind farms, Japan can get rid of fossil fuel imports without increasing energy costs. This removes three quarters of its greenhouse gas emissions and eliminates the security risks of depending on foreign energy suppliers.

**Japanese energy is cheaper, too**

Our study comprised an hourly energy balance model, using representative demand data and 40 years of historical hourly solar and wind meteorological data.

We found that the levelized cost of electricity from an energy system in Japan dominated by solar and wind is US$86-110 (A$115-147) per megawatt hour. Levelized cost is the standard method of costing electricity generation over a generator's lifetime.

This is similar to Japan's 2020 average spot market prices (US$102 per megawatt hour) – and it's about half the cost of electricity generated in Japan using imported green hydrogen from Australia.

So why is it much more expensive to produce electricity from imported Australian hydrogen, compared to local solar and wind?

Essentially, it's because 70% of the energy is lost by converting Australian solar and wind energy into hydrogen compounds, shipping it to Japan, and converting the hydrogen back into electricity or into motive power in cars.

Thus, hydrogen as an energy source is unlikely to develop into a major export industry.

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What about exporting sustainable chemicals? Hydrogen atoms are required to produce synthetic aviation fuel, ammonia, plastics and other chemicals.

The main elements needed for such products are hydrogen, carbon, oxygen and nitrogen, all of which are available everywhere in unlimited quantities from water and air. Japan can readily make its own sustainable chemicals rather than importing hydrogen or finished chemicals.

However, the Japanese cost advantage is smaller for sustainable chemicals than energy, and so there may be export opportunities here.

**What about other countries?**

While large-scale fossil fuel deposits are found in only a few countries, most countries have plenty of solar and/or wind. The future decarbonised world will have far less trade in energy, because most countries can harvest it from their own resources.

Solar and wind comprise three quarters of the new power stations installed around the world each year because they produce cheaper energy than fossil fuels. About 250 gigawatts per annum of solar and wind is being installed globally, doubling every three to four years

Densely populated coastal areas – including Japan, Korea, Taiwan, the Philippines, Vietnam and northern Europe – have vast offshore wind resources to complement onshore solar and wind.

Prime Minister Scott Morrison driving a hydrogen car in November last year. AAP Image/Pool, William West

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What's more, densely populated Indonesia has sufficient calm tropical seas to power the entire world using floating solar panels.

Will international markets need Australian energy for when the sun isn't shining, nor the wind blowing? Probably not. Most countries have the resources to reliably and continuously meet energy demand without importing Australian products.

This is because most countries, including Japan (and, for that matter, Australia) have vast capacity for off-river pumped hydro, which can store energy to balance out solar and wind at times when they're not available. Batteries and stronger internal transmission networks also help.

**Australia's prospects**

Getting rid of fossil fuels and electrifying nearly everything with renewables reduces greenhouse emissions by three quarters, and lowers the threat of extreme climate change. It eliminates security risks from relying on other countries for energy, as illustrated by Europe's dependence on Russian gas.

It will also bring down energy costs, and eliminates oil-related warfare, oil spills, cooling water use, open cut coal mines, ash dumps, coal mine fires, gas fracking and urban air pollution.

Australia's coal and gas exports must decline to zero before mid-century to meet the global climate target, and solar and wind are doing most of the heavy lifting through renewable electrification of nearly everything.

But as our research makes clear, while Australian solar and wind is better than most, it may not be enough to overcome the extra costs and losses from exporting hydrogen for energy supply or chemical production.

One really large prospect for export of Australian renewable energy is export of iron, in which hydrogen produced from solar and wind might replace coking coal.

This allows Australia to export iron rather than iron ore. In this case the raw material (iron ore), solar and wind are all found in the same place: in the Pilbara.

While hydrogen will certainly be important in the future global clean economy, it will primarily be for chemicals rather than energy production. It's important to keep perspective: electricity from solar and wind will continue to be far more important.

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LOCAL NEWS

# SMALL NUCLEAR REACTORS COME WITH A BIG PRICE TAG: NEW REPORT

By Hamish Fitzsimmons | 31 March 2022 | Source: Australian Energy Council

Amid calls for a nuclear industry in Australia the phrase 'small modular reactor' is sometimes thrown about as a solution to our energy needs.

Small modular reactors (SMR) are talked about a lot but there isn't much to show at this stage. There is one currently operating in Russia and they remain a work-in-progress.

SMRs are generally considered to be reactors of 300MW or less developed as modules which can also be combined for larger plants. The International Energy Agency (IEA) has listed more than 50 SMRs in development.

The calls for nuclear power in Australia have shifted from building large-scale plants to advocates arguing for SMRs as a cleaner alternative to fossil fuel generation. The Federal Government's Technology Investment Roadmap had a watching brief on this technology.

There are a number of key impediments to nuclear power generally; its high capital cost, long build times, and the need to gain a strong social licence and political bipartisanship.

A further issue is the lack of flexibility in nuclear plants given the need to complement a grid dominated by variable renewable generation in the not-too-distant future.

SMRs are claimed to have a number of perceived benefits:

- Arguably lower capital costs and construction times than conventional nuclear plants.
- Given the modular design they may be portable and can be expanded as required.
- Can underpin renewables through a "flexible base that offers strong load-following"
- Provide synchronous generation that can provide essential system services.
- Can be used in remote locations like mine sites and for high load demand, such as desalination plants.
- They can be installed on brownfield sites, such as retired coal power plant sites, and make use of existing electricity infrastructure.
- Can be used to supply process heat, assist in hydrogen production as well as the development of synthetic fuels.

Despite these perceived benefits, modern SMRs are still in development stage and are yet to reach commercialisation, and as such, remain an unproven technology to date.

Dr Ziggy Switkowski, the former head of the Australian Nuclear Scientific and Technology Organisation who chaired a federal review of nuclear power in 2006, told the Federal Parliamentary inquiry "on paper, they look terrific" but also flagged that we won't know the potential for SMRs "until the SMRs are deployed in quantity, and that's unlikely to happen for another 10 or so years". Even that timeframe now looks optimistic.

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SMRs are expensive too. In 2019 the Rolls Royce company proposed a 440MW plant with a reported price tag of $2.7 billion for Australia.

In the USA, Portland based NuScale Power says it will have SMR modules operational by the end of the decade.

**It's all about the base**

Nuclear power plants operate as baseload generators; they are not designed to respond quickly to follow changes in load. SMRs are expected to be able to respond faster than traditional nuclear plants, so could be a better fit with increasing amounts of renewable generation capacity.

Inflexibility is a problem that is particularly acute in Australia due to the fastest growth in variable renewable generation in the world. This challenges the electricity market as it has to deal with supply that fluctuates widely during the day, depending on the weather. Current nuclear generation is not agile enough to deal with rapid rises and falls in supply and demand; It cannot 'fast start' like pumped hydro, gas-fired peaking plants, and batteries.

NuScale states that its modules can ramp up quickly – but this is based on modelling and it's difficult without operating plants to assess the accuracy of its claims. Regardless, operating SMRs at reduced capacity, as with larger nuclear plants or any dispatchable plant, will impact its economics.

A new report by the Institute for Energy Economics and Financial Analysis (IEEFA) pulls no punches when it describes the small modular reactor (SMR) project NuScale is building for the Utah Associated Municipal Power Systems (UAMPS). It the first and only SMR design to receive design approval from the US Nuclear Regulatory Commission.

"Too late, too expensive, too risky and too uncertain. That, in a nutshell, describes NuScale's planned small modular reactor (SMR) project, which has been in development since 2000 and will not begin commercial operations before 2029, if ever."[i]

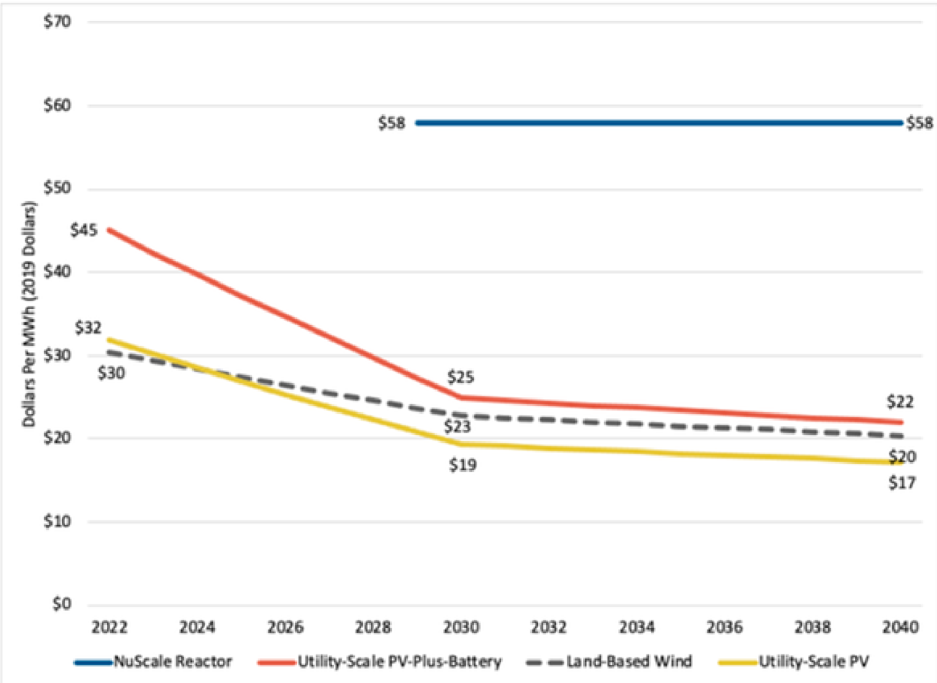
The report questions NuScale's $58/MWh price of power, saying it is likely to be much higher and sounds a warning to buyers of the power that they will bear these costs via long-term contracts.

"By 2029, the soonest the first module is projected to be in service, that price, escalated at 2% per year, will have climbed to $69/MWh. More importantly, neither the $58 nor the $69 price is a guaranteed or actual price. Instead, it is just the currently estimated target price developed by NuScale and UAMPS through a modeling exercise about which very few details and no calculations have been released."

The report estimates the cost of the SMR technology against new build renewables and battery storage.

# LOCAL NEWS

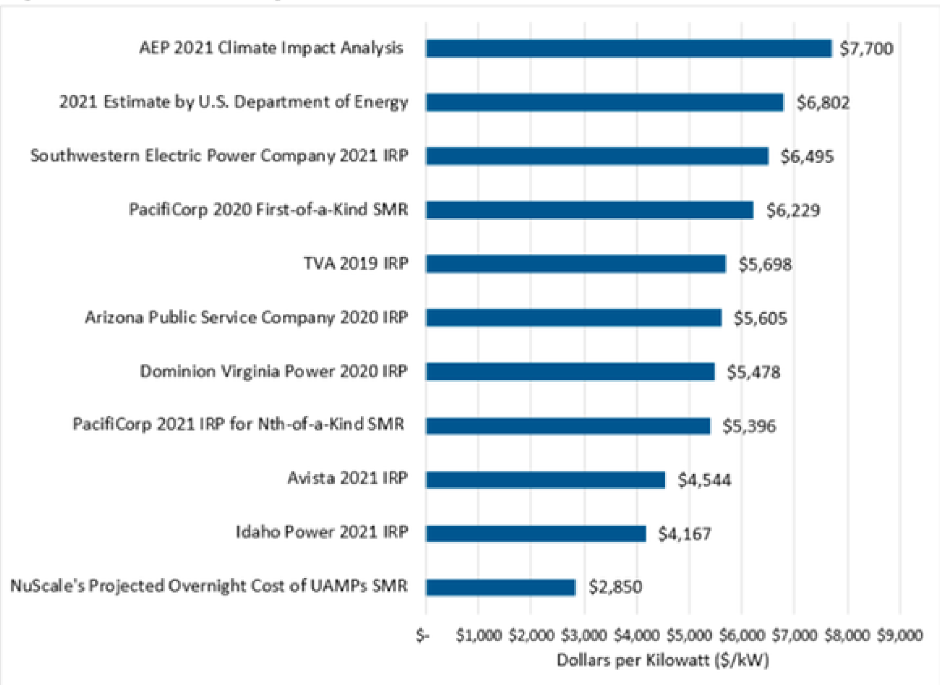
**Figure 1: Comparative costs of SMR and RE technologies**




Sources: UAMPS Presentation to Los Alamos County, page 4. July 21, 2021; National Renewable Energy Laboratory, 2021 Annual Technology Baseline: Utility-Scale PV-Plus-Battery.

The report also raises questions about the development costs with entities "without vested interests in the technology's commercialization" expecting them to be much higher than NuScale's current overnight cost estimate of USD2,850/kW.

**Figure 2: Overnight cost estimates**

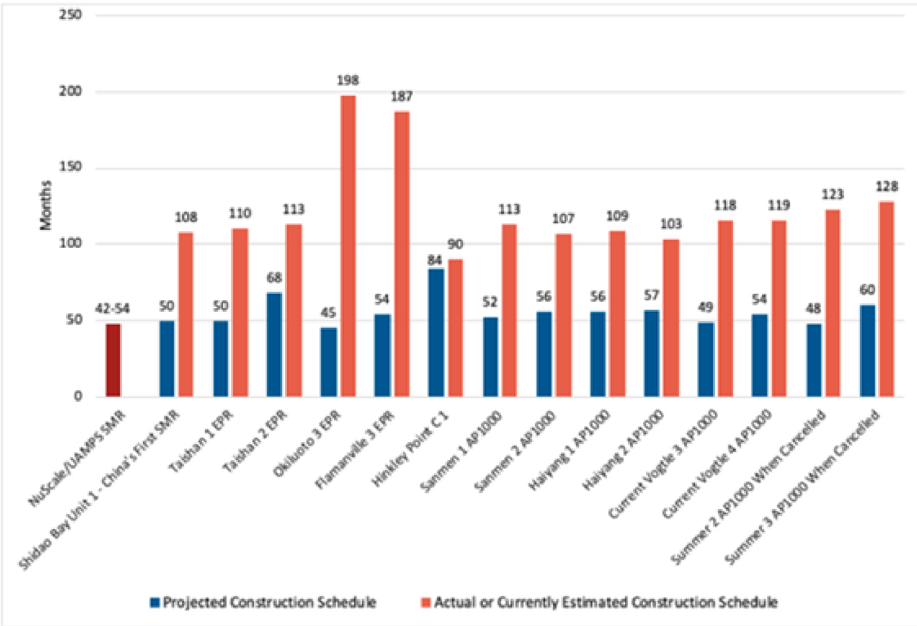



Source: World Nuclear News and Utility Integrated Resource Plans and Climate Impact Analyses.

It flags that recent nuclear industry experience shows that build times for new nuclear reactor designs have taken "more than twice as long to build as the owners projected at the start of nuclear".

# LOCAL NEWS

**Figure 3: Schedules for New Build, New Design Nuclear Plants**




Source: World Nuclear News and the IAEA Power Reactor Information System (PRIS)

The report is critical of NuScale's claims about the flexibility of the SMR saying, "NuScale's marketing is misleading because they can't really say what the new SMR's features will do because none have been built and operated. It also examines cost overruns on other nuclear projects including the Hinckley reactor in the UK, Okiluoto 3 EPR in Finland and Flamanville EPR in France.

"In addition to higher construction costs, these projects also have experienced higher financing costs as their construction schedules have been extended dramatically."

NuScale has rejected the claims stating that they mischaracterise its costs and does not accurately reflect or examine scheduled timeframes. NuScale continues to have support from major companies and in December last year the company and Spring Valley Acquisition Corp., a publicly traded special purpose acquisition company, reached a merger agreement. Existing NuScale shareholders, including majority owner Fluor, will retain their equity in NuScale and roll it into the combined company. Fluor will provide engineering services, project management, administrative and supply chain support. Additional investors in NuScale include Doosan Heavy Industries and Construction, Samsung C&T Corp., JGC Holdings Corp., IHI Corp., Enercon Services, Inc., GS Energy, Sarens and Sargent & Lundy.

A further challenge for NuScale's plant is that the grid is rapidly evolving. As in Australia, the generation fleet will be very different in the US in the coming decades. The IEEFA report expects the growth in variable renewables in the western US by the end of the decade will put downward pressure on prices and increase NuScale's competition. It cites reports that at the end of 2020 there was an estimated 280,000MW of proposed solar, wind and battery storage capacity in the active utility and regional interconnection queues in western US . It underlines that like Australia the amount of renewable generation is increasing at a rapid pace which will bring a focus on transmission and congestion management.

IEEFA argues: "The new paradigm involves fast-growing numbers of flexible and dispatchable solar and wind farms located at geographically diverse sites, often with grid-scale storage batteries, and increasing numbers of distributed energy resources (rooftop solar). This new grid, without large conventional fossil and nuclear "baseload" plants is the one against which the NuScale SMR proposal should be evaluated."

[i]Schlissel and Wamsted 'NuScale's Small Modular Reactor' Institute for Energy Economics and Financial Analysis (IEEFA), 2002.

# LOCAL NEWS

## 300 MW PUMPED HYDRO STORAGE PLANNED FOR DUNGOWAN DAM IN NORTHERN NSW

By Sophie Vorrath | 31 March 2022 | Source: Renew Economy

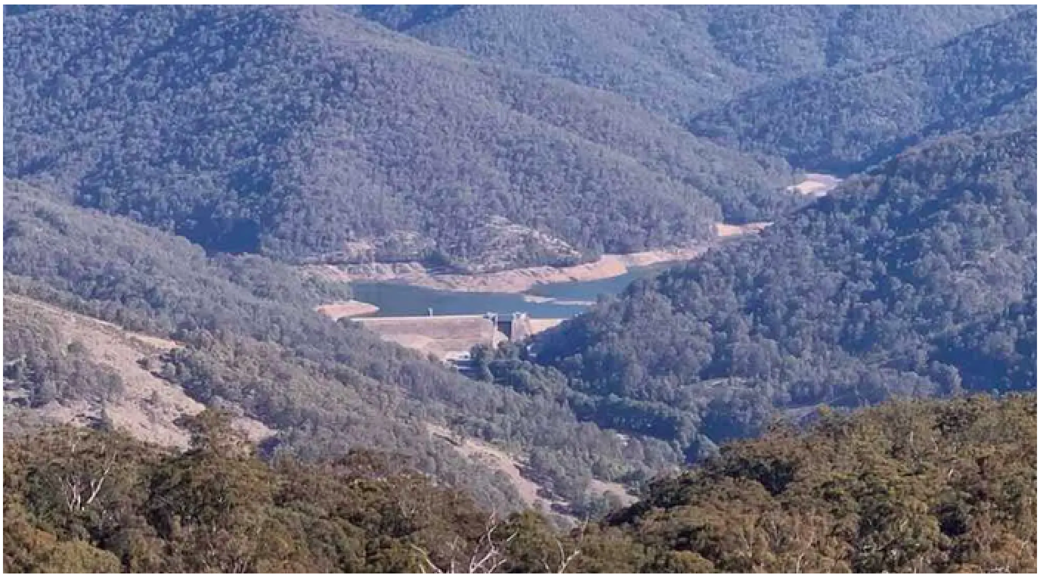


Image: Walcha Energy

Plans to develop a 300MW pumped hydro energy storage project in the New South Wales New England region would generate hundreds of jobs and tip tens of millions of dollars into dwindling coal economies, a new study has found.

Walcha Energy, a joint venture between Mirus Energy and Energy Estate, is proposing to build more than 4GW of wind and solar and up to 10 gigawatt-hours of mixed energy storage, including big batteries and a pumped hydro project at the Dungowan Dam.

An economic impact assessment of the $580 million Dungowan PHES by consultancy ACIL Allen has found the pumped hydro component of the project would deliver significant economic benefits to the region, which hosts some of the state's biggest coal communities, as they transition away from the fossil fuel.

The report, published in full on Thursday, found that over the five years it was expected to take to build the initial 300MW, 10-hour phase of the Dungowan PHES, the project would generate 500 full time jobs on average, using workers mostly from the New England and Upper Hunter regions.

ACIL Allen also forecast that an additional $2.5 billion in gross product or $57 million a year would be generated by the project, with the vast majority of that sum – or around 85% of all operational expenditure – likely to be spent in the local region over the 50-plus years of its operational life.

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Post construction, the Dungowan Dam facility was expected to support "signficiant enduring lcoal employment opportunties," the report added, with 35 full-time equivalent direct jobs and a further 58 full-time equivalent jobs in the lcoal region.

All told, ACIL Allen's modelling suggested that the roughly $8.5 million a year that flowed from the project would translate into a "real income boost" of around $150 a year per resident of the local region.

Walcha Energy director Simon Currie said the results of the study underlined the significance of building large-scale, long life infrastructure such as pumped hydro to support NSW regional communites and help build out the state government's New England REZ.

"Walcha Energy has the ability to offer dispatchable energy to NSW consumers and large energy users through our portfolio of wind and solar backed up by batteries and pumped hydro," Currie said.

"We strongly support the accelerated build-out of transmission infrastructure for the NSW Renewable Energy Zones which will enable retirement of coal-fired power stations and help NSW on its journey."

Dungowan Dam has been supported by the NSW government through a grant under its Emerging Energy Program to complete pre-investment feasibility studies. GE is the technical partner for the project under a joint development agreement.

Its proponents says its added benefits include its close proximity to proposed new transmission lines for the New England REZ, as well as the option of connecting to Tamworth sub-station to pipe renewable energy to the north and the west.

The project is also said to have a high level of "buildability," due to the existing road access to the upper and lower reservoirs, and to hold promise for future expansion – Walcha says there's potential to add additional phases of up to 700MW, with a possible 24-hour operation.

Pascal Radue, president and CEO of GE Renewable Energy's hydro division, describes Dungowan as one of the best pumped hydro opportunities in Australia.

