NATIONAL BULLETIN

Bulletin 10 | 2021

Getting Australia to Net Zero – How and When?

By Jeff Allen, National President of the Electric Energy Society of Australia | 16 October 2021

There has been lots of discussion in the media recently regarding Australia's commitment to Net Zero by 2050. Australia's debate regarding our Net Zero commitment is being held in the context that there is general agreement across most countries that the world must decarbonise its energy systems within the next 10 to 30 years to avoid the worst consequences of climate change. International consensus is that non-complying countries and businesses will be "punished".

In Australia we are seeing many investors as well as businesses making commitments to Net Zero. State governments around Australia are also setting targets and most have plans to achieve results. Many people across Australia are also showing support for strong emissions reduction targets and plans to achieve the result.

The NSW government recently revised its target to a 50% emissions reduction by 2030 compared to the previous 35% goal to reduce emissions below 2005 levels by 2030. This target brings NSW in line with Victoria, which has a 45 to 50 per cent aspiration for 2030. South Australia is aiming for more than a 50 per cent reduction by 2030. Note that South Australia is already more than 50 per cent of the way to achieving Net Zero emissions by 2050. Queensland has committed to achieving zero net emissions by 2050, with an interim target to reduce emissions by 30% below 2005 levels by 2030.

The Tasmanian Government has also committed to zero net emissions by 2050. Tasmania was the first Australian jurisdiction to achieve Net Zero emissions and did so in 2013 and has continued to do this every year since. The Tasmanian government has gone some way to recognising this, by legislating a target of 200% renewable electricity by 2040. Under the target, Tasmania would produce twice its current electricity needs and export the surplus. It would be delivered to the mainland via the proposed A$3.5 billion Marinus Link cable to be built between Tasmania and Victoria. The 1,500MW cable would bolster the existing 500MW Basslink cable. It looks like Tasmania will be 100% self-sufficient in renewable energy by 2022 – a feat achieved by very few countries in the world.

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

The Western Australian Government has set a state-wide target for net-zero greenhouse gas emissions by 2050. Western Australia appears to be the only Australian state with rising greenhouse gas emissions, largely due to the expansion of Liquefied Natural Gas production and exports.

The Northern Territory Government has an objective to transition to a low carbon economy and has a target of Net Zero emissions by 2050. The CSIRO and the Northern Territory Government, together with various companies have joined forces to develop a consortium to assess the viability of a large-scale low emissions Carbon Capture Utilisation and Storage Hub outside of Darwin. Another major project announced recently is the Sun Cable project – the world's largest solar farm and battery storage facility that is to be developed in the Northern Territory along with a 5,000 km transmission system to supply both Darwin and Singapore with reliable and competitively priced renewable energy.

There is a growing view that in a relatively short period of time, the bulk of our electricity generation will move from large, expensive, constant and carbon intensive central power plants; to distributed, cheap, intermittent wind and solar electricity supported by storage. Green Hydrogen may also play a role in our future energy needs. Many companies are seeing investment opportunities flowing from the technologies required to achieve our commitment to Net Zero.

AEMO's 2020 Draft Integrated System Plan indicates a significant reduction in black and brown coal fired generation over the next 20 years – from about 50% of generation to less than 10%.

It looks like "Decarbonisation, decentralisation, and electrification", are the key themes of the energy industry in the next 20 years. Solar PV is becoming so cheap that it makes economic sense to substantially overbuild capacity relative to demand.

In October 2020, the South Australian electricity grid was the first large grid in the world to meet 100% of demand from solar PV and wind. Yet the SA grid only averages slightly over 60% wind and solar over a year. To meet the Government's goal of 100% renewable electricity, SA will substantially 'overbuild' its solar capacity. This means that much of the year the output of solar PV will be surplus to demand in the 10am-3pm period and can be exported for example to NSW via the new "Project EnergyConnect" transmission line.

There is growing support for the concept that in the next 10 to 20 years, energy consumption for most consumers will move from three fuels (electricity, 'natural' gas, and petroleum) to all-electric. This means a massive expansion of electricity consumption at the expense of oil and gas production and their associated distribution industries.