"[This project] proves that with hydropower we can not only significantly advance the energy transition in Australia but also create significant added value for the economic development of the region, the state and the country," Radue said this week.

Walcha Energy says the Dungowan PHES is currently undergoing scoping studies, with a lot of work already completed around the feasibility and suitability of the site, which it says puts it ahead of many competing proposals.

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# 75 kM UNDERGROUND CABLE PROPOSED TO CONNECT AUSTRALIA'S FIRST OFFSHORE WIND FARM TO LATROBE VALLEY

By Giles Parkinson | 1 April 2022 | Source: Renew Economy

The 2.2GW Star of the South project, widely considered to be Australia's most advanced offshore wind project, has started work on mapping the route for a 75km long underground cable to deliver power into the main grid.

Star of the South is one of three offshore wind projects that have sourced funds from the Victoria state government and appears to have the inside running as the government prepares a new scheme to deliver its goal of 2GW of installed capacity by 2028 and 9GW by 2040.

The project, backed by Copenhagen Infrastructure Partners, is likely to be built around 10kms off the coast of Gippsland, and is considering different routes for underground cables to deliver the power into the Latrobe Valley, the home of the state's brown coal generators.

Star of the South said that from Monday April 4, investigations by consultants Douglas Partners at approximately 180 sites would collect and test soil and rock samples to better understand local ground conditions. The work will take up to three months.

Star of the South says its 2.2GW of capacity would account for around 20 per cent of the state's annual electricity needs, and believes it can start delivering that power by 2028 even though it is still in its pre-feasibility stage and is yet to finalise planning approvals.

"Understanding local ground conditions is an important part of designing a safe and efficient underground transmission system"," chief development officer Erin Coldham said in a statement.

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"We're pleased to be co-funding these works with the Victorian Government and sharing what we learn with them as they plan for a new offshore wind industry in Victoria"

Star of the South says a 2.2GW project would create 2,000 direct jobs in Victoria, including around 760 Gippsland jobs during construction and 200 skilled, long-term local jobs during operation.

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# ELECTRIFICATION AND 'PEAKIER' GENERATION: THE GAS OUTLOOK

By Carl Kitchen | 31 March 2022 | Source: Australian Energy Council

When the market operator released its gas outlook for eastern and south-eastern Australia this week a lot of media focus was on the potential for a **"gas squeeze".** It followed the Australian Competition and Consumer Commission (ACCC) also sounding a **supply alarm** at a gas industry conference a week earlier.

But the latest **Gas Statement of Opportunities** (GSOO) also highlights the potential for electrification to impact gas consumption into the future. The GSOO forecasts falls in domestic gas consumption as consumers – residential, commercial and industrial - switch from gas to electricity or zero-emission fuels. It also points to the continuing important firming role for gas generation in the National Electricity Market (NEM), but flags a likely change in the peak demand periods where gas generation will be called on to meet demand and ensure system security and stability. Below we take a closer look at AEMO's latest assessment.

**Electrification**

A net zero emissions by 2050 goal is now shared across major political parties and will drive economy-wide changes, including the substitution of natural gas. The speed and degree of change for the gas sector will be driven by technology developments, government policies, changes in the grid, as well as decisions by industrial, commercial and household users.
AEMO's scenarios in its GSOO include step change, progressive change, strong electrification and hydrogen superpower. It also considers a low gas price scenario. For domestic consumption (ie LNG exports excluded) and excluding gas-powered generation (GPG), step change would see a rapid shift toward net zero emissions with significant electrification with consumers moving from gas to electricity, and could see substituting gas with hydrogen or other zero or low-carbon alternatives to gas, such as biogas or biomass. Progressive change involves slower action initially but with stronger transformation later, while hydrogen superpower under which Australia becomes a major exporter of hydrogen and uses hydrogen domestically to offset gas consumption and less focus on electrification.

In some scenarios, falling gas consumption in some applications may be offset by an increase in gas used for example in steam methane reforming (SMR) hydrogen production to meet domestic hydrogen demand. Residential and commercial

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consumption is anticipated to fall under all scenarios (except low gas price) as consumers move to lower or zero emission alternatives, such as electricity and hydrogen. Strong electrification exhibits the greatest reduction in gas consumption, while under low gas prices it is expected to increase slightly.

The reduction in total domestic gas consumption under three of the scenarios is shown in table 1 below. Note how gas demand for steam methane reforming (SMR) to make hydrogen increases while domestic demand falls.

**Table 1: Forecast domestic gas consumption (excluding gas generation) and SMR Demand**

| | Domestic demand excluding gas generation and SMR (PJ) | SMR load (PJ) | Total (PJ) |
|---|---|---|---|
| | ***Step Change*** | | |
| **2022** | 440 | 0 | 440 |
| **2025** | 395 | 8 | 404 |
| **2030** | 327 | 22 | 349 |
| **2035** | 292 | 31 | 323 |
| **2040** | 246 | 34 | 280 |
| | ***Progressive Change*** | | |
| **2022** | 443 | 0 | 443 |
| **2025** | 431 | 12 | 442 |
| **2030** | 400 | 36 | 436 |
| **2035** | 360 | 62 | 422 |
| **2040** | 341 | 80 | 422 |
| | ***Hydrogen Superpower*** | | |
| **2022** | 450 | 0 | 450 |
| **2025** | 412 | 13 | 424 |
| **2030** | 307 | 78 | 385 |
| **2035** | 240 | 120 | 360 |
| **2040** | 165 | 122 | 287 |

Source: GSOO, 2022

Electrification is expected to occur across the residential, commercial and industrial sectors and the extent to which it is will reduce gas consumption in the scenarios considered is shown below.

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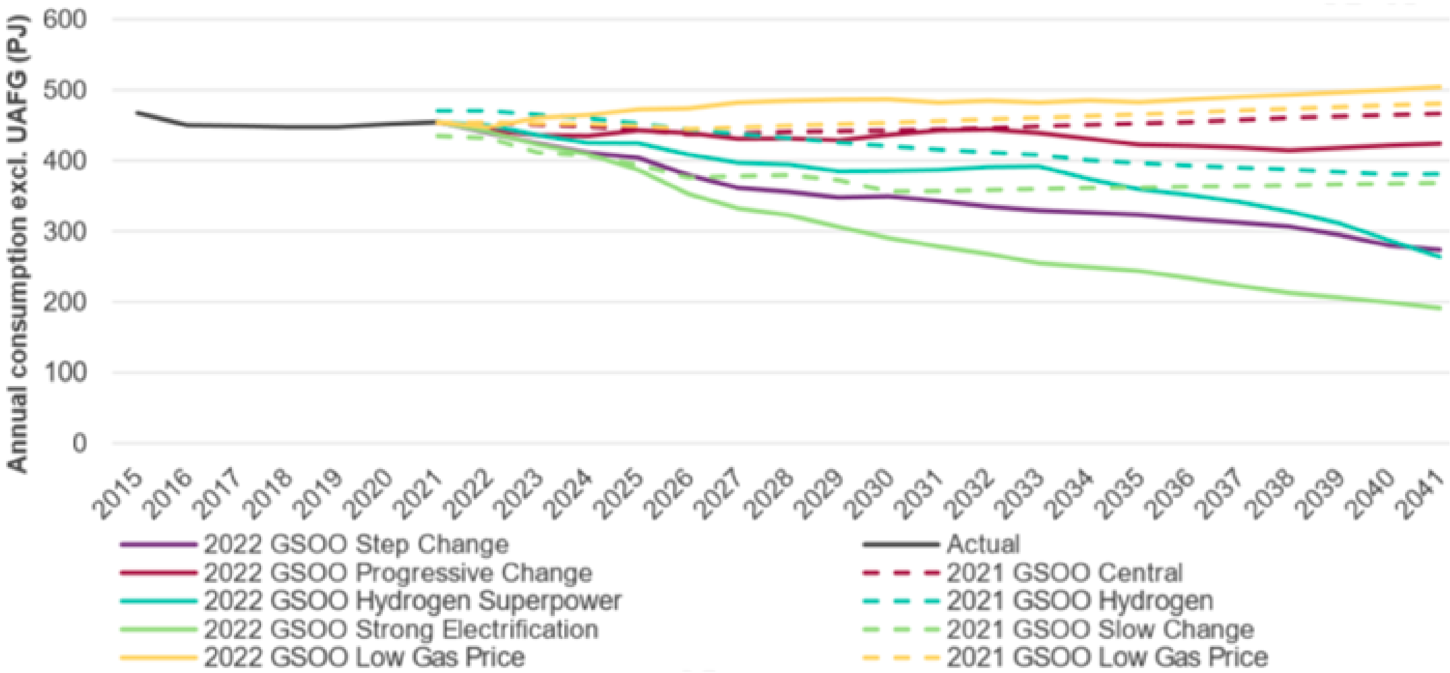
**Figure 1: Actual and forecast annual domestic consumption, excluding gas generation, all scenarios and sensitivities, and compared to 2021 GSOO forecasts, 2015-41 (PJ)**




Source: GSOO 2022.

Note: UAFG means "unaccounted for gas". It is gas lost in the network and not delivered to consumers.

Electrification is expected to drive a reduction in the number of households and commercial businesses connected to gas under all scenarios (except low gas price). Under step change connections would fall by 2.8 million in 2022 to just 1.6 million connections in 2041, while progressive change would lead to 2.9 million connections in 2041 (down from 4.8 million). The latest assessment is 4.5 million and 3.3 million lower respectively than under last year's GSOO central scenario. AEMO notes that it's still unclear if greater electric appliance use will result in physical disconnections from the gas network and whether new households will elect not to connect to gas. Its forecast represents the equivalent connection forecast if electrification disconnected consumers from the gas network, but they might not fall as steeply if expected electrification led to a reduction in gas use but with consumers keeping gas connections.

Domestic electrification would involve replacing long-life assets like water heaters, heating systems and cooktops. The same applies to retrofitting heating in commercial buildings.

Residential and commercial users of gas consume relatively small volumes – estimated to be less than 10TJ each year. Consumption is based on a per connection basis and changes to gas connection forecasts with adjustments made for fuel switching (to electricity and hydrogen), energy efficiency savings, climate change impacts and responses to retail prices for gas.

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Governments are already pushing to increase electrification and support improved appliance energy efficiency. For example, Victoria's Gas Substitution Roadmap has identified both electrification and energy efficiency as important ways to reduce emissions in the short term, while the ACT's climate change strategy includes removing mandatory gas connections to new residential areas. Still, the market operator is not clear on the speed and degree to which households and businesses will switch from gas to electricity.

Equally, the speed and ability of hydrogen to be deployed still rests on technology improvement and consumer uptake. Its impact on gas demand will be driven by how the hydrogen is produced. SMR uses natural gas, so the extent to which this is employed compared to hydrogen produced from other sources such as renewables (green hydrogen) will change the outlook for gas and may not be fully known for some time.

But the increased interest in and focus on developing hydrogen could see users switching from gas to hydrogen fuels, or hydrogen blended into the gas network. The deployment of other zero or low-carbon alternatives to natural gas, such as biogas or biomass, could also have an impact.

Industrial processes are major users of gas and here electrification is more challenging. Industrial processes include areas like metals refining, minerals processing, processing of food and beverages, production of ammonia, cement, pulp and paper, oil, other gases and other chemicals.

Industrial processes often require high temperatures which limits the extent that electrification can be used, although there is some work underway to develop high temperature furnaces for some processes like cement production. In contrast, gas is easily combusted on site to provide the necessary high temperatures. Hydrogen or biomethane may offer an alternative zero emissions option to gas. Biomethane is a direct alternative but may be limited in how much gas it can replace by scale at which it can be produced. The cost of production for any gas alternative will also play a part in determining how broadly and quickly it is adopted.

Industrial gas consumption involves large industrial loads – including minerals processing, primary metal, paper and chemical producers, oil refineries and mining, which represent more than 70 per cent of total industrial gas consumption - as well as small to medium industrial loads (SMILs). SMILs use between 10TJ and 499TJ of gas annually at individual sites.

Under its step change scenario, the market operator expects consumption to fall in the short term before plateauing at around 230PJ from 2027 onwards, but it expects hydrogen to reduce gas demand by 20PJ by 2039. Electrification is expected to reduce gas consumption by 30PJ at the end of the 20-year forecast period. The progressive change scenario would see consumption remain at around 250PJ in the near term and then increasing from 2029 and peaking in the last year of the projected period. This increase stems from an expected growth in gas used to produce SMR hydrogen.

**Gas Generation**

Gas generation will continue to play an important role in the grid and particularly its role in meeting sudden demand changes and providing critical system services to support grid security and stability. As renewables increase in the grid, gas generation along with storage will be increasingly important.

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Gas consumption for generation has trended down since 2010, driven largely by the growth in renewable generation, and in 2020 the NEM reported the lowest gas generation consumption for more than a decade, while 2021 saw a new record low of just over 98PJ (22 per cent lower than in 2020). Aside from growth in renewable capacity, subdued spot prices and higher wholesale gas prices were also factors.

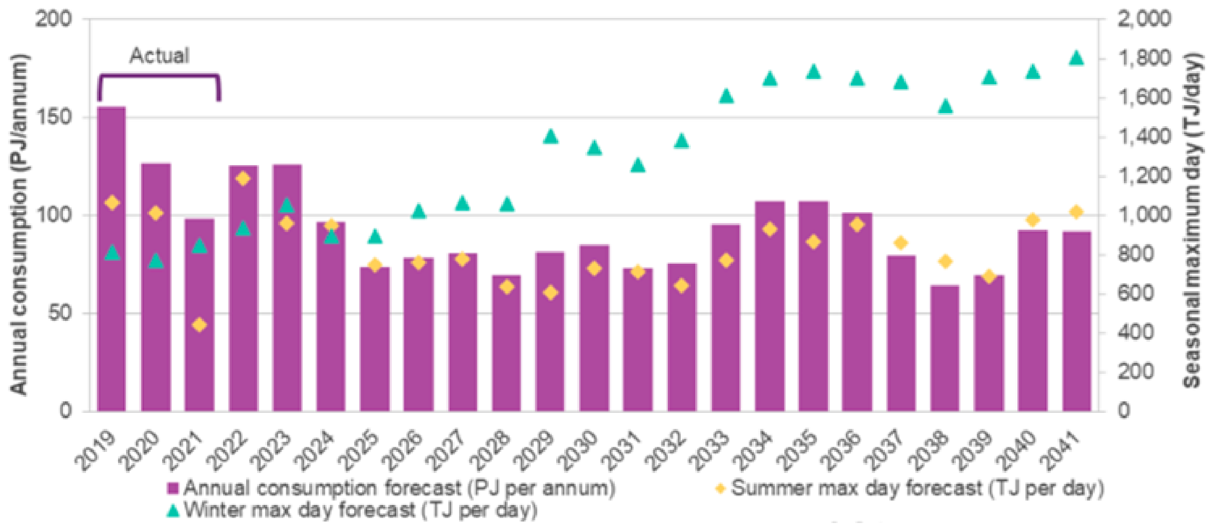
Gas generation will play an important role in ensuring system security it is able to adjust to sudden changes in the supply demand balance, helping manage extended periods of low renewable generation, helping meet the NEM's energy needs if coal generation and other dispatchable sources are unavailable, and providing critical power system services to maintain grid security and stability.

The market operator expects that the annual volumes of gas used in generation will continue to decline until the mid-2020s then flatten out and potentially increase, reflecting its increasing role in meeting demand needs when other generation is not available. Actual consumption could vary widely from the forecast simply because of its role to respond to changes in alternative supply.

Peak gas generation demand is projected to become "peakier". In particular, winter peak day gas generation are expected to increase with an "increasingly 'peaky' profile". Less sunlight and early sunsets, as well as the potential impact of periods of low wind generation means reliance on gas generation to provide firming support is expected to grow, particularly as coal plants retire. Summer has traditionally experienced the highest peak demand periods, but the magnitude of peaks in the colder months are forecast to grow and as a result of greater electrification, gas generation is likely to become winter peaking.

Increasing volatility is forecast to result in the total monthly gas consumption occurring on only a few days in the colder months; it will also see the need for increasingly flexible solutions, such as localised gas storage and dual-fuel capacity for new gas generators. The increased maximum winter demand is shown in figure 2 where the winter max day forecast is expected to double by 2041 under the step change scenario.

**Figure 2: Actual and forecast gas consumption by generators (PJ/annum) and seasonal maximum daily demand (Step Change)**



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Note: The forecast maximum daily demand shown for summer and winter represents the median across different modelled weather patterns.

Source: GSOO 2022

AEMO's forecast for its step change scenario would see a short-term increase in gas generation than previously forecast based largely on increased electrification and the potential for unexpected NEM events, such as plant outages[i], and weather variability. As coal plants exit the market, gas plants are forecast to start more frequently and operate for longer periods given their firming role in the grid. In the longer term (from 2038) there is an expectation that longer duration storage will reduce the need for gas generation to run for extended periods, although they will continue to be needed in challenging weather conditions or when other plant is not available.

On peak days high gas consumption events are expected to remain significant and with a shift to winter peaks there will be the added challenge of tighter supply/demand with winter traditionally being the highest demand period for gas.

[i] The GSOO notes that in 2021 unexpected outages at plants in Victoria and Queensland led to increased gas demand of 21PJ between June and December 2021.

## GRAVITY ENERGY STORAGE SYSTEM PROPOSED FOR DISUSED MINE SHAFTS

By Sophie Vorrath | 28 March 2022 | Renew Economy

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A newly launched Australian start-up has unveiled its own take on gravitational energy storage technology that will use super-heavy weights in legacy mine shafts to capture and release energy, with around 3GWh of potential storage capacity already identified for development.

The company, called Green Gravity, is headed up by ex-BHP executive Mark Swinnerton, who has led the engineering of the technology from Wollongong in New South Wales, and is working with universities and engineering partners – including the University of Wollongong and Soto Engineering – to develop it further.

The new company and technology launch comes as Swiss outfit Energy Vault gathers huge interest and numerous deep-pocketed investors in its “gigawatt-scale” kinetic energy based energy storage solution inspired by pumped hydro, but using blocks of solid material instead of water.

So far, the Swiss energy storage company has attracted interest from such giants of industry as Korea Zinc, Enel Green Power, Saudi Arabia’s Aramco and Swinnerton’s former employer, BHP.

Even Andrew Forrest’s Fortescue Future Industries is proposing to use gravity to charge the batteries in its “infinity train”, that will feature trains laden with iron ore charging as they come down the hills from mines to the port, injecting enough energy into the batteries to take the empty trains back to the starting port.

And, of course, pumped hydro operates on the same principal, Charging, or pushing water up to a higher resevoir, and then letting the water flow downwards to spin the generator when needed.

Green Gravity wants to use the potential gravitational energy of large masses, but Swinnerton says there are a few key differences to his company’s technology – some of which promise to make it cheaper and easier to build and more flexible in its applications.

The first key difference is in the use of proven mechanical parts and disused mine shafts – the latter of which exist in “bucketloads” around the country, Swinnerton told RenewEconomy on Monday. He puts the number at nearly 100,000. Not all of these are suitable, of course, but Green Gravity has so far identified 175 mine shafts profiled across about 80 mines that it believes are very highly suited to housing the technology and would require minimal work to be converted for energy storage purposes.

“We’ve got about 3GWh of capacity already identified as really highly suited to our technology” said Swinnerton.

“This is real capacity that … is spread across the [National Electricity Market] and usually already connected to, or right next to existing transmission infrastructure.

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"This is real capacity that … is spread across the [National Electricity Market] and usually already connected to, or right next to existing transmission infrastructure.

Given the basic physics of the technology, what each Green Gravity system offers will depend somewhat on the size and depth of the existing mine shaft, as well as the weight and density of the mass used to capture and release the energy.

Some of the multitude of smaller disused mine shafts scattered, for example, throughout country Victoria, could prove valuable as a source of community renewables energy storage for regional communities, Swinnerton points out.

That said, to make the most of the spaces and depths the mine shafts offer, Green Gravity's technology will initially use "super, super heavy" weights made from steel, and possibly also iron ore.

On the financial side of the equation, Swinnerton says the company has so far been backed by a number of private investors, but is talking with the federal government and with the NSW state government about the possibilities of grant funding.

The company has also "started conversations" with venture capitalists and is aiming to conduct a fund-raising round in the next few months. And there's lots of interest from miners, too.

"We're really encouraged about the reception we're getting across the full spectrum of mining houses. It's very attractive for many of them, as both an energy storage solution and in terms of mine rehabilitation.

According to Green Gravity's head of business development, Fionna Millikan, of the roughly 85,000 decommissioned legacy mine sites around Australia, and of that number only 3,000 have been rehabilitated, which adds up to a "large liability" for industry and government.

"Green Gravity's concept of using the potential energy in a mass in a vertical mine shaft has a lot of advantages," says David Whittle, a senior research fellow at Monash University and expert in mine planning.

"The environmental footprint of such an operation is very, very small. Even compared to things like lithium batteries. …So this has got to be one of the lowest environmental footprint renewable energy storage concepts there is," he said.

"By reusing the existing infrastructure of disused mines, Green Gravity is developing sustainable energy storage infrastructure at a very competitive cost," Swinnerton added.

"In the coming years our technology will offer a viable and scalable alternative to lithium-ion solutions.
"Green Gravity is working with multiple large energy, manufacturing and mining companies to rapidly develop a demonstration plant at a mining site."

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# VIRTUAL POWER FAST BECOMING A REALITY

By Carl Kitchen and Hamish Fitzsimmons | 24 March 2022 | Australian Energy Council

Earlier this month Origin Energy revealed it was targeting growth in its **Virtual Power Plant** program of 2000MW - up from around 200MW – drawing on batteries, solar PV installations, demand response and electric vehicle chargers. Indeed right across the Australian Energy Council's membership VPPs are being looked at was a way of managing DER in the grid and providing new products to customers.

It underlines that VPPs have been identified as playing a key role in the future energy mix in Australia with the Australian Energy Market Operator (AEMO) expecting an increasing role for distributed energy resources in its draft **2022 Integrated System Plan** (ISP).

This has been supported by the revolution in domestic solar PV with more than **3 million homes and business now with installed systems**. There was an estimated 25GW of rooftop solar at the end of last year with the installation of 3GW in each of the past two years. Despite this the potential for aggregated distributed energy resources (DER) remains nascent.

VPP trials show that aggregated DER can provide not just generation, but demand response, contingency frequency control and ancillary services (FCAS) and potentially network services AEMO was positive about the **results of its series of VPP trials** which we look at in more detail below.

Hurdles to overcome, based on the findings of a new Institute for Energy Economics and Financial Analysis (IEEFA) **report**, include the current lack of dependable revenues for customers or VPP providers and development costs, particularly for start-ups. The costs include the need to develop aggregation software systems and associated hardware to aggregate DER, determine when to use the capacity behind-the-meter (BTM) or when to export and to which markets.

While IEEFA believes the margins for operators are currently thin, it does anticipate the opportunity for strong growth with changes in the grid, and notes that this has not stopped an estimated 20 commercial VPP products being made available in the National Electricity Market (NEM). Below we take a closer look at the report and recent VPP developments.

**Why VPPs**

A VPP has the potential to be a capital and cost-efficient way to create replacement capacity, For example **Origin** is looking to the coordination of distributed assets to replace some of the Eraring power station's capacity when it exits the market and to firm renewable assets "at a very low cost". It also sees the benefits of VPP for retailers by creating lower churn and "deeper engagement" while seeking to "fulfill customers' expectations for lower costs, decarbonisation and energy autonomy".

The first major VPP project was undertaken by AGL in South Australia in 2016. Supported by ARENA, this included the sale and installation of 1000 batteries in Adelaide with a total 5MW capacity. This participated in the market operator's demonstrations for wholesale market and contingency FCAS using a cloud-based platform.

Simply Energy has also been involved in an ARENA supported project, VPPx, involving 1361 households providing 6MW of capacity to the SA grid and integrating with a distributed energy market platform. The project found there are economic

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benefits to all stakeholders and led to Simply Energy developing a new VPP offer which it launched in May 2021.

The Australian Energy Market Operator (AEMO) established a VPP demonstration program and trials in 2019 and participants in these are shown in figure 1. They included:

- VPP portfolios across all mainland NEM states.
- A total registered capacity of 31 MW (equivalent to a small scheduled hybrid solar farm plus battery). All VPPs used batteries in their portfolios.
- Approximately 7,150 consumers signed up (almost 25 per cent of customers with registered batteries in the NEM).

Overall, the trials showed that VPPs could deliver FCAS, respond to energy price signals, and deliver local network services "at times simultaneously". AEMO also noted that VPPs have been able to support the power system during numerous major contingency events over the last two years, including separation events between South Australia and Victoria as well as trips of major generating units.

AEMO reported VPPs in the trial increased market share of contingency FCAS to 3 per cent of market share in April 2021, up from 0.6 per cent in April 2020.

According to AEMO Manager DER Market Integration, Matt Armitage, household batteries showed they could play a role in FCAS.

"Evidence indicates that household batteries are highly effective at providing contingency Frequency Control Ancillary Services (FCAS), with VPP's supporting the power system during major contingency events in the National Electricity Market over the last two years.

"Consistent with previous reports, VPPs are also highly capable of responding to energy market prices in real time and can deliver local network services, at times delivering more than one service simultaneously," he said.

AEMO also reported though that while VPPs are very capable of responding to energy market prices in real time, "their behaviour is largely dominated by serving the household first and maximising the self-consumption of rooftop PV".

**Figure 1: Participants in AEMO VPP Demonstrations**

| | Energy Locals (Tesla SA VPP) | AGL | Simply Energy | sonnen | ShineHub | Energy Locals (Members Energy) | Hydro Tasmania |
|---|---|---|---|---|---|---|---|
| DUID | VSSEL1V1 | VSSAE1V1 | VSSSE1V1 | VSNSN1V1 | VSSSH1S1 | VSVEL2S1, VSNEL2S1 | VSQHT1V1 |
| Jurisdiction | SA | SA | SA | NSW | SA | VIC and NSW | QLD |
| Registration * | MC | MC | MC | MASP | MASP | MC | MASP |
| Battery technology | Tesla PowerWalls | Tesla PowerWalls | Tesla PowerWalls | sonnen | AlphaESS | Alpha ESS Saj/Everready | Tesla PowerPack |
| FCAS delivery | Proportional | Proportional | Proportional | Proportional | Switched | Switched | Proportional |
| Registered capacity (Aug 2021) | 16 MW All cont FCAS | 6 MW All cont. FCAS | 4 MW All cont FCAS | 1 MW All cont FCAS | 1 MW All 6 cont FCAS | 1 MW (x2) All 6 cont FCAS, except L6 | 1 MW All 6 cont FCAS |

*Registration types are MC = Market Customer, MASP = Market Ancillary Services Provider

Source: AEMO

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According to IEEFA almost all participants in AEMO's trial are continuing to offer VPP products to households and providers such as EnergyAustralia and Origin also offering commercial VPP products to residential customers. Meanwhile in WA, Synergy has established a schools VPP pilot program involving 17 schools, which is the state's first VPP. While in WA **Synergy has established a schools VPP pilot program** involving 17 schools, which is the state's first VPP.

Commercially available VPPs have been participating in the wholesale market, FCAS markets and the Reliability and Emergency Reserve Trader scheme (RERT) and have also occasionally provided distribution network support services, including thermal, voltage or peak demand management. The IEEFA report notes that aggregated household DER can't participate in the NEM's wholesale demand response mechanism currently and has only been involved in the RERT in trials.

VPPs are coordinated using cloud-based gateway via an inverter with embedded energy management capability or a dedicated device to provide on-site gateway to manage behind-the-meter DER.

**The future of retail?**

The IEEFA sees VPPs as the future of retail, arguing that the acceleration in DER and electric vehicles will be an important factor in driving this, along with improved profitability from aggregated DER as a result of increased solar and battery capacity, particularly from EVs, falling costs and broader use of DER with demand response capabilities.

It expects that with more household supply and storage sitting behind the meter it will be hard for retailers without VPP to be profitable. It also flags that sales from the grid will continue to fall "eroding gentailer" profitability while exports from DER will increase along with opportunities for aggregators. But it also notes that the highest value use of DER can be expected to be behind the meter, as a means to reduce power bills by avoiding network and other costs. So into the foreseeable future VPP revenue for customers will continue to be small compared to behind-the-meter savings from solar and battery storage. It estimates average household bill savings from VPP involvement is around $200 annually, much less than savings from households storing solar output.

And AEMO has also sounded a note of caution, saying the rapid growth of DER in Australia's energy system leaves open new types of cyber security threats, which could ultimately pose a threat to power system security. Another challenge that would need to be overcome.

While it seems clear VPPs will continue to develop and grow as more domestic and commercial properties have rooftop solar installed and the cost of batteries fall and the scale of available storage increases and energy markets evolve, the extent to which it will represent the future of retailing remains debatable.

# ELECTRIC VEHICLE NEWS

## NISSAN UNVEILS PROTOTYPE SOLID STATE BATTERY CELL PRODUCTION PLANT

By Sophie Vorrath | 8 April 2022 | The Driven


Japanese auto maker Nissan has made key progress on the road to producing its own version of potentially game-changing electric vehicle battery technology, unveiling on Friday a prototype production facility for laminated all-solid-state battery cells.

The commercialisation of solid-state batteries is a quest being pursued by a number of the biggest players in the auto industry, as the key to making electric vehicles cost-competitive with ICE cars.

That's because solid-state batteries claim to have an energy density approximately twice that of conventional lithium-ion batteries, significantly shorter charging time due to superior charge/discharge performance, and lower cost due to being comprised of less expensive materials.

Late last year Nissan joined the quest, announcing plans to go to market with its own solid-state batteries by 2028, as part of the car maker's Nissan Ambition 2030 roadmap.

This week's unveiling of the prototype production facility, within the Nissan Research Centre in Kanagawa Prefecture, marks a first step towards this goal.

From here, Nissan plans to establish a pilot production line at its Yokohama Plant in fiscal 2024, with materials, design and manufacturing processes for prototype production on the line to be studied at the prototype production facility.

The auto maker reiterated this week that it believes all-solid-state batteries can be reduced to $75 per kWh in fiscal 2028 and to $65 per kWh thereafter, placing EVs at the same cost level as gasoline-powered vehicles.

"Nissan has been a leader in electrification technology through a wide range of R&D activities, from molecular-level battery material research to the development of safe, high-performance EVs," said Kunio Nakaguro, executive vice president in charge of R&D.

"The knowledge gained from our experience supports the development of all-solid-state batteries and we've accumulated important elemental technologies," Nakaguro added.

"Going forward, our R&D and manufacturing divisions will continue to work together to utilize this prototype production facility and accelerate the practical application of all-solid-state batteries."

# ELECTRIC VEHICLE NEWS

## HYUNDAI TO ALLOW ITS EV BATTERIES TO DO "EV TO EVERYTHING"

By Bridie Schmidt | 7 April 2022 | The Driven

Hyundai is planning to extend the bidirectional charging capabilities in its battery electric vehicles (BEVs), so they can play an integral role as part of the electricity grid, as well as powering to devices.

Currently, the South Korean automaker's Ioniq 5 is capable of what is known as "vehicle-to-load", otherwise known as V2L, which allows drivers to draw a charge from the car's battery. For example, to boil a kettle when out camping, or to charge the laptop when using the car as a "mobile office".

With a battery that can store enough energy to power a home for 4 days under the floor, the use of this kind of transformational technology changes cars from purely transport products to a kind of mobile energy storage.

Hyundai now plans to join the likes of Nissan by extending its technology to include vehicle-to-grid. Nissan has long had V2G tech in its Leaf, and has used in past emergency applications supplying power to recovery efforts, for example after the Fukushima disaster.

In addition to using V2G for emergency efforts, this technology allows energy stored in BEV battery packs to be transferred to an electricity network, commonly known as a "grid."

The energy stored in BEVs not only helps to stabilise the grid, but it also feeds the system to help manage energy demand during peak times and emergencies.

Hyundai says it has been trialling a number of Ioniq 5s modified with V2G technology – which requires a different interface and inverter system to V2L – in two "V2X" (vehicle-to-everything) projects in the Netherlands and Germany.

To support V2G, BEVs must have the necessary hardware, such as a bidirectional onboard charger that allows energy to flow to and from the battery pack, as well as software to govern the discharge.

Because only a small portion of the battery capacity is required for driving, the remaining energy can be fed back into the grid and used by local energy distribution companies.

In the Netherlands, Hyundai is trialling its V2G technology with We Drive Solar, a Dutch mobility company, in Utrecht.
As part of a project that aims to see the medieval city become the "world's first bidirectional city", We Drive Solar is deploying a fleet of 25 Ioniq 5 cars in a car-sharing scheme for inhabitants of new housing projects.

A second trial in Germany is looking at how EVs can be used in "vehicle-to-home" (V2H) applications.
Cradle Berlin, Hyundai's corporate venturing and open innovation firm, is leading the V2H pilot project in which a specialised Ioniq 5 fleet is used in a closed home energy system, to evaluate the potential to exchange energy between the car and the house.

# ELECTRIC VEHICLE NEWS

## AUSTRALIA'S FIRST ELECTRIC PRIME MOVER FLEET HAS SWAP AND GO BATTERIES

By Giles Parkinon | 5 April 2022 | The Driven


Australian company Janus Electric has unveiled what it says is the country's first electric prime mover fleet, unveiling four converted heavy haulage vehicles in Sydney that can swap batteries and provide vehicle to grid services.

The conversion technologies of Janus is focused on what it says is a sweet spot in the industry – the need for all heavy vehicles to have a major engine rebuild after one million kilometres.

"This provides an ideal opportunity to convert to electric," CEO Lex Forsyth says. "Electrifying our road network is no longer a pipedream for future Australia, but a real tangible solution for today that we can act on now."

The Janus fleet currently features converted prime movers from Kenworth, Freightliner, Mack, Volvo and Western Star. "We don't need to purchase brand new electric vehicles to electrify Australia's freight network, our technology simply converts the heavy vehicles already out on Australia's roads," Forsyth said.

Janus is using 630kWh batteries that – depending on the size of the load – can deliver around 400kms of range for a B-double. It will feature a 540kW motor. The batteries are located within easy reach below the cabin (see picture below) and can be swapped within four minutes.


Janus will be building a series of major recharging and battery swap stations around the trucking network, but says these can also be operated by private networks or existing petrol providers.

These stations will have a capacity of around 38MW, with a 20MW feed to and from the grid. "We'll have the largest virtual power stations in the grid," he says.

Forsyth says the charging and swap stations will feature grid to battery, battery to grid (to provide services such as FCAS), and battery to battery technologies, which will be used when the truck tracking system decides the resources of multiple batteries be focuses on one or two if they are needed urgently.

# ELECTRIC VEHICLE NEWS

The batteries take around four hours to recharge and Forsyth says that means the batteries will last longer with a slower charge (around four hours).

And he says it makes sense to swap the batteries, given that a "fast-charge" of such a battery will need at least 1.2MW. And he says it makes sense to have "swappable" batteries given the rapid change in battery chemistries, which will deliver better efficiency and less weight.

"There's a constant evolution, and that's why it makes sense to have exchangeable batteries," he said.

Forsyth says the economics of the electric battery technology are already compelling. On a kilometer to kilometer basis, they are around one third of the price – around 33c per kilometers compared to 96c per km for diesel. Even with the cost of batteries, the technology delivers savings of around one third over diesel.

And once the batteries are depleted – say to around 70 per cent – they can be re-purposed as stationary storage.

Dusty, a mechanic and truck driver (left), took The Driven for a short trip around the tarmac at the White Bay Cruise Terminal in Sydney. "It's so smooth to drive," he says. "The noisiest part is the air conditioning. And with the (regeneration) you have one pedal driving, you only need to brake if you want to come to a complete stop."

Forsyth is also dismissive of hydrogen alternatives, noting that there are a "rainbow" of colors for hydrogen, ranging from black, brown, gray and blue, and even green hydrogen is not necessarily zero emissions if the source of power (wind and solar farms) have already sold green certificates for other companies to claim offsets.

"If the LGCs are sold to another company to offset emissions, it should not be used as green energy. That would mean they are still being used to greenwash carbon emissions," he says.

He says batteries provide 85 per cent efficiency, compared to around 30 per cent for diesel and 28 per cent for hydrogen.

Forsyth says the conversion process is relatively simple and costs around $150,000.

Janus takes out the diesel engines, the radiators, the collars and the fuel tanks and exhaust pipes and air intakes, and gives them back to the fleet. And then they install their JCM conversion system. The trucks use between 1.2kWh and 1.8kWh per kilometer, depending on their size.

Janus has already struck deals with Oz Minerals and Qube, and it says there is strong interest from mining companies, trucking companies, and petrol station operators keen to latch on to the new technology.

The company is raising $10 million ahead of an expected IPO and stock exchange listing later this year.

Janus Electric J403 May 11th 2021 - Watch on YouTube https://youtu.be/g4EbWRDXzZw

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# ELECTRIC VEHICLE NEWS

## UQ BREAKTHROUGH COULD DOUBLE LIFE OF HIGH DENSITY EV BATTERIES

By Bridie Schmidt | 29 March 2022 | The Driven

UQ'S PROFESSOR LIANZHOU WANG. SUPPLIED

A technique developed by Australian researchers that adds an extremely thin protective layer – just one atom thick – on battery cathodes could see lithium-ion batteries with extremely high energy density become viable for use in electric vehicles.

EV batteries in use today generally give between 200-400km driving range depending on the size of the battery, and the car. It's proving to be enough for mane people to start switching to EVs, but the cost to manufacture them, combined with degradation of driving range over time still has many drivers worried.

Researchers from the University of Queensland (UQ) say the new findings could double the life of high energy density batteries to the point they become viable for use as they no longer degrade within a few hundred cycles.

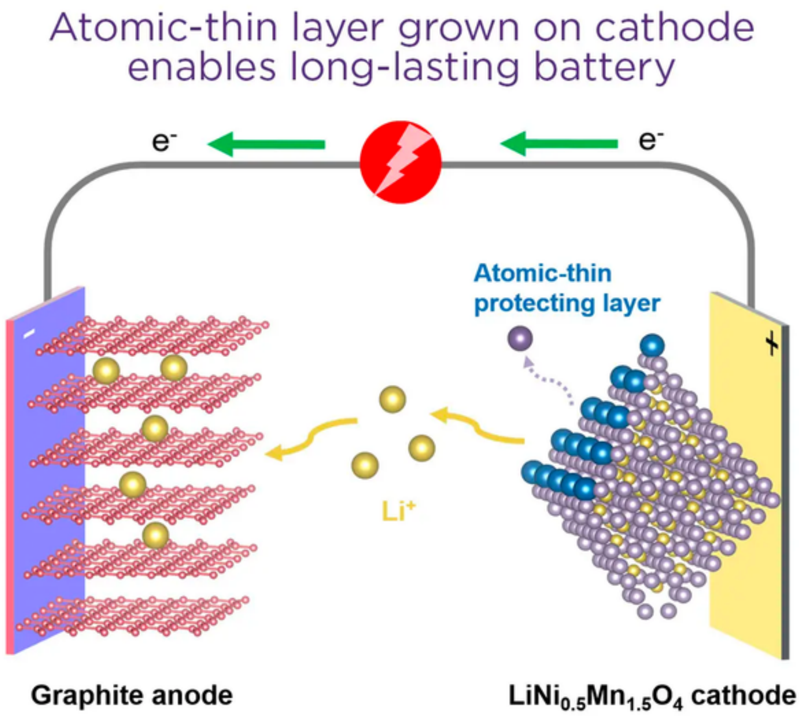
The upshot of the research is that once commercialised, we could be seeing EVs with much longer driving range and batteries that last a lot longer.

The energy capacity of lithium-ion batteries, particularly in those with chemistries that have a much higher energy density than ones used today in electric cars, degrade over time because of the formation of lithium dendrites caused by the energy transfer when charging and discharging.

In the new research outlined in a recent paper in Nature Communications last Wednesday, researchers described how adding a layer that is just one atom-wide, which significantly reduces the degradation caused at high voltage.

Instead of lasting just a few hundred cycles, batteries using the atom-wide anti-corrosive layer could be charged and discharged more than 1,000 times, said Professor Lianzhou Wang who leads the team from the School of Chemical Engineering and Australian Institute for Bioengineering and Nanotechnology (AIBN) at UQ.

# ELECTRIC VEHICLE NEWS




SOURCE: UQ

In a statement Wang said that, "Our process will increase the life-span of batteries in many things from smart phones and laptops, to power tools and electric vehicles," Professor Wang said.

"This new approach features a minimal protective coating at a scalable process, paving the way for the deployment of these abundant high-voltage materials for next generation high energy batteries."

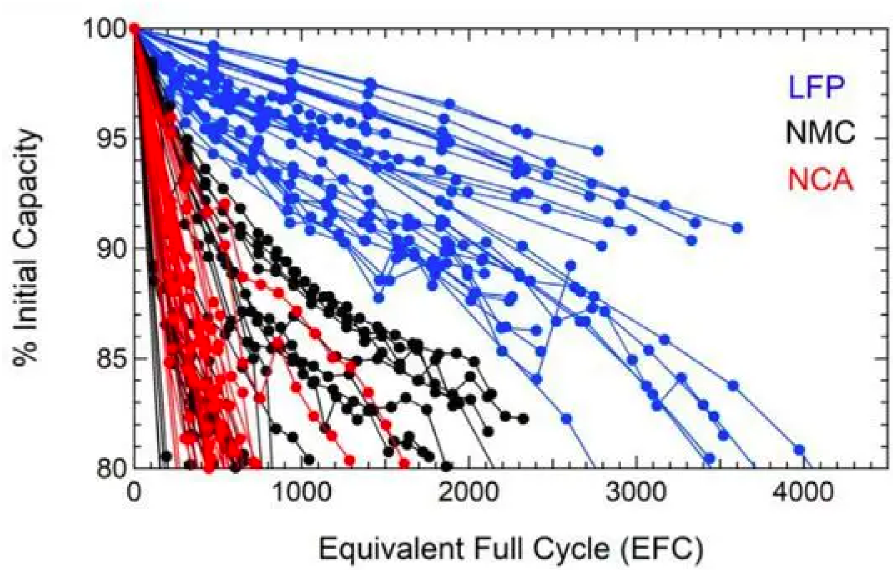
Research conducted by the team found that after 1,000 cycles, capacity retention remained at 77%.

For context, according to a 2020 paper from the Journal of the Electrochemical Society, lithium-iron-phosphate (LFP) batteries that avoid the use of rare earths including cobalt such as those used in the standard range Tesla Model 3 can cycle up to 4,000 times before capacity dips below 80%.

However, current LFP chemistries have a much lower energy density compared to nickel-based chemistries, meaning EV makers must use larger and heavier batteries which contributes to poorer vehicle energy efficiency.

But Wang says the new technology could be used on higher energy density versions of LFP batteries. In a note to The Driven, Wang said that, "Some advantages of the new material include … cobalt-free and low-cost materials, high voltage of the single cell, and more than 1000-cycle stability," and that the new technology offers "at least 20% more energy" than the LFP batteries currently used by Tesla.