Australian-American entrepreneur Saul Griffith is the founder of Rewiring America and author of Electrify and the approach he is proposing for Australia covers the replacement of gas heaters and gas hot water systems with reverse cycle air conditioners, heat pump hot water systems and induction cooktops and replacing diesel and petrol vehicles with EVs. Electricity – due to the significant increase in solar and wind generation – will be the cleaner, cheaper, and more efficient source of energy for households.

His papers make for interesting reading. He indicates that Australia's 10 million households are responsible for the largest portion (~42%) of our domestic emissions, with 33.5% attributed to home energy and personal vehicle usage. Thus, moving to "all electric" will provide lower annual expenses than the existing technologies for virtually all households by 2030.

Will the most economical path to powering our everyday lives be because of significantly increased rooftop solar take-up and the use of storage capacity in vehicles, house-batteries, and thermal systems?
Interesting times ahead – particularly for electrical engineers.

EECON 2021

The WA Chapter together with the EESA National Council, is pleased and proud to invite you to our National Electric Energy Conference in Perth.

A two-day Technical Conference with pre and post tours including a National University Poster paper competition from **Sunday 21st through to Wednesday 24th November 2021**

This event will be a hybrid conference with two technical streams debating the **"The New Energy Challenges"** and sharing with you the National **"Challenges and Opportunities".**

EECON2021 will be held at the Golden Ballroom at the Pan Pacific Perth plus online through our conference provider 2em. There will be a great range of **sponsors and exhibitors** who will provide a great opportunity for attendees to understand some of the latest technologies, products, and services currently available, as well as those becoming available in the electric energy area at the Pan Pacific on **Monday 22nd and Tuesday 23rd November.**

You need to ask yourself, are you up to date with the changes in our Electric Energy industry. Are you up to date with the changes and technological developments, the falling costs of renewable generation and batteries, the rise of SAPS an increasingly viable way of supplying power particularly in remote areas? The surge in VRE, utility scale variable renewable generation, which has a different character to traditional generation – and that is – it is highly variable. Have you thought about the big disrupter, the cost versus pricing model in each network? Do we want export charging introduced, how are we going to encourage self-consumption with electric vehicles and household batteries? DER integration is a major challenge. The blunt reality is, we will end up stuck in a world where we have more pressure for networks to increase spend on solar enablement, more zero export limits and more solar curtailment. Who is holding the responsibility for the right trade-off between cost, reliability, and security? We want you to come to Perth and get a full 360 Degrees experience. We offer an excellent networking opportunity, especially in this time of change. The role of EESA is to nurture and grow our industry capability, and future engineering and safety leaders who are going to be the future innovators, influencers, and change-makers. The 2021 Conference provides a key forum to grow collective knowledge and understanding of engineering, technology, risks and solutions and their impact on our industry.
EECON 2021 conference is going to update you on the New Energy Landscape, their Challenges and Opportunities. You can decide whether our industry is going through an "Evolution" or is this a "Revolution"? We invite you to come and participate and decide for yourself.

You will be able to connect to our 2-day technical program via our on-line streaming platform. You will be able to ask questions, but you will not be able to rub shoulders with your customers, your suppliers, and our industry experts if you do not attend in person.

EECON 2021

Our opening plenary, **"Is the electricity supply industry in revolution or evolution?"** speakers:

- EGM, Energy Queensland — Peter Price
- CEO, Western Power — Ed Kalajzic
- CEO, Horizon Power — Stephanie Unwin
- CEO, Synergy — Jason Waters
- Head of Energy Policy WA — Kate Ryan
- CEO, Siemens Energy Australia — Michael Bielinski

Our closing plenary **"What to do now? – A personal perspective"** speakers:

- Minister for Energy, WA Gov't — Hon Bill Johnston MLA.
- Director, Electric Power Consulting — Robert Barr
- EGM, AEMO WA — Cameron Parrotte
- GM Asset Strategy, Alinta Energy — Gary Bryant
- EGM, NERA — Miranda Taylor
- Director, Hydrogen Society AU, — Adam Osseiran

What is your spin on what is happening, are we in a revolution or is our industry just evolving?