# ELECTRIC VEHICLE NEWS




SOURCE: HTTPS://IOPSCIENCE.IOP.ORG/ARTICLE/10.1149/1945-7111/ABAE37

Wang says he believes the team's new research could have a significant impact on sectors that rely on rechargable batteries such as in computing and transport.

"We're confident the nanotechnology will have widespread applications across industry, including in consumer electronics, electric vehicles and the energy storage sector," he said.

Citation:
Title: Epitaxial growth of an atom-thin layer on a LiNi0.5Mn1.5O4 cathode for stable Li-ion battery cycling
Published in: Nature Communications volume 13, Article number: 1565 (2022)
Date: 23 March 2022
DOI: https://doi.org/10.1038/s41467-022-28963-9

This article has been updated with quotes from Professor Wang regarding potential battery chemistries and cycles.

ELECTRIC VEHICLE NEWS

# EV BATTERIES DRIVE HOME ENERGY STORAGE REVOLUTION

By Jeff Postelwait | 4 May 2021 | T&D World

**As battery costs fall, the flexibility of battery energy storage is making it useful and cost-effective in a wider variety of applications.**

Jon Wellinghoff says he does not worry about power outages anymore.

"I just bought an electric vehicle, actually, and now I have 100 kW of storage sitting in my garage, and I also have two Tesla Powerwalls. So, in my house that never peaks over 3 kW, I now have 15 or 20 times my peak that I'm able to store," the former Federal Energy Regulatory Commission (FERC) chairman said of his home in Berkeley, California, U.S.

Flow battery technology, where chemical energy is provided by two chemical components dissolved in liquids and stored in separate tanks that are pumped through the battery system, is a promising, yet still immature technology, for grid energy storage applications. It can scale easily, uses lower-cost/more abundant materials, and is safer than many current generation battery technologies. Pictured above, a scientist at works on a flow battery design on one of PNNL's prototyping labs.

Wellinghoff said electric cars like his Ford Mustang Mark E have been a factor in grid-scale batteries becoming cheaper, more efficient and used by utilities in a growing variety of applications.

"There are some technology advances taking place, and manufacturing processes are being streamlined. Production is ramping up, so you're seeing economies of scale. There's now a greater demand for batteries," Wellinghoff explained.

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Battery energy storage is unlocking more value for utilities than in the past.

"They can stack value with the services they provide to the grid. They want to use a battery in [PJM Interconnection] for volt/VAR support. That's a new application for energy storage and it used to be done exclusively by generators," Wellinghoff noted.

PNNL's all-organic aqueous flow battery uses two inexpensive and readily available electrolytes, one containing methyl viologen and another with 4-HO-TEMPO.

**Unlocking Value**

Wellinghoff is far from the only person who sees big things ahead for energy storage.

When asked who wants to buy into energy storage today, Jason Burwen, interim CEO of the U.S. Energy Storage Association (ESA) — a trade group that represents all forms of energy storage — said: "Everyone. Five years ago, it was mostly independent power producers. Now it's regulated utilities, smaller forward-thinking coops, all kinds of utilities."

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The DOE's $75 million Grid Storage Launchpad facility at PNNL, shown here in a conceptual architectural rendering, will consolidate a broad range R&D capabilities under one roof to accelerate the development of next-generation grid energy storage technologies, including the ability to test new battery designs under realistic grid operating conditions. DOE recently approved the project for design and construction, which could begin later this year.

Burwen said that, while California would remain a leader for the time being, smaller utilities and coops in places like Arizona, Colorado, Indiana and Idaho are making their first major steps into energy storage at the project stage.

"As those utilities retire old fossil capacity, they see energy storage with renewable as providing replacement capacity," Burwen explained. "Florida has a 490-MW battery supposed to come on-line this year."


Often the first step in research to develop next-generation battery technologies is identifying promising new materials and chemistries from countless potential combinations, which can be like searching for a needle in a haystack. Above, a PNNL researcher uses High Throughput Experimentation (HTE) equipment to efficiently analyze thousands of potential chemistry combinations for new battery designs.

According to Burwen, cell prices for batteries dropped 90% over the last decade and, as production ramps up, the economies of scale effect is making itself felt.

"What's dropping is the cost of battery supply for vehicles, and grid batteries get to ride the coattails," Burwen said. "There are now more players coming into the space." This is leading to utilities and grid operators thinking of using batteries in ways that previously would not have been economically feasible.

"So, whereas grid batteries were only providing ancillary services as recently as six years ago, you are seeing them deployed to contribute to resource adequacy," Burwen said. "I've noticed an increasing value for having higher power in your asset. So, even if you see, for example, a 2-hour battery, it might be a high-power battery and it will be operating for 4 hours of capacity, but it has the option to discharge a lot of energy in an hour, if needed. These are extremely flexible and configurable assets."

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# ELECTRIC VEHICLE NEWS

**Maturing Technology**

Today's batteries offer enough flexibility to be useful in a greater variety of applications, and energy storage now can complement different types of projects.

"So, the question becomes, what kind of capability do you need? What kind of value do you want?" Burwen asked. "The analogy here is what was smartphones competing against? Land lines? People wouldn't have estimated that smartphones would be competing against basically all consumer electronics."

Energy storage is even maturing to the point where it can take the place of building a new power generation asset or building grid upgrades.

"When you add storage to your mix, everything becomes more flexible. You can increase hosting capacity of a transmission circuit without having to build a lot of new facilities. So, it's easy to think of it as a competitor, but what it really is, is more of an enabler and a partner," Burwen said.

While Lithium-ion (Li-ion) is the dominant battery technology for grid-scale applications, other electrochemistries are presented as having life-cycle or duration advantages over Li-ion. When asked which battery technology was the best, Burwen said, "I love all my children" and would not say one is better than the other. However, he did say that each has their pros and cons.

According to Vince Sprenkle, senior advisor for energy storage at Pacific Northwest National Laboratory (PNNL), several battery chemistries could challenge Li-ion in the future and, in most cases, they are being designed with grid-scale energy storage in mind. These battery chemistries include the following:

1. The power and energy components of **redox flow batteries** are independent and situated like a car — where the engine is the flow battery stack that delivers power and the gas tank is the flow battery electrolyte that provides the range, or discharge duration, based on how much fuel is in the tank. According to Sprenkle, the separation of these components enables greater flexibility, so they may be tailored to specific uses depending on how much power and battery life are needed and in what ratio.

2. **High-temperature sodium systems** use a ceramic electrolyte to move sodium between a molten metal anode and sodium sulfur or nickel metal halide. Sodium-sulfur systems have been shown to deliver full energy over 7 hours. Nickel metal chloride systems offer a flexible discharge duration of 3 hours to 10 hours. Because of the molten metals used, high temperatures are required. This offers the advantage of being useful in temperature extremes that would make conventional batteries less efficient.

3. **Sodium-ion batteries** can be built in the same factories as Li-ion, but swap Lithium for sodium for cost benefits and an easier-to-maintain supply chain. Using cheaper materials to make essentially the same battery could cut costs by around 70%, Sprenkle said.

4. **Zinc batteries**, like nickel zinc (Ni-Zn) or zinc manganese dioxide, are at various stages of development, with more advancement in Ni-Zn chemistry. The advantages are higher specific energy and lower cost as well as safe operation, Sprenkle said.

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# ELECTRIC VEHICLE NEWS

"Increasing renewable generation and need for improved grid resiliency are driving storage solutions that can provide power over days, weeks and even seasons. Conventional batteries, such as Li-ion, may not best suited for these applications as the costs increase significantly with increasing discharge durations," Sprenkle explained.

Flow batteries and other technologies may enable longer-duration systems to eventually be cost effective for 100-plus hours but will still have a challenge with seasonal shifting energy because of self-discharge, Sprenkle said. Self-discharge, which occurs at higher temperatures, is when batteries have internal chemical reactions that reduce stored charge without being used. Ambient conditions like temperature impact the round-trip efficiency of the complete energy storage system.

As for the service life question surrounding battery technology, Sprenkle said this can be improved on by using the right technology for the right application. Li-ion batteries degrade faster when maintained at a high state of charge, for example, while the opposite is true for lead-acid batteries. Charging at high rate can damage Li-ion and zinc-based chemistries, whereas some lead-acid cell designs prefer a high charge rate.

Wellinghoff said that, while his area of expertise is policy and the energy market — and he "only knows enough about electrochemistry to be dangerous" — he is skeptical of newer technologies that have yet to show they can constitute a large share of the battery market.

"There are multiple other chemistries beyond Lithium, that's true. I have yet to see one that is a clear, breakthrough winner," Wellinghoff said. "Vanadium has been around a while, but it's still struggling to gain any kind of significant market share."

He added that many in the industry think of battery storage being only large-scale utility storage in front of the meter, but behind-the-meter storage also should be considered.

**Behind-The-Meter Opportunity**

Speaking of his home in Berkeley, which has energy storage as well as solar panels and an electric vehicle, Wellinghoff said this array of technologies delivers potential benefits to utilities that he as a consumer might not have had in mind.

"I didn't buy it to support the grid. I bought it to take me to the store or protect me from blackouts, like the one we had here last October. So, the price doesn't matter so much. The price is baked into some other use," Wellinghoff explained. "So, if [the California independent system operator] says if you make some of that energy storage available to us every month, I will pay you US$20 a month. That's great. I'll take that."

Wellinghoff added that FERC's Order 2222 will enable this sort of market participation. The policy will allow distributed energy resource (DER) aggregators to function as market participants and use their resources in a way that accommodates their physical and operational characteristics.

"It's about what the consumer who may have storage behind the meter is using it for, multiple purposes [like] driving around, going to the supermarket, protecting themselves from blackouts," Wellinghoff said. "I may be willing to use parts of my resource to protect the grid if I were compensated for that. So, you get a lot more and multiple uses for the asset when it's behind the meter."

# ELECTRIC VEHICLE NEWS

Using batteries this way has been made cost-effective by the improvements shown by battery technology in the past two decades.

Greg Dixon, CEO of Voltus Inc., a software company that packages DERs together for commercial, industrial, residential and institutional customers, said batteries are going through a "virtuous cycle" right now.

"Batteries are going the way solar has for the past 20 years. Density, cost, integration — everything has been improving to make it a cheaper source of energy. It's a virtuous cycle: more application, more demand, more capacity," Dixon explained.

Dixon also drew a comparison in the way these resources can be pooled with how computer science has advanced.

"Think about computing in the '70s. It was just mainframes. Nothing was networked. Now, we have everything networked; it's nothing but [that]. Power is moving that direction, too," Dixon said.

**New Battery Uses**

Dixon agreed with ESA's Burwen that all sizes and types of utilities now are getting into batteries.

"Battery energy storage is a great dancing partner for intermittent renewables. Just about every utility is trying to use more renewables. The simple answer is they all are," Dixon said.

Jon Newman, market applications associate at Fluence Energy, a joint venture of Siemens and AES Corp. that is developing large energy storage projects in more than a dozen countries, said the front-of-the-meter energy storage market is dominated by independent power producers with one-term power purchase agreements.

"That's where we see most of the growth, most of the megawatts. Utilities directly owning projects are becoming more scarce and we see this as a trend that will continue," Newman said.

The flexible peaking capacity of energy storage batteries is rising to challenge natural gas-powered peaker plants, he said, and the batteries are flexible enough to be used in other ways. For example, his company is looking at energy storage as a transmission asset.

"We are very bullish on this. We use the acronym VTL: virtual transmission line. You might see this also called storage as a transmission asset. In our view, this is a major growth opportunity for utilities to deploy capital and increase their resilience," Newman explained.

According to Fluence, VTL can add transmission network capacity faster and at lower cost than traditional pole and wire projects. A solution of this type was proposed by Fluence in Australia and would use a pair of 250-MW facilities.
Newman said the mature state of energy storage is addressing the efficiency issues temperature extremes introduce to batteries.

"We have packages that can harden the battery against cold or hot weather," Newman noted. "We have batteries in very hot places, in the desert in Chile, and also in cold places like [the Northeastern U.S.] and Northern Europe. We have one that's even north of the Arctic Circle."

# ELECTRIC VEHICLE NEWS

Regarding life-cycle issues, Newman said Fluence looks at battery arrays as 20-year lifetime assets, perhaps longer.

“The batteries do degrade along time, but built into the system is overbuild when the system is new or augmentation by adding cells to an existing system to maintain its power rating. It’s almost considered an O&M cost,” Newman said. “Doing this doesn’t disrupt the normal operation of the system.”

As a company, Fluence is technology agnostic and constantly reevaluates the technologies it uses. Newman said flow batteries and hydrogen-based energy storage are on Fluence’s radar.

“All techs have different roles to play on the grid, and they each have things they excel at,” Newman said.

**Hydrogen, A New Storage Fuel?**

Hydrogen could be a pathway to achieve 100-plus hours of energy storage, PNNL’s Sprenkle said. Excess electricity is used to split hydrogen from water. The hydrogen is stored either in high-pressure tanks or naturally occurring caverns and then fed into a fuel cell to make emission-free electricity.

“Declining electrolyzer and fuel cell cost will enable greater adoption of these systems, but the biggest challenge may be the low round-trip efficiency of the process. Taking account of the losses in generating the hydrogen, the energy required to compress and store it, and then the additional losses when converting hydrogen back to electricity — these systems may only be 30% to 40% efficient compared to batteries that can accomplish the same at greater than 80%,” Sprenkle said.

Because of these losses, the power generated by the process must be worth nearly twice the input just to break even, Sprenkle added. Making hydrogen this way is more valuable as a feedstock for chemical processes or a transportation fuel than it is for converting it back to electricity.

“Improving the round-trip efficiency of these systems will help the economics, but ultimately the resiliency gained from long-duration storage systems like hydrogen will need to be recognized and monetized appropriately,” Sprenkle added.

One application for hydrogen power, Wellinghoff said, could be using it in existing power plants whose owners want to get away from fossil fuels.

“Hydrogen does make sense at a site that has available interconnection into a large amount of renewables. Hydrogen can be produced at that site and used in a power plant,” Wellinghoff said. “So, I think hydrogen has a role to play with helping use off-peak renewable power that would otherwise be curtailed or dumped.”

Wellinghoff said he does not see this as being cost competitive with conventional battery storage.

Burwen said there is enthusiasm for hydrogen because it offers an answer to the life-span problem batteries have, and it can be transported somewhat easily to other places, unlike large, heavy batteries.

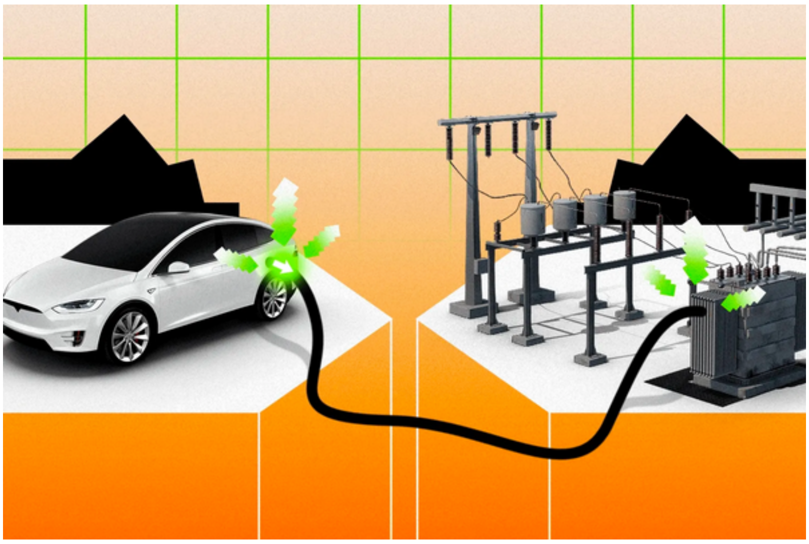
“There’s questions as to what that looks like, but folks are starting to pilot projects. There’s a stage where you take it from the lab to the pilots,” Burwen said. “NextEra Energy has a pilot project planned, and I suspect there will be more underway. [The Los Angeles Department of Water & Power] is premising their decarbonization on a hydrogen strategy.”

# ELECTRIC VEHICLE NEWS

## CALIFORNIA'S VEHICLE-T0-GRID EXPERIMENTS OFFER GLIMPSE OF THE FUTURE

By Grace Donnelly | 19 March 2022 | Source: Emerging Tech Brew

**It's the US leader in bidirectional EV charging, which lets people contribute energy back to the grid.**



The tech already exists for an EV battery to power your house. Now carmakers, utilities, and regulators are working out how that energy-storage tech could help bolster bigger things—namely, the power grid, as both the demand for electricity and reliance on renewables grow.

California has been the US leader in policies that support electrifying transportation, and is crafting regulations that would ban the sale of any new gas-powered cars in 2035. In October 2019, the state passed a bill that requires the California Public Utilities Commission (CPUC) to maximize the use of "feasible and cost-effective" vehicle-grid integration by 2030—one of only a few of its kind in the country.

Vehicle-grid integration (VGI) encompasses both what the industry refers to as V1G, meaning intelligently-managing EV charging, as well as vehicle-to-grid (V2G), which involves discharging power from the vehicle's battery back to the grid.

"We've got a pretty volatile grid here, to say the least. We've got a lot of public safety power shut-offs and just a lot of renewables that we need to figure out how we can sustainably integrate that into the grid," Sarah Woogen, head of US operations and analytics at charge management company Mobility House, told Emerging Tech Brew. "Because of that, and because California policymakers just tend to be a little more progressive than some other states, we are seeing a lot happen here first, which is expected."

Since it passed its 2019 VGI bill, California has been backing programs to determine how to deploy and scale VGI technology.

"It runs the gamut from your sort of simpler off-peak charging rebates, to dynamic rates, up to demand-response programs, where you're just shifting or modulating the charging of the vehicle or the fleet. And then all the way up to these bidirectional use cases where you're providing backup power, or providing other services to the grid and providing other value to the customer," Zach Woogen, policy specialist at the California-based nonprofit Vehicle-Grid Integration Council (VGIC), told us.

While California is putting resources behind these VGI programs, it is certainly not the only state thinking ahead on V2G technology. New York, Colorado, and Massachusetts also have pilots in place. And beyond government initiatives, utilities and private companies are getting involved, too: Just last week, the utility Pacific Gas and Electric (PG&E) announced it will partner with both GM and Ford on V2G pilot projects in California, neither of which are part of the state's programs.

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# ELECTRIC VEHICLE NEWS

**Testing, testing**

The CPUC and California Energy Commission (CEC), along with other state agencies such as the California Air Resources Board, are working together on best practices for VGI. The state is funding pilot programs to figure out how to work EVs into the power grid, without draining drivers' batteries and hampering their travel needs.

Last year, the CPUC expanded its Emergency Load Reduction Program (ELRP)—designed to manage energy supply and demand to avoid electricity outages—to include more EV participation. The program pays customers $2 per kWh for exporting energy from the vehicle's battery, which VGIC's Woogen said could amount to hundreds or thousands of dollars in earnings annually, depending on the type of EV and charger.

The ELRP now enables aggregation of residential and commercial EV battery capacity in order to create an energy source large enough for utilities to manage. This summer could see megawatt-scale participation from the new aggregator subgroup of ELRP (which will likely be composed of customers ranging from school buses to individual EV owners), according to VGIC estimates.

VGIC's Woogen said that's important because it's the first program in the US that attempts to address the scalability of VGI.

"It's allowing aggregators this opportunity to really construct a business model and really provide this value to their customers," he said.

The CPUC is also facilitating funding for investor-owned utilities in the state to research VGI education and compensation for customers. PG&E and utility Southern California Edison have asked the CPUC to approve a combined $29 million in funding for seven different VGI pilots.

San Diego Gas & Electric, another major utility, is hoping to get approval from the CPUC for a V2G Export Rate that would compensate customers who discharge energy from EVs to the grid, though the application is still in the early stages, according to VGIC's Woogen.

The state is interested in advancing vehicle-to-building (V2B) applications as well. The CEC is currently evaluating applications for $19.5 million in grants to fund pilot programs that use EV batteries as backup power for homes and other buildings.

These pilots will be focused on verifying the safety of V2B tech and testing how it might improve grid resilience during outages, Kiel Pratt, supervisor of the transportation planning and analysis unit at the California Energy Commission, told Emerging Tech Brew.

# ELECTRIC VEHICLE NEWS

“[That program is] to move the ball forward with that kind of technology development, making sure there’s an ecosystem for not just equipment providers, but validating that these things can be installed safely and used by customers,” he said.

**What’s next**

VGI is still years away from a scenario where EVs can seamlessly supply power to the energy grid.

Using an EV battery as an alternative to a generator when you need backup power is one thing, but ensuring that electricity can safely be distributed to the grid requires considerations about complicated electrical issues like direct current vs. alternating current, interconnection, and interoperability.

Policy makers can encourage interoperability by making it a prerequisite for grant funding, Woogen from Mobility House said. But the main difference between using EV batteries as backup power in a V2B application and putting electricity back onto the grid is interconnection, she said. Independent systems operators (ISOs), which control the electrical power system, need to be able to bring energy from behind the meter (on the customer’s side) to front-of-meter (on the grid side).

"A lot of the ISOs are now going to start looking at, ‘What is the pathway to allow that?’ But even that’s five years in the future, maybe more,” she said.

And even if all the technology works together perfectly, convincing EV owners to participate is “where a lot of the work lies,” VGIC’s Woogen said. In addition to providing people with sufficient education and incentives, Pratt said participation must be easy.

“Maybe some of the early adopters are energy nerds, and they don’t mind looking at the stats or getting out their phone to configure something pretty often,” Pratt said. “But really, this stuff is not going to work at scale if it’s cumbersome for the customer.”

# ELECTRIC VEHICLE NEWS

## WE NEED TO THINK BEYOND LITHIUM

By Thomas Maschmeyer | 19 April 2022 | Source: Sydney Morning Herald

Are electric cars becoming the victim of their own success? This week Stuart Crow, chair of lithium producer Lake Resources, highlighted a critical problem on the battery horizon. " There simply isn't going to be enough lithium on the face of the planet, regardless of who expands and who delivers, it just won't be there," he said.

There has been a global surge in new car sales of electric vehicles. Globally, plug-in EV registrations were up 99 per cent in February, year-on-year . In the UK there were more EVs sold in March than for all of 2019; a 78.7 per cent surge on March 2021, according to SMMT (the Society of Motor Manufacturers and Traders).

In Norway 86 per cent of all new car sales in March were EVs. Even in less developed markets, like Australia, sales of electric cars have tripled, albeit from a low base. March was the best month ever for EV sales in Australia, now at 2.5 per cent of the market.

By 2030 EVs are expected to hit about half of all new car sales, up from about 8 per cent last year. Across Europe, governments are mandating the phasing out of the internal combustion engine for personal cars. The UK is set to ban the sale of petrol and diesel cars from 2030.

This is great news for the planet, right?

Sure. But everything has knock-on consequences. EVs need batteries and for now that means lithium.

In the 12 months to the beginning of March the price for lithium carbonate, a base raw material to make lithium batteries, skyrocketed more than 700 per cent, according to Trading Economics.

Lithium prices have hit historical highs with a run-on impact into batteries prices and supply chain bottlenecks. The geopolitical crisis triggered by the Russian invasion of Ukraine is adding to the uncertainty.

According to Benchmark Mineral Intelligence, at current rates by 2030 demand for lithium batteries will outstrip supply by more than five times the entire 2021 lithium market.

This has created an unsustainable raw material crunch horizon for lithium-ion batteries and their applications.

While most consumers will focus on what this means for EVs, mobile phones and laptops, perhaps a more serious impact of these surging prices will be in the stationary energy storage market.

Without sustainable, safe and affordable energy storage for wind and solar farms, the global transition from an economy based on fossil fuels to renewables will be impossible.

What does this mean for the energy transition?

# ELECTRIC VEHICLE NEWS

Analysts Wood Mackenzie estimate that by 2030 there will be 1 terrawatt-hour of battery energy storage deployed worldwide, a massive hike on today's capacity. This will require billions of dollars in energy storage infrastructure investment. This is a huge market that lithium-ion batteries alone will simply not be able to supply.

All this energy from wind and solar will need to be stored somewhere. We will need batteries everywhere to support a renewable and decentralised energy grid.

If lithium is being squeezed, what else will we use to store this enormous amount of energy?

It is quite right that lithium is prioritised for EVs, electronic consumables and the emerging electronic aviation industry. Lithium is a super-light element and, despite lingering safety concerns, ideal for small transport and mobile electronics.

But lithium is no longer the only game in town when it comes to stationary energy storage. Other technologies are coming online, whether they use sodium, zinc or vanadium. Energy storage systems for wind and solar do not need to move, so systems based on heavier raw materials can be just as good as lithium, right?

In fact, they can be better.

Alternative energy storage systems can use safer, more abundant and cheaper materials to store renewable energy. And many are far more suited to long-duration energy storage needed for gridscale solar and wind power.

For the energy transition to work it comes down to being able to successfully capture energy when the sun is shining and the wind is blowing and store it for long enough and safely enough to despatch when it is needed.

The market is forcing the pace of the energy transition and lithium on its own will not be able to fill this demand. This will need a diversification in the raw material base for renewable energy stationary storage systems.

Thomas Maschmeyer is a professor at University of Sydney and founder and principal technology advisor at Gelion.

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# RETROSPECT

## THE ELECTRICAL ASSOCIATION FOR WOMEN (AUSTRALIA), SYDNEY

By Terry Miller | April 2022

Clarence and Grosvenor streets 1936


Contributed By Private collection
(Electrical Association for Women Cookery Book, compiled and published by Mrs FV McKenzie, Director of the Electrical Association for Women (Australia) Sydney, published by The Electrical Association for Women (Australia), Sydney 1936, p 4)

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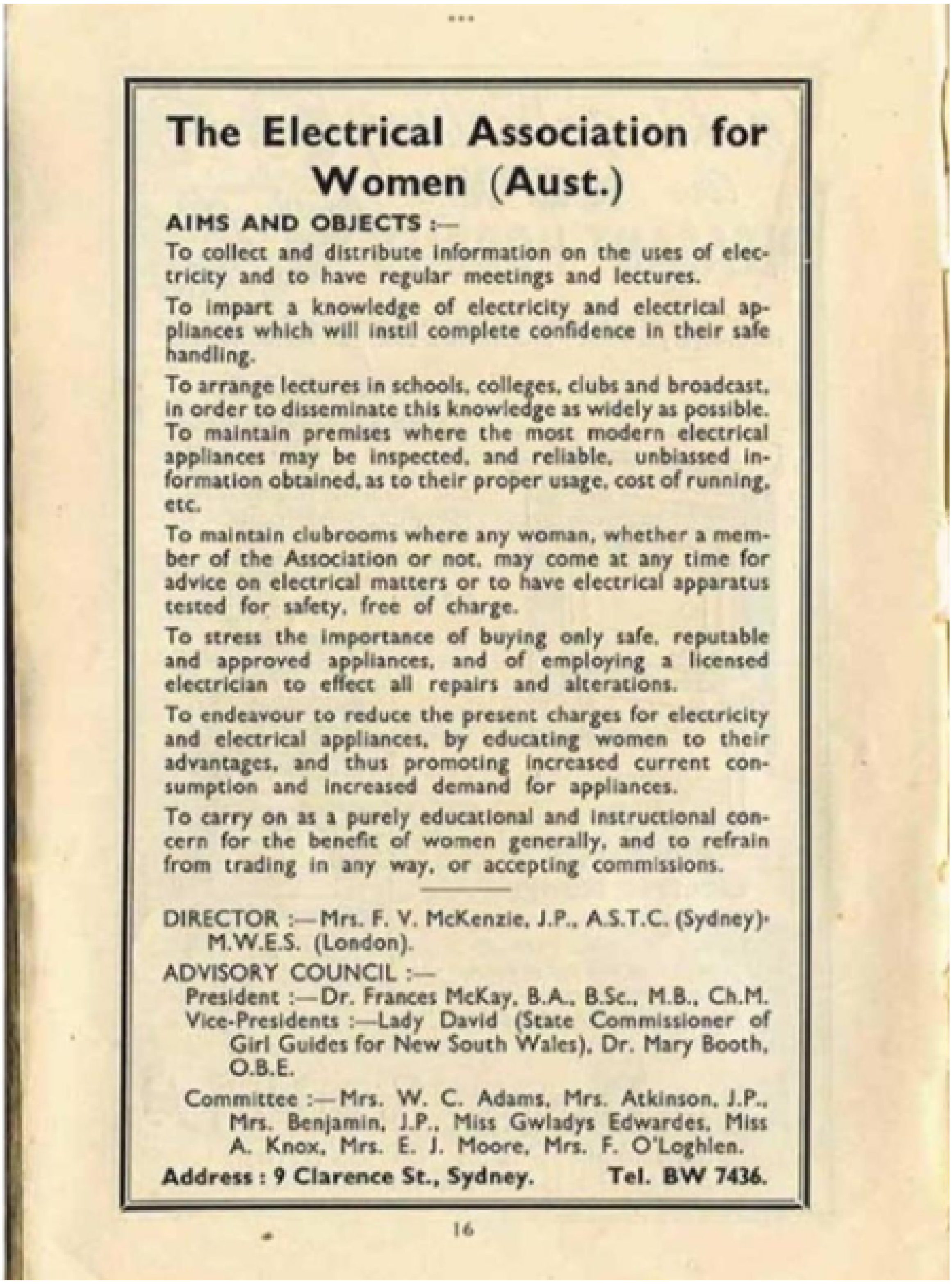
# RETROSPECT



## The Electrical Association for Women (Aust.)

**AIMS AND OBJECTS :—**

To collect and distribute information on the uses of electricity and to have regular meetings and lectures.

To impart a knowledge of electricity and electrical appliances which will instil complete confidence in their safe handling.

To arrange lectures in schools, colleges, clubs and broadcast, in order to disseminate this knowledge as widely as possible. To maintain premises where the most modern electrical appliances may be inspected, and reliable, unbiassed information obtained, as to their proper usage, cost of running, etc.

To maintain clubrooms where any woman, whether a member of the Association or not, may come at any time for advice on electrical matters or to have electrical apparatus tested for safety, free of charge.

To stress the importance of buying only safe, reputable and approved appliances, and of employing a licensed electrician to effect all repairs and alterations.

To endeavour to reduce the present charges for electricity and electrical appliances, by educating women to their advantages, and thus promoting increased current consumption and increased demand for appliances.

To carry on as a purely educational and instructional concern for the benefit of women generally, and to refrain from trading in any way, or accepting commissions.

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# HUMOUR BREAK


*"After I introduce you to solids, I'm going to need your help with some computer stuff."*

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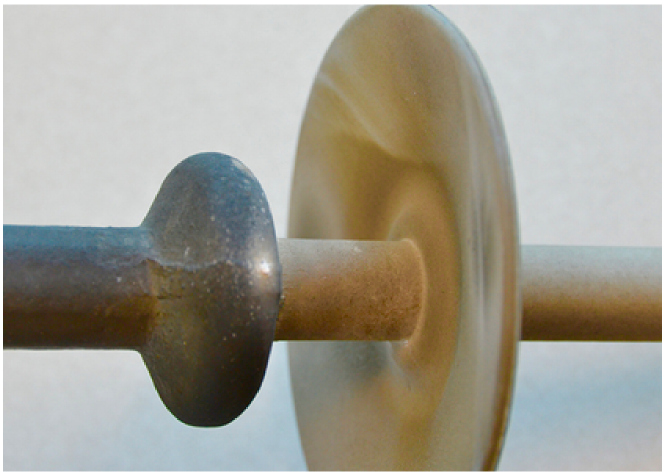
## INTERNATIONAL NEWS

# Corona: Deadly Enemy for Polymeric Insulation

By INMR | 1 April 2022 | IMNR

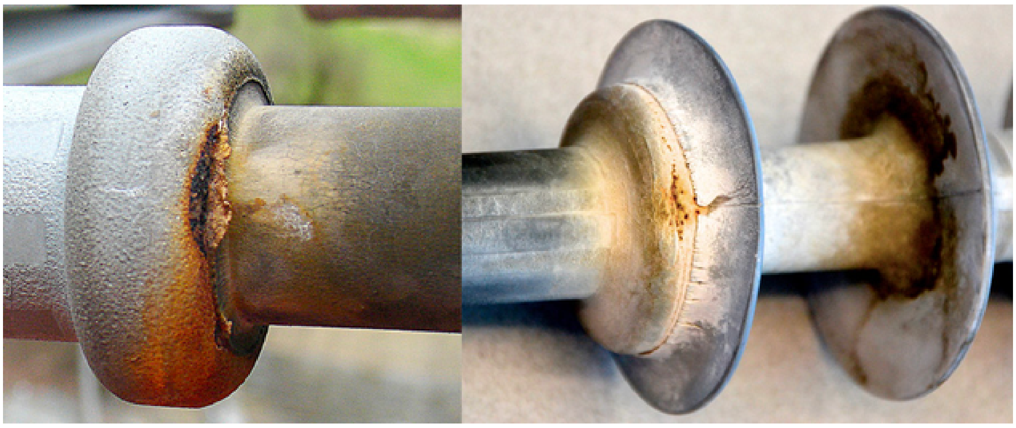


It has long been known that corona can lead to insulation failure. However not all aspects of the problem are fully understood and are still being researched, including magnitude and duration of corona to initiate degradation, best detection methods and development of suitable tests to predict performance in its presence.


Detection of corona using UV cameras.

When it comes to composite insulators, corona activity can originate from hardware, voids within the material or from interfacial defects. Most of the light produced by such corona has a wavelength shorter than 400 nm and therefore falls in the UV range. By contrast, most solar radiation is in the 400-700 nm visible range – the shorter wavelengths filtered by the earth's ozone layer. In fact, some peaks in the UV region of the corona spectrum match or exceed those in the solar spectrum. Polymeric materials are more susceptible to degradation from UV produced by corona than from solar radiation, particularly if the corona takes place close to the material. Corona ruptures stable oxygen molecules (O2) to create radicals that combine with the molecules to form ozone (O3). The ozone then attacks double and triple bond sites in elastomeric materials such as silicone rubber or EPDM. The result is cracking. Even tiny amounts of ozone in the ppm range are sufficient to initiate cracks, however the time required for this depends on material formulation.

# INTERNATIONAL NEWS



Examples of insulator degradation initiated by corona.

Although most modern elastomers are stabilized against this threat, some eventually succumb to ozone attack should its concentration become sufficiently high. Corona also produces oxalic and nitric acids in the presence of surface moisture from humidity, dew or fog. Depending on pH, this can also locally degrade polymers. Corona can even 'drill' holes in a material, suggesting that degradation is not solely due to chemical attack by ozone. In fact, researchers have calculated the temperature at the tip of the discharge and shown it to be high enough to cause 'evaporation' of even inorganic materials. There is also suggestion of mechanical attack, like sandblasting, due to the impact of repeated discharges on a material. It is indeed rare in power engineering that any one physical phenomenon can trigger so many possible modes of degradation.

To illustrate the potential impact of corona, past research involved ground-based inspection of composite insulators on 115 kV, 230 kV and 500 kV lines in the U.S. southwest using a corona camera and binoculars. Several 230 kV towers were equipped with composite insulators with and without corona rings on adjacent phases. The 115 kV insulators did not have corona rings whereas the 500 kV insulators had rings on the line as well as on the ground end hardware. Given the dry conditions of the service territory, the utility operating these lines had decided not to replace the 230 kV insulators not equipped with corona rings. This allowed comparative study of the effects of corona on composite insulators since all other factors were the same (i.e. same design, material, manufacturing details, location and system voltage). The corona observed on these insulators, many of which had been in service for over 25 years, was sporadic and originated from hardware.

The 230 kV insulators being evaluated comprised three generations of composite insulator technology. Some were removed for further examination and it was found that the shed closest to the line end without a corona ring exhibited minor to serious changes in the form of hardening, cracking and discoloration. It was clear that these insulators were approaching their end of useful life and indeed would have probably already failed in locations having more precipitation. By contrast, none of the insulators equipped with corona rings showed such degradation. This demonstrated that when it comes to composite insulators, design and need for a corona ring depend not only on voltage level but also service environment. For example, in the case of insulators in environments with heavy contamination, high altitude or frequent wetting, it is prudent to have a line end corona ring even at lower transmission voltages.

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# INTERNATIONAL NEWS

## Environmental Microsensors in Utility Applications

By Brent Barker | April 2022 | EPRI Journal

Advances in electronics manufacturing are driving the proliferation of small, portable, inexpensive environmental sensors. These *microsensors* are far less expensive than the larger monitoring equipment used today by the electric power industry for compliance with environmental regulations. However, the number of parameters that they can measure is limited, and the measurement quality is not regulatory-grade. Nevertheless, as their performance improves and costs come down, the future role of environmental microsensors is likely to expand.

"Monitoring equipment is being miniaturized," said EPRI Principal Technical Leader Stephanie Shaw. "Although microsensors don't include the complex analyzers and extra calibrations needed for regulatory compliance, they have the potential to provide utilities with screening data in unmonitored areas and supplement existing monitoring programs. They can run on batteries or small solar panels and are light enough to be carried by technicians, whereas regulatory-grade instruments are very bulky and often must be stored in climate-controlled cabinets."

To date, the quality of microsensor measurements has not been consistently high, though the U.S. Environmental Protection Agency (EPA), the California South Coast Air Quality Management District, and other industry stakeholders are working to improve measurement quality through thorough testing and comparison against reference instruments. Microsensors may also put environmental monitoring in the hands of the public. Today it's feasible as part of emerging "*citizen science*" for the public to use smartphone-powered sensors to measure air quality near industrial facilities. This has spurred some utilities to work with EPRI to test these devices.

EPRI's *SENTINEL* project is investigating the potential of new microsensors, and electric utilities in the United States have hosted field studies of three applications: measuring airborne particulate matter near a coal-fired plant, measuring indicators of groundwater quality near a *coal ash* impoundment, and real-time monitoring of ground movement at a coal ash impoundment.

"We're trying to answer two questions," said EPRI Senior Technical Leader Bruce Hensel. "First, since there has been insufficient verification of the quality of these sensors, we want to find out what they can and cannot measure in the field and assess the accuracy of the data they capture. Second, if they work well, do they represent an opportunity for utilities to expand their environmental monitoring networks and save on monitoring costs?"

Environmental applications for microsensors potentially relevant to utilities include:

- Provide environmental data to help identify the best locations for regulatory-grade monitoring instruments
- Detect pollutants at power generation facilities
- Create early warning/detection systems
- Monitor worker exposure
- Educate local communities and other stakeholders about environmental conditions and other issues

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# INTERNATIONAL NEWS


A microsensor for groundwater monitoring.

**Particulate Matter at Coal Piles**

The utility hosting the study of particulate matter measurements wanted to know if microsensors could detect a dust plume coming from the power plant's on-site coal stockpiles. Those in long-term storage, typically a year or more, are coated with a sealant, while those being moved and conveyed into the plant are subject to wind and other weather.
Downwind of the coal piles, EPRI and the utility tested microsensors that measure various sizes of airborne particulate matter (1, 2.5, and 10 microns). Their accuracy was gauged relative to measurements from equipment whose precision is accepted by the U.S. federal government.

The nine-month test yielded mixed results for the microsensors. Comparisons to the reference monitor showed numerous false positives when the temperature fell below 0°C. The sensors didn't perform well in winter cold or summer humidity but did pick up the dust plume under more moderate conditions.
"The sensors are not perfect, but they are useful for screening. They can fairly reliably detect the presence of windblown dust and, when placed in multiple locations, give utilities a tool to inform action," said Shaw.

**Measuring Ground Movement**

Another utility's network of ground movement microsensors monitors the stability of berms (man-made embankments) at a coal ash impoundment. The utility has shared its real-time data with the SENTINEL team, which in turn will share with other industry stakeholders.

Sensors known as piezometers measure *pore water pressure*. In-place inclinometers measure the lateral displacement of a berm. Settlement plates characterize the interface between native soil and fill material, and other sensors measure soil settlement at various depths.

"The ground movement tests revealed that these are very sensitive instruments and provide a powerful data set capable of showing early stages of ground movement. This provides an early warning system for potential failure of berms, dikes, or impoundments at coal ash facilities, giving utilities time to take action to shore-up these structures before a catastrophic failure occurs," said Hensel.

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# INTERNATIONAL NEWS

**Measuring Groundwater Quality**

EPRI is also testing microsensors in a groundwater monitoring project at a coal ash management facility. At present, there is no suite of microsensors that can replace a comprehensive groundwater monitoring program, which relies on laboratory measurement of pH, total dissolved solids, sulfate, chloride, calcium, and boron as well as various trace elements, such as molybdenum and arsenic. Microsensors are available only for measuring pH, chloride, and electrical conductance (which provides a close parallel to total dissolved solids).

"Whereas the ground movement sensors are reliable and provide very useful information, sensors for groundwater monitoring are not as advanced," said Hensel. "For the most part, the groundwater sensors we need are not available. The ones that are available are not cost-effective yet; they are not always reliable and require routine maintenance."

That said, new microsensors can supplement traditional groundwater monitoring in a few applications. "Strategically positioned sensors can provide additional data between manual sampling events, particularly in *karst* and other groundwater systems with rapid flow," said Hensel.

**"Wide Open" Future**

"We wanted to give these new microsensors a solid test in practical applications at utility facilities, comparing them with the more expensive, sophisticated monitoring systems used by utilities today," said Shaw. "They are at an early stage of development, and we see promise if not perfection. Because of their portability and lower cost relative to other monitoring equipment, they are ready for some specific applications now—detecting a coal dust plume, characterizing water flow underground, providing early warning of dike instability. The future possibilities are wide open. EPRI will continue to track microsensor technologies with potential to provide more detailed environmental data and lower utilities' monitoring costs."

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## Extreme air pollution hampering India's solar electricity generation

By E&T editorial staff | 1 April 2022 | E&T

**India will struggle to meet a target of generating 100 gigawatts of solar power this year as high levels of atmospheric pollution are hindering the country's ability to generate energy, a study has found.**

Atmospheric pollution reduces solar power generation because it both absorbs and scatters the Sun's rays, as well as leaving deposits on solar panels that reduce their efficiency.

A study carried out by IIT Delhi calculates that between 2001 and 2018 India lost 29 per cent of its solar energy potential as a result of atmospheric pollution - equivalent to an annual loss of £635m.

As of March this year, India had only reached the halfway mark of 50 gigawatts of installed solar capacity, according to the research group, Mercom India.

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# INTERNATIONAL NEWS

Put simply, aerosols - which include fine particulate matter, dust, mist and fumes suspended in the air - significantly reduce incoming solar radiation in what we call the 'atmospheric attenuation effect'," said study author Sagnik Dey. "This needs to be factored in when undertaking large solar energy projects."

Many projects are also failing to account for the "soiling effect" of aerosols depositing on solar panels altogether, he added.

"Since air pollution over South Asia has been on the rise, both effects need to be addressed and mitigation steps taken to maximise benefits from solar power installations."

In heavily polluted regions particulate matter can cause a drop in photovoltaic solar power generation by more than 50 per cent, most of it caused the soiling of panels, according to a previous study. Aerosols in the atmosphere also work against solar power generation by increasing cloudiness and interfering with rainfall which could wash out particles.

Acid rain can also corrode solar power equipment and support structures which increases maintenance costs. Acid rain is caused by pollutants like sulphur dioxide and nitrogen oxides, released mainly through industrial and vehicular emissions, rising high into the atmosphere and mixing with water, oxygen and other chemicals to form corrosive acid droplets before falling back as rain.

"Mitigating air pollution would certainly reduce smogginess which can in turn improve solar power generation, and modelling studies do suggest that polluted clouds have a longer life and that aerosols inhibit precipitation," said Bhupendra Das, environmental researcher at Nepal's Tribhuvan University, Kathmandu.

"However, it is well to remember that there are several other factors to cloudiness than air pollution."

The study recommends optimally tilting solar panels to take maximum advantage of solar radiation which will help to reduce the accumulation of aerosol deposits when compared to horizontal panels.

Articulated panels fitted with tracking mechanisms to constantly follow the sun are more expensive than fixed panels, but also have greater resistance to the accumulation of aerosol deposits.

According to the study, the best way to enhance solar energy production is to implement government initiatives such as the National Clean Air Programme launched in 2019 with the aim of reducing fine particulate matter (PM2.5) concentration by 20 to 30 per cent by 2024 relative to 2017 levels.

Mitigating air pollution would "accelerate India's progress to achieve its solar energy target at a lesser installation capacity, avoiding additional expenditure for the expansion of solar energy infrastructure", the study reads.

The Swiss IQAir world air quality report for 2021 shows the whole of northern India falling in a zone which exceeds the WHO standard of 10 microgrammes per cubic metre for particulate matter by seven to 10 times.

A study from 2017 showed that China's air pollution problem was also hampering its efforts to increase the amount of electricity it generates from solar panels.

# INTERNATIONAL NEWS

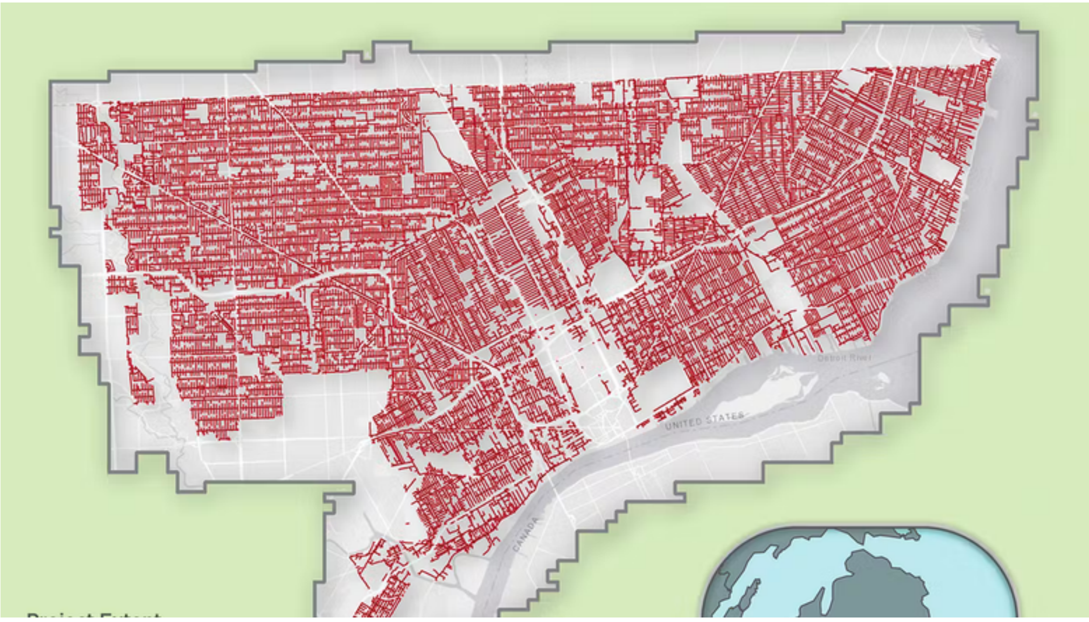
## Leveraging High-Density Distribution LiDAR in Detroit

By A. J. Smith and Craig Jackson | 14 January 2022 | T&D World

The total return on DTE Energy's investment for the data-gathering technology was 10.5 times the initial outlay for the utility.

Two years ago, DTE Energy faced a limited operations and maintenance budget for vegetation management along with territory-specific challenges. The Detroit, Michigan-based utility set a goal to decrease vegetation-related outages while optimizing its vegetation management budget.

To better understand the risk across its system, DTE considered implementing a light and detection ranging (LiDAR) survey, commonly used by utilities to provide accurate measurements of vegetation proximity to conductors of highly regulated transmission lines administered by the North American Electric Reliability Corp. (NERC). A LiDAR survey also could play an integral role in helping the utility to transition from cycle-based maintenance to condition-based maintenance.




DTE's 2018 project area, above, contains more than 2,300 miles of distribution and sub-transmission lines that Quantum Spatial acquired high-density LiDAR data for vegetation management analytics.

# INTERNATIONAL NEWS

In addition, DTE was interested in whether LiDAR analytics could provide similar accuracy and value to its distribution lines. Would the return on investment (ROI) lower the utility's overall vegetation management spend?

**Pressing Problems**

To test whether LiDAR could provide the desired ROI, the utility looked inward at its service territory. DTE's territory contains roughly 31,000 miles (49,890 km) of distribution lines and sub-transmission lines. Partially a result of Detroit's economic downturn, DTE experienced population loss and urban blight, leaving the utility with fewer customers and putting stress on its vegetation management budget.

The downturn also left Detroit with rising safety concerns and access issues, which resulted in a decade of limited maintenance for some regions. A significant amount of the distribution rights-of-way (ROW) contained dense vegetation that posed substantial outage risk to DTE's system and customers. These circumstances made Detroit a suitable area for remote inspections. DTE kicked off a project to test LiDAR's ability to identify, measure and prioritize risk, and see if it could be done at an ROI that would enable the utility to maintain or reduce its vegetation management budget.

**Performing Inspections**

To test the technology's efficacy for distribution vegetation management in Detroit, DTE engaged Quantum Spatial Inc. to plan and perform the wide-scale LiDAR collection. Quantum Spatial collected the LiDAR data, using a Piper PA-31 twin-engine aircraft equipped with a RIEGL 1560i LiDAR sensor, and delivered it to DTE just 16 days after project initiation.

The project resulted in a raw and classified LAS point cloud with an average point density of 32 points per sq m. The LiDAR survey produced several valuable data sets that could contribute to DTE's vegetation management strategy.

**Vegetation Encroachment Categories:**

At the time of flight, vegetation was encroaching on a primary wire:

| ZONE | DESCRIPTION |
|---|---|
| 1 | Within 1.5 ft |
| 2 | 1.5 - 3 ft |
| 3 | 3 - 6 ft |
| 4 | 6 - 9 ft |
| 5 | 9 - 15 ft |

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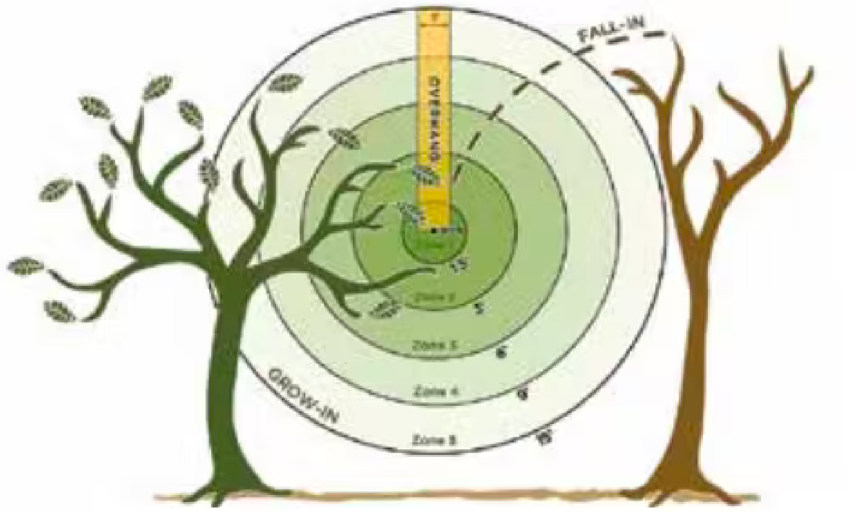
# INTERNATIONAL NEWS




Overhang: A tree is found to have a branch overhanging up to 15 ft above a wire and within half a foot on either side of the wire | Fall in: A tree is found to have the potential to fall across the line based on proximity to wire and tree height.

Critical to DTE, the survey identified all vegetation encroaching or tall enough to strike its conductors, providing a comprehensive and detailed inventory of the project area's vegetation threats. These threats were classified according to their proximity to the nearest primary wire as well as by their potential to fall in or overhang above the wire by up to 15 ft (4.6 m).

The utility also received a full inventory of vegetation encroachment by volume. The encroachment was broken down into priority zones to better assess each circuit's immediate needs. In addition to vegetation encroachment data, the survey also provided critical information like rectified pole and span locations and a detailed clearance analysis.

Following completion of the survey, DTE conducted spot checks of 200 locations to assess the accuracy of the LiDAR data. Encroachments measured in the survey were accurate to within 4 inches (102 mm), a level of accuracy previously unavailable to the utility. The spot checks also helped DTE and Quantum Spatial to identify the survey's limitations and understand how best to use the data.

**Volumetric Analysis**

Though the results of the LiDAR survey were accurate when estimating encroachment to conductors, vegetative conditions in the area resulted in unique challenges. When producing canopy segmentation data, the survey struggled to identify codominant stems where one trunk may separate into multiple canopies. In addition to struggling with codominant stems, DTE found planning work based on only priority-zone threat levels did not provide enough context for planning the actual work needed for each tree canopy.

To provide further context, DTE turned to Quantum Spatial's volumetric assessment to focus on severe encroachments and understand the volume of vegetation that needed to be removed per individual zone infraction. By relying on the volumetric analysis within each priority zone, as opposed to relying strictly on a LiDAR-based tree count, DTE was able to shift its focus to ensure it was making the most effective decisions when prioritizing assignments.

# INTERNATIONAL NEWS

**A Paradigm Shift**

Prior to LiDAR, DTE's service territory introduced a high level of uncertainty when managing bids from outside service providers. Because of the accessibility demands and scale of sensitive areas, the utility rarely can inspect potential encroachments comprehensively prior to routine trimming.

The character of the region's geography encourages contractors to make opportunistic bids or forces contractors to build significant contingencies into their pricing. Because of the inherent unknowns in its territory, DTE was forced to concede these higher costs.

The new trove of data available to DTE brought about a fundamental shift in the bid negotiation process. With a standardized, quantified inventory of encroachments, the utility could level the playing field among vendors and drive competitive pricing. The new data was useful for managing time and equipment (T&E) contracts as well as negotiating fixed-bid contracts, as the LiDAR data enabled DTE to quantify precisely the work involved to each bidder.

Armed with precise data, DTE developed models to determine whether bid estimations matched the reality of the assignment. The utility trained its machine-learning algorithm, a linear regression model, by providing it with examples of circuits with known vendor bids.

As more information was provided to the model, it could estimate the cost of future contractor work by drawing correlations with historical data. Most importantly, the model could identify outlier circuits that may be overbid, empowering DTE employees to compare the bid price with the LiDAR survey.

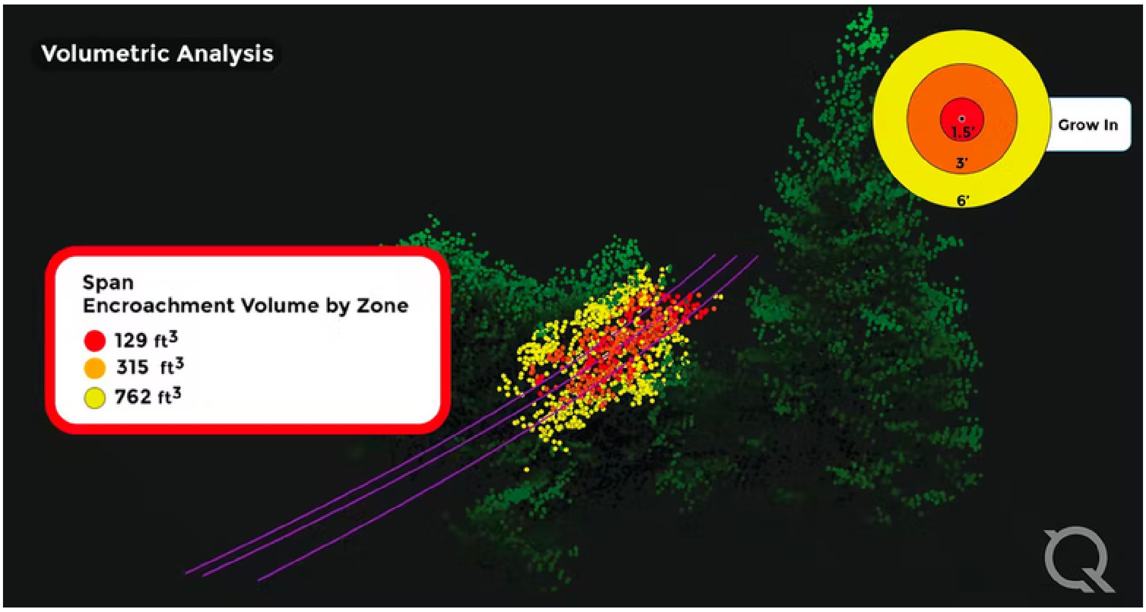
Using a K-means clustering algorithm, the model grouped similar circuits together based on the structure of the LiDAR data. The K-means clustering model further enhanced the conclusions of the linear regression model, emphasizing those bids that did not align with historical performance and enabling DTE to negotiate pricing further, based on solid data.

**Contract Costs**

DTE put its LiDAR data to the test in a series of bid negotiations for both expedited and general maintenance trimming. In one instance, the LiDAR pricing model predicted the contractor line mile cost should be just 48% of current prices on a T&E contract. Using the model's estimated bid, DTE provided an actionable target line mile cost to the contractor. The utility shared the LiDAR-based audit information with the contractor to show its current productivity was almost double that of the calculated run rate. This conversation led to the contractor's cost falling about 30%.

One of the greatest successes of the LiDAR program was the ability to identify an area of unexpectedly severe vegetation encroachment relative to its anticipated maintenance cycle. Using the encroachment data derived from the LiDAR survey, DTE was able to expedite maintenance trimming in the area. The expedited maintenance trimming request went out with a firm fixed-price bid and covered a single substation in a highly sensitive community.

# INTERNATIONAL NEWS




Red, orange, and yellow lidar returns designate the cubic feet of vegetation required to be removed on a single span of distribution wires. This cubic assessment assists work planning, contract negotiations, and contractor auditing.


Red, orange and yellow lidar returns designate vegetation encroachment severity and push pin colors designate encroachment type. Volume required to be removed is attributed and shown at the encroachment zone level. This assessment assists work planning, contract negotiations and contractor auditing.

# INTERNATIONAL NEWS


The utility received multiple bids that were higher than expected. Therefore, DTE used the LiDAR data to quantify the true work volume for the substation and, subsequently, the true work value of the project. The pricing model generated estimated bids for the assignment, and the utility ultimately saw a final price reduction of 28.6% for its expedited maintenance trimming request. These savings covered the entire cost of the Detroit LiDAR survey project.

**Defining Bid Scope**

In addition to ongoing and expedited 2019 projects, DTE applied its LiDAR survey data to its yearly contracting process for 2020. All bidders were provided with the LiDAR data results, which included a true and comprehensive assessment of the locations and amount of work that needed to be performed.

In previous years, DTE had observed an extremely high variance in bid prices between vendors and frequently received bids that did not align with the utility's expected cost. The detailed LiDAR information brought contractors and DTE to a consensus, where DTE received total bid prices from all bidders that were within 5% of the utility's anticipated 2020 cost. Beginning the bid process with fundamentally accurate data and having less variance between bids provides a level playing field for contractors and DTE. This data also enables more reasonable expectations for bids from both parties moving forward.

Additionally, the utility was able to negotiate discrepancies on an individual circuit level between the predicted price and bid price based on the LiDAR and volumetric results, successfully driving down the final cost of the agreements even further.

**Condition-Based Program**

In addition to the trim contracting benefits, the LiDAR data enabled DTE to identify critical vegetation hotspots so it could proactively address situations that pose imminent outage threats and, in turn, extend the trim-cycle life of these circuits.

# INTERNATIONAL NEWS

Furthermore, the LiDAR data empowered DTE to identify areas where contractors failed to meet their trimming obligations. Multiyear LiDAR data collections over the same area will further enhance this capability as well as provide additional change-detection analytics, such as providing information about growth rates.

Ultimately, LiDAR data enabled DTE to make a program shift from cycle-based maintenance to condition-based maintenance. Making the shift to condition-based maintenance is a topic of interest for many utilities, as prioritizing and allocating trimming to be based on threat and need instead of a somewhat arbitrary timeline is logical.

That said, the shift requires time, logistical planning and change management, as it is a significant departure from how many utilities and trim contractors operate today. Most importantly to make the shift, utilities need to know exactly where vegetation threats are across their system and how to prioritize them, which is exactly what LiDAR surveys provide.

**Benefits Beyond ROI**

Following completion of the project, DTE worked with Quantum Spatial to conduct a thorough yet conservative cost-benefit analysis that included data points such as corridor miles, inspection frequency, average clearing cost per mile, system average interruption duration index and system average interruption frequency index.

The predicted ROI for the project area over a five-year cycle included both outage reduction and trim reduction as well as the overall optimization of inspections and trimming. The total ROI was 10.5 times DTE's initial outlay. Since completing the original LiDAR survey in December 2018, DTE has commissioned additional surveys to capture other areas of its service territory. Based on the success of the program, the utility is considering expanding it on an executive level.

The impact of DTE's LiDAR survey has extended beyond financial gain. Most importantly, the increased efficiency of the utility's vegetation management program has led to improved public relations, as an overall decrease in outages has boosted customer satisfaction. The program's deliberate targeting of vegetation also has led to a safer work environment for DTE employees and its contractors, as the targeted data enables field employees to limit the amount of time spent in sensitive neighborhoods.

In the short-term, DTE will continue to use volumetric data analytics to inform targeted trimming strategies, future vegetative growth and bid negotiation techniques. DTE also plans to explore other remote-sensing technologies to monitor vegetation control in more rural areas of its service territory. As the utility continues to perform cyclical LiDAR surveys over the next several years, new information will feed into its models to adapt and enhance a more comprehensive program, further honing its effectiveness.

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# INTERNATIONAL NEWS

## Lithium-ion roadblocks drive development of US-based alternatives for grid battery storage

By Elizabeth McCarthy | 5 April 2022 | Source: Utility Dive

*Adeline Kon/Utility Dive*

**Dive Brief:**

- There is a growing focus on emerging battery technologies that use domestic minerals and elements because supply chain constraints are impeding lithium-ion battery storage. According to university, government and industry officials, alternate battery chemistries must and can become cost-competitive.
- To help meet growing decarbonization goals, preferred alternatives to lithium-ion need to be long-duration, with at least 10 hours of output, and have minimal or low toxicity, experts agreed at an April 1 session of MIT's 2022 Energy Conference.
- Emerging grid storage technologies in the running include sodium and iron-air batteries, ones using stacks of retired electric vehicle car batteries with considerable life remaining, and those reusing metals from recycled EV batteries.

**Dive Insight:**

Lithium-ion batteries are the dominant technology used for energy storage today but since the start of the war in Ukraine, the price of imported lithium has gone up twofold, said MIT professor Yang Shao-Horn. It is "now the most expensive component" in lithium-ion batteries, she told conference participants. The price of other key metals has also soared. "This sharp increase in the cost of lithium potentially can drive other [storage] technologies and move them faster," she said, pointing to sodium-ion battery chemistries as one example. This technology is "moving rapidly," nearly matching lithium-ion's battery performance, with costs expected to be "substantially lower," Shao-Horn noted.

President Biden highlighted the need for domestically-sourced technologies March 31 when invoking the Defense Production Act to reduce reliance on foreign imports of key elements and metals used in the soaring grid battery storage and EV markets. Biden's move authorizes the Department of Defense "to support the production and processing of minerals and materials used for large capacity batteries" while ensuring "strong environmental, labor, community, and tribal consultation standards."

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"You can't have high toxicity," Thomas Winter, Fluence vice president of strategic technologies, told the MIT audience, "As costs have come down, new technologies have become unlocked," a trend that's expected to continue, Winter said. He stressed that both domestic sources of battery elements and local battery manufacturing are key. If batteries are headed to the U.S. market, they need to come from the U.S., if used in Europe, they need to come from Europe, or if used in India, they must come from India, Winter added.

Like Shao-Horn, Winter also touted the promise of sodium-ion batteries. "Solid-state batteries are exciting" because of their density and the fact that they're safer than lithium-ion, he said.

Another promising technology is metal-air chemistry, including iron-air.

If sodium and metal-air battery technologies become cost-competitive, they are superior to lithium-ion storage because they are more stable with lifetimes that are more than twice as long — 25 years compared to lithium's eight to 10 years, Lawrence Berkeley National Laboratory Senior Scientist and Division Director Robert Kostecki told Utility Dive.

Form Energy is developing a battery using iron, air and water to create what it calls "reversible rusting." Expected to be able to discharge for up to 100 hours, "the battery breathes in oxygen from the air and converts iron metal to rust," according to the company. It has been awarded federal grants from the Department of Energy's Advanced Research Projects Agency-Energy and the state of California. In late February, Form Energy signed a deal with Georgia Power for a 15 MW/1,500 MWh storage project.

Scott Burger, Form Energy senior manager, said at the April 1 MIT conference session that the company is looking at ways to buy zero-carbon iron. That includes powering production with renewably-powered green hydrogen.

Burger estimated the installation costs of iron-air batteries will be below $20 kWh, which will help the technology compete with lithium-ion batteries and also the gas-fired generation they would replace.

Other developing storage technologies include electric vehicles with grid-connected communication software that can supply power to the electric system at times of stress. Another candidate is reusing EV batteries that lack sufficient capacity for driving needs but are sufficient for energy storage.

As the transportation system gets more electrified, that represents terawatt-hours of power that can be part of our power system, said MIT's Shao-Horn.

***Correction:*** *An earlier version of this story misidentified the source of federal grants for Form Energy. They came from the Department of Energy's Advanced Research Projects Agency-Energy. In addition, the article misquoted Fluence's Thomas Winter, who used the term solid-state batteries, not salt-state. We have corrected the quote accordingly.*

# INTERNATIONAL NEWS

## Magneto-electric transistors promise low power future for non-silicon chips

By E&T Editorial Staff | April 2022 | Source: E&T

**Scientists have created what they believe is the first magneto-electric transistor that could help to make electronics more power efficient.**

Along with curbing the energy consumption of any microelectronics that incorporate it, the team's design could reduce the number of transistors needed to store certain data by as much as 75 per cent leading to smaller devices.
It could also lend those microelectronics "steel-trap memory" that remembers exactly where its users leave off, even after being shut down or abruptly losing power

Many millions of transistors line the surface of every modern integrated circuit, or microchip. By regulating the flow of electric current within a microchip, the tiny transistor effectively acts as a nanoscopic on-off switch that's essential to writing, reading and storing data as the 1s and 0s of digital technology.

But silicon-based microchips are nearing their practical limits, and the semiconductor industry has been investigating new technologies to help chips progress further.

"The traditional integrated circuit is facing some serious problems," said researcher Peter Dowben at the University of Nebraska-Lincoln. "There is a limit to how much smaller it can get. We're basically down to the range where we're talking about 25 or fewer silicon atoms wide. And you generate heat with every device on an (integrated circuit), so you can't any longer carry away enough heat to make everything work, either."

"So you need something that you can shrink smaller, if possible. But above all, you need something that works differently than a silicon transistor, so that you can drop the power consumption, a lot."

So rather than depend on electric charge as the basis of its approach, the team turned to spin: a magnetism-related property of electrons that points up or down and can be read, like electric charge can, as a 1 or 0.

They combined a layer of graphene with chromium oxide which allowed them to flip the spins of the atoms at its surface up or down by applying a small amount of temporary, energy-sipping voltage.

When applying positive voltage, the spins of the underlying chromium oxide point up, ultimately forcing the spin orientation of the graphene's electric current to veer left and yield a detectable signal in the process.

Negative voltage instead flips the spins of the chromium oxide down, with the spin orientation of the graphene's current flipping to the right and generating a signal clearly distinguishable from the other.

"Now everybody can get into the game, figuring out how to make the transistor really good and competitive and, indeed, exceed silicon," Dowben said.

The new, lower power, approach could help to cut the energy footprint of digital memory by 5 per cent globally if widely adopted, the researchers predict.

# INTERNATIONAL NEWS

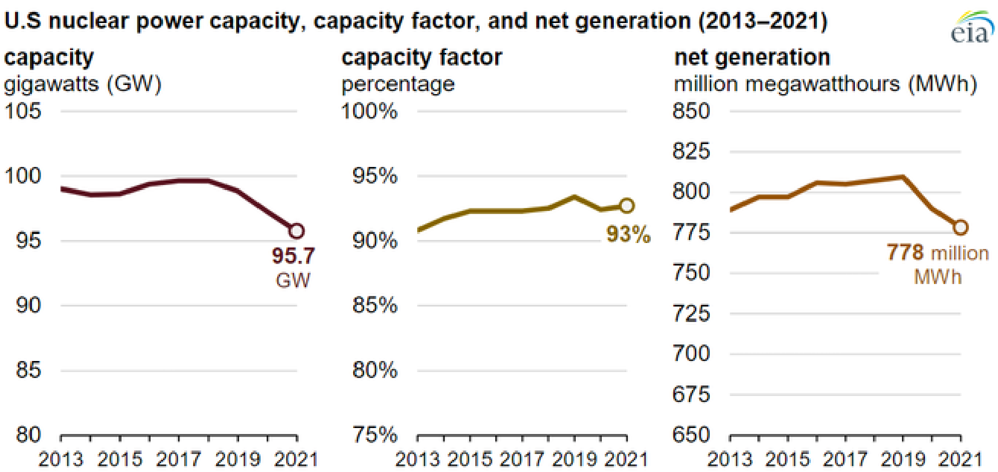
## U.S. nuclear generation declines for second straight year

By Kevin Clark | 12 April 2022 | Source: Power Engineering

U.S. nuclear power generation declined for the second straight year, according to the latest reporting from the Energy Information Administration (EIA). Output from the country's nuclear fleet totaled 778 million MWh in 2021, a 1.5% decline from 2020.

Six nuclear units with a total capacity of 4,736 MW have retired since the end of 2017. In 2021, Entergy shut down the nuclear reactor for Unit 3 at Indian Point Energy Center in Buchanan, New York. The decommissioning of Indian Point's final operating reactor was announced several years prior following pressure from numerous political groups.

Indian Point's first unit entered commercial operation in the early 1960s. Unit 2 went offline permanently in 2020. Despite the retirements, Nuclear's share of U.S. electricity generation across all sectors in 2021 closely mirrored its average share in the previous decade: 19%.




***Source*** *U.S. Energy Information Administration, Electric Power Monthly*

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# INTERNATIONAL NEWS

In the coming years, three more reactors with a combined 3,009 MW of capacity are scheduled to retire Michigan's Palisades is expected to retire later in 2022, and California's Diablo Canyon is slated to retire one generating unit in 2024 and a second in 2025.

Although output has been increasing from renewable energy sources and natural gas plants, EIA noted the U.S. nuclear fleet continues to operate at high and consistent utilization rates. Additionally, the Biden Administration has identified the nation's fleet of 93 reactors as an important clean energy resource.

The U.S. Department of Energy (DOE) is seeking input on a newly established $6 billion program aimed at supporting the continued operation of U.S. nuclear reactors.

The Civil Nuclear Credit Program (CNC) was born out of the infrastructure bill signed into law in November 2021. It allows owners and operators of commercial reactors to apply for and bid on credits to support their continued operations. Credits are intended to be allocated over a four-year period beginning on the date of selection.

A recent Associated Press survey of the energy policies in all 50 states and the District of Columbia found that about two-thirds said that nuclear, in one fashion or another, will help take the place of fossil fuels. Roughly one-third of the states had no plans to incorporate nuclear power in their green energy goals

Two nuclear generating units remain under construction in Georgia. Vogtle Units 3 and 4 are expected to come online by the end of 2023. Each unit is rated at 1,114 MW, and they will be the first nuclear units to come online in the United States since 2016. Numerous cost overruns and construction problems have delayed the project to this point.

## Long Duration Energy Storage Council - Form Energy - Best practice modeling to achieve low carbon grids

Source: Long Duration Energy Storage Council

**Form Energy**
**Why Today's Grid Planning Tools Fall Short and How New Approaches Can Lower Electric Costs and Increase Reliability**

**EXECUTIVE SUMMARY**

Transitioning to a zero carbon electricity grid is likely to be a multi-trillion dollar undertaking1. Nearly one in three Americans currently have difficulty paying their energy bills,^2 underscoring the importance of making this transition at least cost and ensuring that electric utilities, regulators and grid operators have the best possible analytical tools available to plan future energy resource investment.

Utilities use a type of tool called a capacity expansion model to plan least-cost portfolios of energy resources (including

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generation, transmission and energy storage) to meet forecasted energy demand and clean energy goals. Many of the models in wide use today are ill-equipped to cost effectively guide the transition to a low-to-zero-carbon grid because they were not designed to account for the variability of renewable energy resources from hour to hour over a year, or across multiple years.

In this study, we articulate our view of best practices that modelers can use to plan cost effective and reliable low carbon grids. This view is backed by leading academics and practitioners. We highlight some key limitations of many of the commercially available tools today, summarize research underscoring the costs of these issues, and point to methods that modelers should use to plan lower carbon, lower cost, more reliable grids. Finally, we summarize a case study using Form Energy's capacity expansion tool and data from one of Form Energy's commercial partners^3 , to demonstrate the measurable cost and reliability benefits that best-practice modeling methods can bring to utilities and their customers. The case study underscores many of the major findings from academia.

**Limitations of incumbent capacity planning tools**

The capacity expansion models in wide use today were designed around a planning mindset that assumed that thermal power plants are predictable and available when needed. Thus, if the electric grid had enough resources to meet peak demand, the grid would be capable of meeting demand at any other time. These tools were also built in an era that lacked the computational power and analytical methods available today. As a result, the tools include certain simplifications to save computational time and analytic complexity. Most notably, legacy capacity expansion models:

1. Design resource portfolios based on limited time samples: Rather than make investment decisions based on a model of at least one full year, incumbent models design resource portfolios using a small sample of hours or days, and assume that this trimmed down time series accurately captures the full intra-year variability of renewable resources and storage.
2. Design portfolios using 'typical' operating conditions: Incumbent models optimize portfolios for using 'typical' weather data, relying on reliability models to ensure the resulting portfolios are reliable across weather conditions. However, renewable generation and demand varies significantly from year-to-year, and portfolios designed for a single snapshot are less cost effective and reliable than a portfolio designed for diverse grid conditions.

- 1 One recent cost estimate comes from Chloe Holden, 2019. The Price of a Fully Renewable US Grid: $4.5 Trillion.
- 2 U.S. Energy Information Administration, 2018. One in three U.S. households faces a challenge in meeting energy needs.
- 3 The case study relies on sensitive data. We have anonymized the data and partner identification as a result.

**Capacity expansion model capabilities needed**

Academic and industry progress in building new capacity expansion models has led to an emerging set of best practices about how to plan low carbon grids that rely substantially on renewables and storage. Where possible, capacity expansion models should:

1. Make investment decisions based on at least one full year of grid operations at hourly resolution , including weather and load variability that reflects day-to-day, week-to-week, and season-to-season fluctuations.
2. Make investment decisions based on multiple weather years and key future system conditions , such as technological availability, commodity prices, or other variables.

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Incorporating this level of granularity often requires modeling trade-offs, and the academic literature points to advanced modeling techniques that can avoid the need to capture multiple years of weather and system data at 8,760-hour granularity. Where these techniques are employed, it's critical that their efficacy is benchmarked against the full granularity model. Despite the impact of model simplifications on planning outcomes, few commercial models today use the advanced methods pursued in academia and none provide any guarantee of the performance of the model simplifications employed.

**The benefits of modern capacity expansion modeling**

Lower Costs: Models that represent hourly grid operations and can co-optimize portfolios across multiple scenarios produce lower cost portfolios than models that use time sampling and typical weather years. Our case study confirms existing research and finds that, for one particular utility, full year, hourly resolution modeling produces portfolios that are more than 10% cheaper than time sampled portfolios.

Accurate Technology Representation: Models that preserve the full time chronology of a year can accurately model technologies like long duration energy storage, which can produce energy continuously over days and can shift energy across seasons. By contrast, models that break apart the year's chronology often can't accurately model such technologies. Time sampling techniques overestimate baseload value, underestimate flexibility value, and often exclude long duration storage technologies altogether.

Increased reliability: Full year, hourly resolution modeling and co-optimization across scenarios of future system conditions produces portfolios that are more reliable than those produced by less capable models that consider single snapshots of the future.

**INTRODUCTION**

The U.S. spends roughly $200 billion each year^4 on electricity generation to meet growing electric demand and to replace old power plants. These investments translate to costs for customers, and, if insufficient, the electric grid's reliability can suffer. Further, investments in new fossil fueled power plants can lock utilities into producing high levels of greenhouse gas emissions and causing other environmental and health damages that last decades. It is essential that decision makers make the best, most informed investments possible.

Electric utilities and their regulators rely on capacity expansion models

- computer models that help utilities identify the least cost portfolio of power infrastructure investments needed to meet demand
- as one of the primary tools to inform their investment decisions.^5 Unfortunately, the vast majority of the capacity expansion models used today were developed for electric grids with fossil fuel backbones and embed many assumptions that reflect this fact.

The power system is changing. In 2010, wind and solar contributed less than 2.4% of U.S. electricity generation capacity, but this quadrupled to 9.9% by 2019. Renewables and storage comprise the majority of planned power investments around the country, portending a continuation of these trends (see Figure 1). As the power sector transitions, the models utilities and developers use to guide their investment decisions need to adapt as well.

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**Study purpose**

This study compares new, best-in-class capacity expansion modeling approaches with existing modeling tools to evaluate how their differences impact electric resource needs, portfolio costs and reliability in grids with high levels of renewables. The study reviews the current state of capacity expansion planning and highlights some of the primary shortcomings of these planning techniques. This paper then recommends capacity expansion modeling best practices drawn from academic and industry research. Finally, this paper summarizes a simple case study based on data from one of Form Energy's utility partners, to underscore the value of these recommendations.

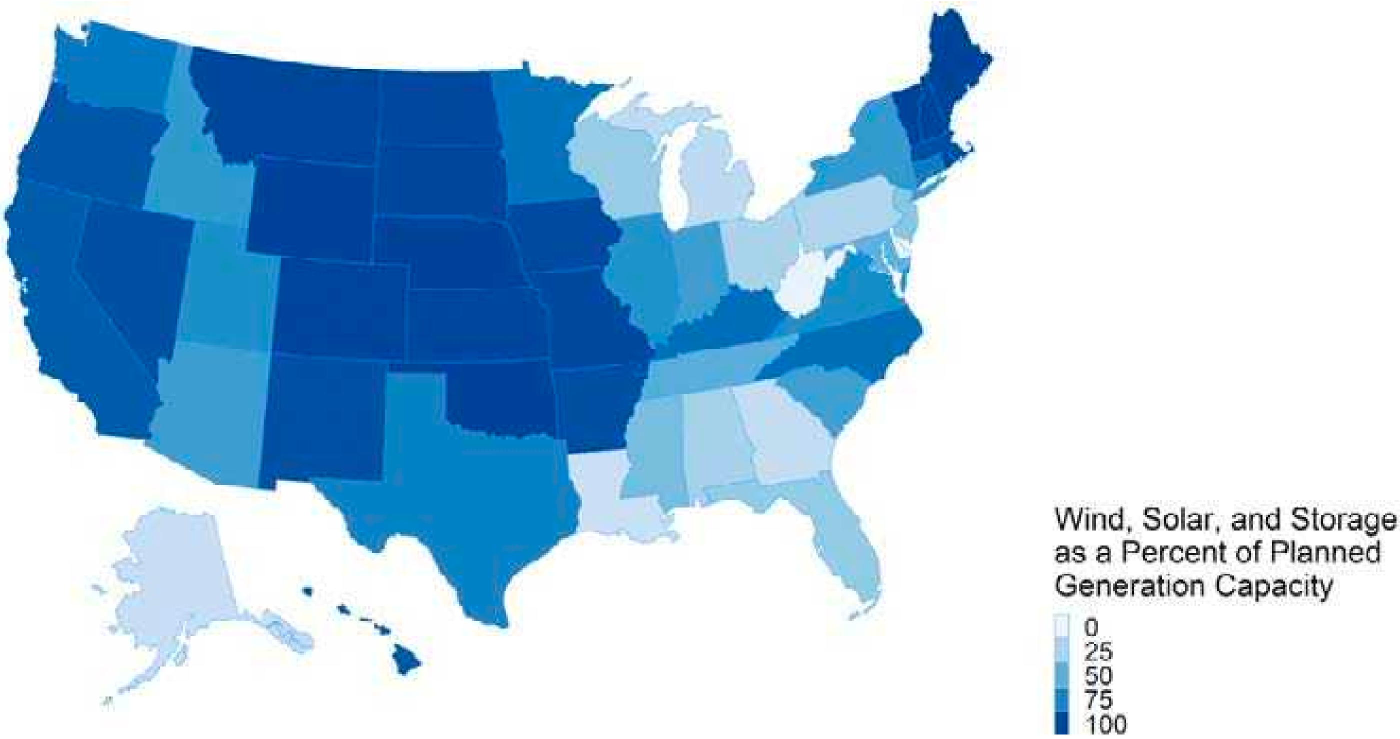


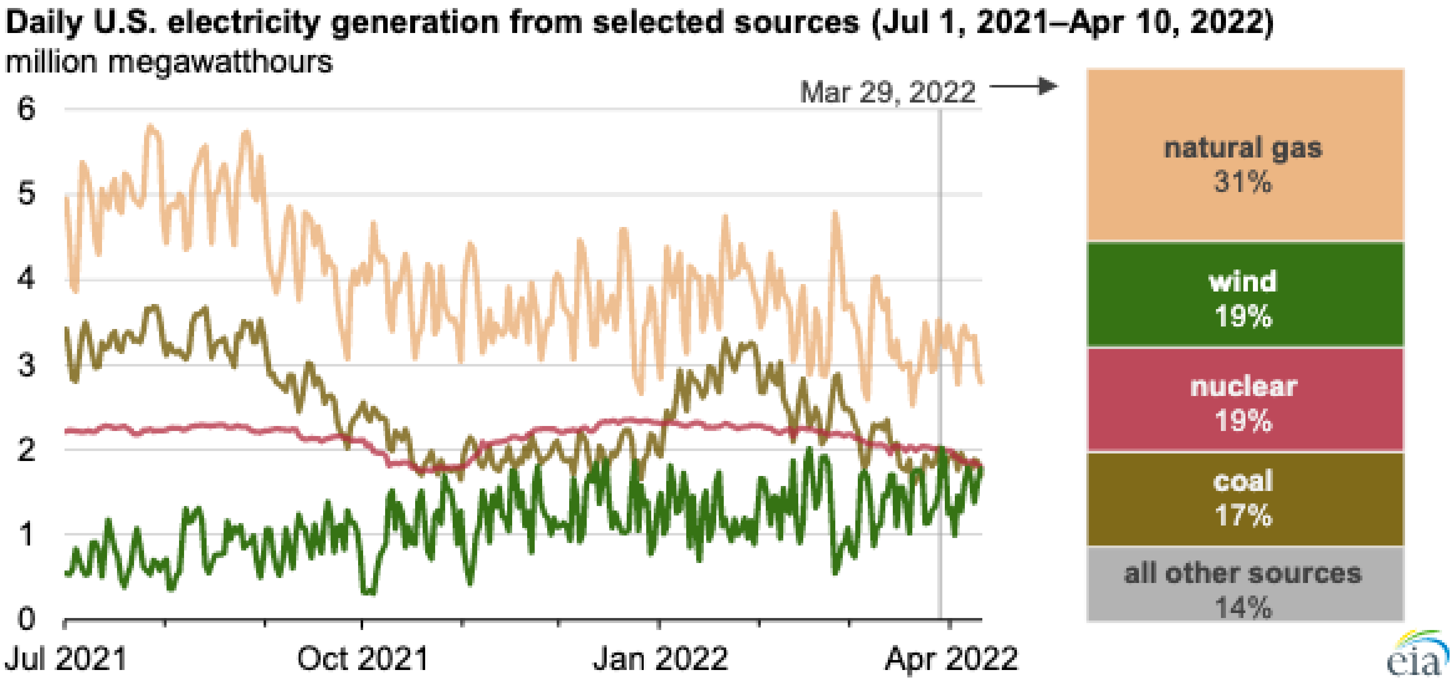

**Figure 1: Renewables and storage as a fraction of planned generation capacity by state**

To read the full whitepaper you can download it here.

# INTERNATIONAL NEWS

## Wind was second-largest source of U.S. electricity generation on March 29

14 April 2022 | Source: US Energy Information Administration

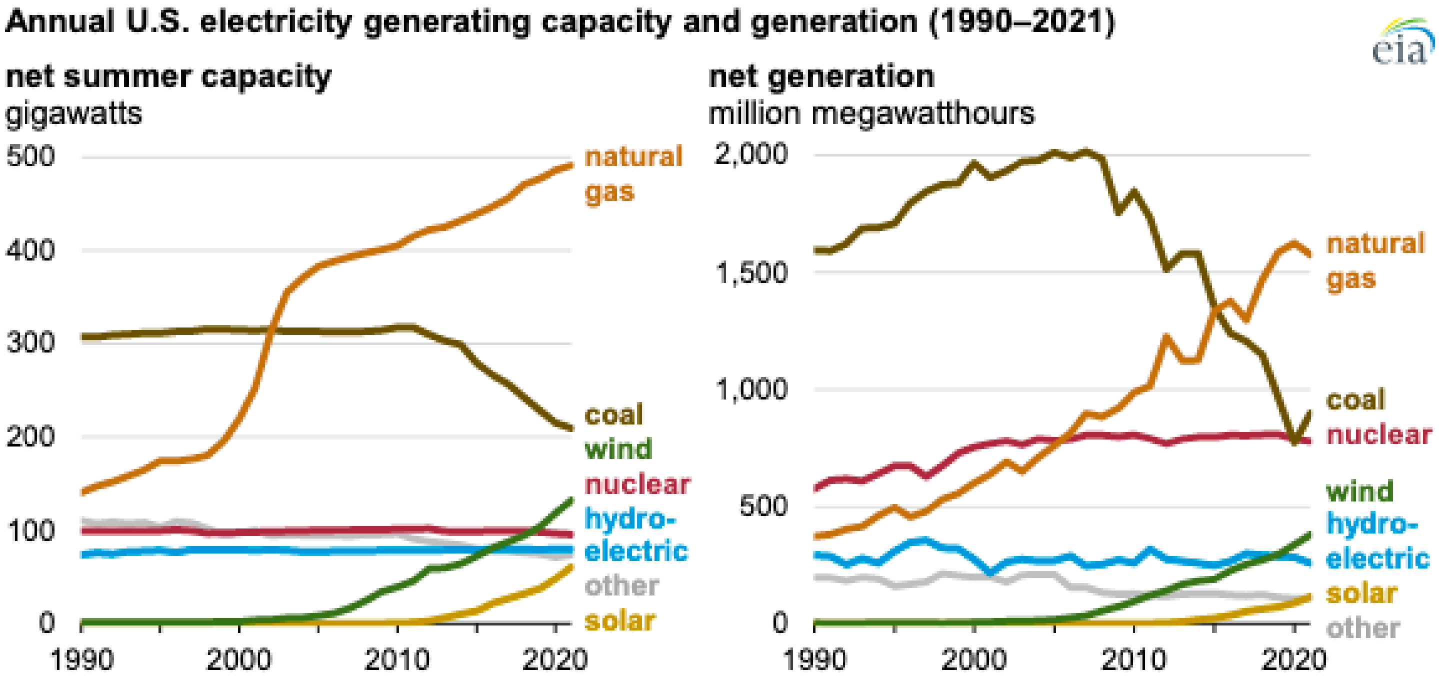



On Tuesday, March 29, wind turbines in the Lower 48 states produced 2,017 gigawatthours (GWh) of electricity, making wind the second-largest source of electric generation for the day, only behind natural gas, according to our *Hourly Electric Grid Monitor*. Daily wind-powered electricity had surpassed coal-fired and nuclear electricity generation separately on other days earlier this year but had not surpassed both sources on a single day.

Consistent growth in the installed capacity of wind turbines in the United States has led to more wind-powered electricity generation. In September 2019, U.S. wind capacity surpassed nuclear capacity, but wind still generated less electricity than nuclear because of differences in those technologies' utilization.

The average capacity factor of U.S. wind generators (35% in 2021) is lower than the average capacity factor of nuclear generators (93% in 2021), which are designed to run at or near full output, which they typically do. Wind turbines currently rank as the third-largest source of generating capacity in the United States, behind natural gas-fired generators and coal-fired generators.

# INTERNATIONAL NEWS




In the United States, wind speeds, and correspondingly, wind-powered electricity generation, often peak during spring. On March 29, the Southwest Power Pool (SPP), which covers parts of Oklahoma, Kansas, Nebraska, North Dakota, South Dakota, and neighboring states, and the Electric Reliability Council of Texas (ERCOT) both reported new wind penetration records. Wind penetration represents the share of electric demand satisfied by wind generation. SPP reported wind penetration of 88.5% on March 29, and ERCOT reported wind penetration of 67.2% for the same day.

Because electricity demand tends to be lowest in the spring and fall months, some generators—including both nuclear and coal—reduce their output or scheduled maintenance during these months. Also, on days when weather patterns lead to more wind generation, competing coal-fired and natural gas-fired generators often are called upon to reduce their output so that overall electricity supply matches demand.

The natural variation of wind speeds contributes to very different amounts of wind generation, depending on the time of day or season. Wind first ranked as the second-largest source of U.S. electricity generation for an hour in late March 2021. On a monthly basis, we have had less wind generation in the United States than natural gas-fired generation, coal-fired generation, or nuclear generation. We do not expect wind to surpass either coal-fired or nuclear generation for any month in 2022 or 2023, based on our most recent *Short-Term Energy Outlook* forecast.

Our *Hourly Electric Grid Monitor* publishes electric generation from generators that are metered within reporting balancing authorities. Typically, balancing authorities do not meter generators on the distribution system—both large-scale resources and small-scale distributed resources, such as rooftop solar photovoltaic systems. The data series in our *Electric Power Monthly* represent our official statistical reports and include both large-scale and small-scale resources in the generation data.

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# INTERNATIONAL NEWS

## All Bets Are Off For US Energy Outlook

April 2022 | Source: EEnergy Informer

*EIA's forecasts were dated before the publication came out*

Perry Sioshansi in the April edition of EEnergy Informer writes that in early March 2022, the Energy Information Administration (EIA) released its Annual Energy Outlook (AEO2022). The timing was unfortunate. With the war engulfing Ukraine and threatening to spread beyond, practically every assumption made in projecting the future are off even though the US is physically removed from the conflict. Global energy prices – oil, gas, coal, you name it – have risen significantly as markets react to the prospects of a protracted war and the potential for the conflict spreading beyond Ukraine's borders, either by design or accident. The International Energy Agency (IEA) is recalibrating its models to reflect the new geopolitical realities of energy

Assuming no war in Ukraine post Ukraine invasion. It has already released a ten-point plan to reduce global demand for oil in response to the crisis.

Stay tuned. Until the dust settles, expect uncertainty, volatility and supply disruptions. Virtually everycountry, net exporters as well as importers, will be re-examining their energy security vulnerabilities and adjusting policies as they go. For the short-term, many countries will put their climate concerns on the sidelines as they scramble to meet their energy needs for the immediate future. Germany, for one, has already decided to go back to the drawing board on its energy goals.

These issues aside, the longer term trends in the US electricity sector are likely to prevail, namely no new coal or nuclear additions between now and 2050 and lots of renewables. US retail electricity prices,low by international standards, are expected to not only remain low but to drop, thanks to the addition of low cost renewables which will require significant additional storage .While the growth of renewables are expected, the EIA does not seem to be nearly as bullish as California about their future prospects.

https://www.eia.gov/outlooks/aeo/pdf/AEO2022_ChartLibrary_Electricity.pdf

# CIRED INTERNATIONAL NEWS

## CIRED Porto Workshop 2022 E-mobility and power distribution systems

2 & 3 June 2022

CIRED workshops on specific topics are organized in Europe every two years between CIRED main conferences. In 2022, the workshop will address "**E-mobility and power distribution systems**". It will be held on 2-3 June 2022 in Porto, Portugal. **Registrations** for the 2022 CIRED Workshop in Porto are now open! Find all relevant information on the Registration page.

Head to the registration website to join us! Early rates apply until **13 April**.
Full paper submission for CIRED Porto Workshop 2022 is now **closed**. Selected authors will be notified by **25 March 2022**.

Four renowned keynote speakers have already confirmed their participation in our Porto Workshop:
Filipe ARAUJO, Porto City Hall (Portugal)
Jan HAUGEN IHLE, Ionity (Norway)
Lili LI, Tsinghua University (China)
Luca LO SCHIAVO, ARERA (Italy)

**See you in Porto!**

Our hybrid workshop will take place in Porto on **2-3 June**.

Attend the workshop in person for all our live **oral presenta0ons** and **poster sessions**!

Unable to join us in Porto? We offer you the possibility to participate through our **online platform** and access all our live streaming, recordings, presentations, Q&A, chat and posters.

**Important dates**
**25 March 2022**: Full papers notification of acceptance
**13 April 2022**: Early rates registration deadline
**2 - 3 June 2022**: CIRED 2022 Porto Workshop

## CIRED PAPER

# ANALYSIS OF THE OPTIMUM ALLOCATION OF BESS FOR CONTINGENCY SUPPORT

Paper 0020 | Madrid | June 2019

Battery Energy Storage Systems (BESS) are modular and flexible assets that can provide a different set of services. One of these services is power quality improvement. BESS provides support during network contingencies, reducing the outage duration and the number of customers affected by the outage. The effectiveness of this service depends on the size and the location of the BESS in relation to the location of the failure. This paper presents a methodology to determine the optimal location of BESS for continuity of supply improvement and for facilitating the integration of renewable energy and distributed energy resources. The methodology is applied to a real network case in order to compare the optimal location of BESS in the transmission grid or in the distribution grid.

**DOWNLOAD PAPER**

# CIGRE INTERNATIONAL NEWS

## WORLD LEADING TECHNICAL PROGRAMME HEADLINES THE 2022 PARIS SESSION

The Paris Session is back in its in-person format for 2022! We are excited to bring you one of the most comprehensive technical programmes we have seen yet from this unique thought leadership congress.

With a massive 950+ Technical Papers spanning the end to end power system, this is a must attend event for all serious power system professionals.

The Session opens on 28 August featuring a keynote speech by Dr Arshad Mansoor, CEO of the Electrical Power Research Institute (EPRI), who will talk about 'Resilient Decarbonisation'. This is followed by a panel discussion on 'Energy transition - featuring equipment, technology, systems and market coupling', introducted by Marcio Szechtman, Director Transmission Eletrobras (Brazil), and Chair of CIGRE Technical Council.

Following this opening, covering the salient issue facing the industry, the Session then offers a wide ranging technical programme including:

**Six key workshops**

The CIGRE Study Committee's workshops feature experts from different parts of the world, presenting their most recent studies and experiences on:

- Large power system and market disturbances (Monday afternoon, 29 August)
- Extra-long transnational transmission lines (Monday afternoon, 29 August)
- Oscillatory instabilities and interactions in inverter based resource (IBR) dominated power systems (Tuesday afternoon, 30 August)
- Standardization of cybersecurity in power utilities digital infrastructures – a joint vision from IEC, IEEE and CIGRE (Tuesday morning, 30 August)
- SF6 alternatives for transmission and distribution substations and their switchgear (Wednesday morning, 31 August)
- Knowledge transfer of substation engineering and experiences (Friday morning, 2 September)

# CIGRE INTERNATIONAL NEWS

**16 Group Discussion Meetings**

The Group discussion meetings (GDM) form the main components of the Session, with four daily conferences run in parallel from Tuesday, 30 August, to Friday 2 September, throughout each day.
The contributions prepared by the delegates who wish to answer the questions of the Special Reporters during the GDMs, will be collected through the registration platform, as in 2021.

**16 New Tutorials**

The 16 Study Committees have selected tutorials delivered by Working Group members, from Monday 29 August to Thursday 1 September: two in the morning, and two in the afternoon.

The topics selected for this Session will relate to:
- Synchronous condensers for power systems with low or zero inertia generators
- Life extension of oil-filled static machines
- Field experience with vacuum switching devices
- A new era for submarine cables
- Coatings for power network equipment
- Asset health indices for equipment in existing substations
- DC grid benchmark models for systems studies
- Wide area protection
- Global grids
- TSO-DSO cooperation - Control centre tools requirements
- Interactions between wildlife and electrical infrastructures
- Evaluation of temporary overvoltages in power systems due to low order harmonic resonances
- Carbon pricing in wholesale electricity markets
- Electric vehicles as distributed energy resource systems
- Electric performance of new non-SF6 gases and gas mixtures for gas-insulated systems
- Artificial intelligence application and technology in power systems

**Poster Session**

There is a record 950+ new technical papers for the 2022 Paris Session. The poster sessions will have a dedicated space for authors to present their papers, in a poster format, to interested delegates from Monday 29 August to Thursday 1 September. Each of the 950+ final papers will have a space and a time slot for this purpose.

The Paris Session really is the leading global event for power system expertise. Join us in Paris this August and be a part of the first Session of CIGRE's second century and help the world deliver sustainable electricity for all!

EESA

## CIGRE INTERNATIONAL NEWS

threats. Developed by the American Superconductor Company and funded in part by the DHS Science and Technology Directorate, the Resilient Electric Grid system (REG) uses a high-temperature superconductor wire that can carry 200 times the power of standard copper wire and provide self-healing capability. ComEd is the first utility in the nation to permanently install AMSC's REG system into the grid.

Our initiatives continue to line up with our core responsibilities such as maintenance, new construction and engineering but the character and form of the work is changing rapidly. Customers and policy makers are demanding new standards of performance across multiple dimensions of clean, resilient, safe, secure and affordable. New systems require our engineers and crews to develop new skills and competencies and to revise established practices. Many new systems require testing. That's why we recently built a state-of-the-art lab to conduct extensive testing of advanced technologies to ensure their safety and effectiveness before being tested by the harsh realities of large power grids serving millions of customers.

Our microgrid demonstration project, in concert with the DOE and over a dozen partners, incorporates multiple components that were first tested in our lab. For instance, the microgrid integrated solar storage technology was lab tested along with the microgrid master controller prior to field deployment. The benefits of these technologies are clear. The Bronzeville Community microgrid directly serves more than 1,000 residences, businesses, and public institutions from the ComEd grid, including 11 customers that provide critical public services. The utility-operated microgrid cluster was designed and deployed to maximize community benefit; it also informs how we can deploy technologies to integrate DER and provide higher levels of resilience across our service territory. Through these projects, we are learning as part of a community of partners.

**Conclusion**

The electrical grid of the future cannot be provided by the technologies of today. As an industry, we must continue to draw on our history of integrating new technologies and making things work in the real world that powers our lives 24X7. The global deployment of the electric grid produced incalculable benefits, improved the lives of billions, and increased access to economic, medical, educational and cultural opportunities that were once only accessible to the very few. Now, the bar has been raised in a big way, driven by climate change and other threats such as cybersecurity. As we transform to meet these challenges, our industry is poised to deliver on a new era of power, achieving new standards of safety, reliability, resilience and sustainability. This new era of power will energize a future we all want, a future accessible to all.

# EECON 2021 RECORDINGS AVAILABLE


## SESSION RECORDINGS FROM EECON 2021 ARE NOW AVAILABLE TO STREAM.

EECON is the annual national technical conference by the Electric Energy Society of Australia. The set of video recordings from EECON 2021 is now available to stream online.

The theme of the conference was The New Energy Landscape – Challenges and Opportunities. The conference presented a constructive dialogue on addressing the issues found to deliver clean energy, sustainably and economically, through stimulating discussions and debates by leading global experts who will bring a wealth of experience from all over the world. It also provided trends, steps, and examples already taken, by industry and with industry to achieve renewable replacements of fossil fuel energy.

The videos are available for sale to the general public at the full rate, and discounts are available as below. If you were a registrant for the conference you are entitled to free access to the recordings.

EESA members that did not attend the conference can access the recordings for a reduced rate of $20. Use this code at checkout: **EECON21member22**

# UPCOMING EVENTS


## EECON 2022 ‘Our Energy Future – Unlocking Net Zero’

### October 11-12th 2022 at the Royal International Convention Centre Brisbane Queensland. Pre-conference drinks and tours will be on October 10th 2022.

EECON is coming to Brisbane in 2022! The Australian Government has made a commitment to carbon neutrality, commonly referred to as Net Zero, in the not so distant future. With the target set, the questions now in everyone’s mind are ‘How will Australia (we) get there?’, ‘What will the future Australian energy mix look like’ or ‘What future opportunities should we investigate now?’

Come and join us at Bowen Hills, Brisbane where we will discuss our energy future with senior industry leaders and practioners, innovators, entrepreneurs and analysts.

**The Technical Program:**
Abstract submissions are currently open (closing 1st June 2022) with authors able to submit their exciting work in the following key focus areas:

- The future Australian and global energy landscape.
- People, technology and systems unlocking net zero.
- The impact of new generation and of retiring generation.
- Customer-centric developments in the electricity industry.
- The future of utility assets and asset management.
- The relationship between policy, regulatory and economic settings and the evolving grid.

**The Venue:**
EECON2022 will visit the historic Brisbane Showgrounds which is a world-class events and lifestyle precinct located on the fringe of the city's CBD. It’s home to the state-of-the-art Royal International Convention Centre (Royal ICC), a four and a half star Rydges Hotel and vibrant King Street dining hub, making it a sought-after and leading events destination. Events held at the Brisbane Showground’s Royal ICC are sure to impress with their exceptional menus. It’s the ONLY centre in Australia offering award-winning food and wine carefully selected from the RNA's prestigious Royal Queensland Food and Wine Show (RQFWS) and iconic Ekka.

**Registration:**
Registration is now open through the conference website (www.eecon2022.com.au) with EESA members able to use their membership to receive a discount on conference attendance rates. Early bird registration discounts will only apply until 11th August 2022 so get in quick to secure your place at the conference.

We look forward to seeing you at EECON2022 and working together to unlock Australia’s energy future.

EESA

# UPCOMING EVENTS

## Star of the South, Australia's first offshore wind project

**THURSDAY 5 MAY 2022** | **VIC** | **VIEW EVENT**

Overview:
Wind turbines could be spinning off Victoria's coast by 2028, following a state government announcement. In its newly released Offshore Wind Policy Directions paper, the Victorian Government outlines its intent to build up to 9GW of offshore wind energy capacity by 2040. The plan aims to cut emissions and put Victoria at the forefront of an exciting new industry that will create new jobs and supply chain opportunities. Read more.

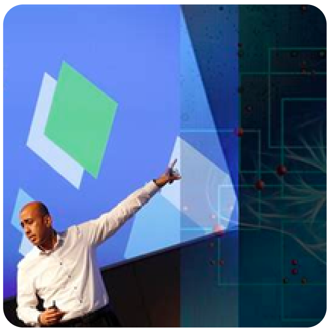
Time: 4.30 PM - 6 PM AEST

Location: Morwell Innovation Centre
Federation University, 1 Monash Way
Morwell, Victoria

Cost: FREE

## MATLAB EXPO 2022

**17 - 18 MAY 2022** | **NAT** | **VIEW EVENT**



Overview:
MATLAB EXPO brings together engineers, researchers, and scientists to hear real-world examples, get hands-on demonstrations, and learn more about the latest features and capabilities of MATLAB and Simulink,.. Read more.

Time: Two-day event

Location: Online via webinar

Cost: FREE

## Large-scale battery storage in the evolving power system – developments and future trends

**THURSDAY 19 MAY 2022** | **QLD** | **VIEW EVENT**

Overview:
Large-scale battery energy storage systems are already providing a range of valuable services to the National Electricity Market. These are incredibly flexible assets, highly configurable in the value stack they can provide, and in the support they offer to the national grid,.. Read more.

Time:
In person: 3:15 - 4:45 PM AEST
Webinar: 3:30 - 4:30 PM AEST

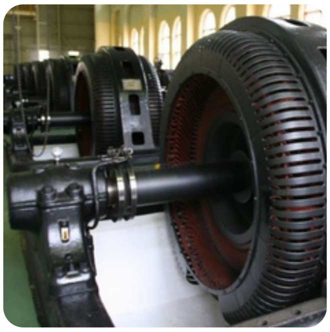
Location: Aurecon, 25 King St, Bowen Hills QLD
OR online via webinar

Cost:
EESA members: $0
EA members: $20
Non-members: $30

# UPCOMING EVENTS

## Synchronous services markets: maximising the capacity of existing transmission networks

**WEDNESDAY 11 MAY 2022** | **TAS** | **VIEW EVENT**



Overview:
Old synchronous generators are quickly being replaced by cleaner, cheaper providers but ones that can't provide synchronous services that used to come for free. If only there was a way to keep receiving these services, without the pollution.

There is,.. Read more.

Time: 5.30 PM - 6.30 PM AEST

Location: In-person at Hydro Tasmania, 4 Elizabeth Street, Hobart.
OR online via webinar

Cost:
EESA members: $0
EA members: $20
Non-members: $30

## AS 1768 Comprehensive Lightning Protection

**MONDAY, 23 MAY 2022** | **NT** | **VIEW EVENT**

Overview:
Lightning and overvoltage transients cause tens of billions of dollars of damage and related losses each year globally.
In this presentation, attendees will learn the key steps required to ensure their facility can withstand the deleterious effects of direct and indirect lightning flashes, including lightning risk assessment, a comprehensive four-step... Read more.

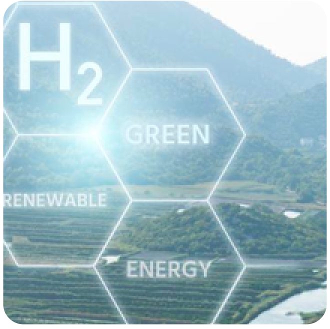
Time: 5:30 PM – 7 PM ACST

Location: Auditorium Engineers Australia Northern Office, 9 Cavenagh St, Darwin NT
OR online via webinar

Cost:
EA members: $0
Non-members: $30

## Renewable hydrogen developments in South Australia

**THURSDAY, 23 JUNE 2022** | **NSW ACT** | **VIEW EVENT**




Overview:
South Australia has the wind, sun, land and infrastructure to be a world-class renewable hydrogen supplier.
Hear from South Australia's Department for Energy and Mining about the State's major current and proposed renewable hydrogen developments and initiatives.
These initiatives include The State's Hydrogen Action Plan, Export.. Read more.

Time: 6:30 PM – 8 PM AEST

Location: Level 11, 108 King William Street ADELAIDE, South Australia, 5000
OR online via webinar

Cost:
EA members: $0
Non-members: $30

# UPCOMING EVENTS

## EECON 2022 - Our Energy Future – Unlocking Net Zero

**11 - 12 OCTOBER 2022** | **QLD** | **VIEW EVENT**

Overview:
Even in the time since Brisbane hosted the highly regarded EECON 2018, the pace of change in the electricity industry has only accelerated. EECON 2022 offers delegates from across Australia and elsewhere the opportunity to gather and together solve the many challenges with which we are faced, be they technical, economic, commercial, regulatory, political, or stakeholder.. Read more.

Time: 2-day event

Location: In person at Royal International Convention Centre, Brisbane Queensland
OR
Online delivery via webinar

# THANKS TO OUR CORPORATE MEMBERS

## PLATINUM

**MISSION**
"Through our passion for innovation and always finding a better way, we are taking reliability, customer service and product value- for-money to a new level in the transformer industry."

## GOLD

## SILVER

## BRONZE