Registration is available on-line on the EESA website. **EECON (eesa.org.au)**
Summary of EECON2021 Program included in your full Registration.
Pre-Conference Tour: 3pm Sunday 21st Nov. A walking tour of the Old + New Electrical infrastructure of Perth.
Conference: Monday 22nd Tuesday 23rd Two streams of industry presentations.
Exhibition: Monday 22nd Tuesday 23rd Pan Pacific Golden Ballroom
Partners Tour: 11am Monday 22nd Nov, - Guided walking tour of Kings Park.
Conference Dinner: 6pm Monday 22nd Nov. Pan Pacific Golden Ball room.
Conference Breakfast: 7am Tuesday 23rd Nov, Golden Ballroom, Speaker Kim Hughes.
Poster Paper Competition: 1:00pm - Wednesday 24th November. Western Power Corp, auditorium 360 Wellington St Perth. Undergraduate/Postgraduate competition from 4 WA Universities and National entries.
Post Conference Site Tour: 10am Wednesday 24th November. Western Power control center; (Limited to 20 people)

EESA has made a significant effort to make this years EECON affordable and available to all EESA members, EA members and industry people. Please **REGISTER ASAP** and share with your colleagues. We look forward to seeing you at EECON2021.

CONTENTS

LOCAL NEWS

ELECTRIC VEHICLE UPDATE

CONTENTS

LOCAL NEWS

NUCLEAR DEBATE RESURFACES

Karl Kitchen | 14 October 2021 | Source: Energy Council of Australia

Debate about Australia's national security needs and commitment to nuclear submarines - along with discussion around the need to reduce our carbon emissions while replacing firm, ageing coal plants - has led to **renewed advocacy** for a domestic nuclear power industry.

The question of nuclear power has previously been formally canvassed by **South Australia's Nuclear Fuel Cycle Royal Commission** and subsequently a **Federal Parliamentary inquiry**, which recommended in 2019 that the prospect of nuclear technology be considered as part of the future energy mix. The NSW Parliament also considered **uranium mining and nuclear facilities** in 2020.

The **Australian Energy Council believes** it is sensible to keep technology options open. The best way to ensure this is through a technology neutral approach that assesses the viability of nuclear energy on whether it meets appropriate scientific standards and provides value within a market context.

But nuclear generation has major impediments to its introduction in Australia, and the business case for it is extremely difficult. Below we look at some of the continuing challenges facing nuclear power and the hurdles to it becoming a part of our grid under current scenarios.

Impediments

Key impediments to nuclear power stations remain their high capital costs, long build times, and the need to gain a strong social licence and political bipartisanship. A further issue is the flexibility of nuclear plants given the need to complement variable renewables.

Nuclear plants come with a very high upfront price tag - while running costs may be low, capital costs extremely steep. The UK's new 3,200MW Hinkley Point C nuclear power station was mooted in 2010 with an estimated cost of £16 billion ($28.5 billion). This cost has since ballooned out to £22 billion ($41 billion) while the expected period of completion has been delayed. The first reactor is expected to produce power in June 2026 compared to a previous expectation of the end of 2025. Under a contract for difference the ratepayer-backed guaranteed price for electricity generated by Hinkley was originally agreed in October 2013 and guarantees the plant will get GBP92.50/MWh (AUD$174/MWh) for its first 35 years of operation. In contrast, the **CSIRO** estimates large-scale Australian solar and wind farms levelised cost of energy (LCOE) at $45-70/MWh, and gas-fired plants at $70-120/MWh.

Advocates are not arguing for traditional large-scale nuclear plants for Australia's grid, but rather Small-Scale Modular Reactors (SMRs). The Federal Government's **Technology Investment Roadmap** had a watching brief on this technology. Last week a **new discussion paper** was released that looked at developments to date for three particular designs that it believes are well placed to meet Australia's energy needs and are assumed to be on track for commercialisation at the end of this decade.

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.

LOCAL NEWS

SMRs have a number of perceived benefits:

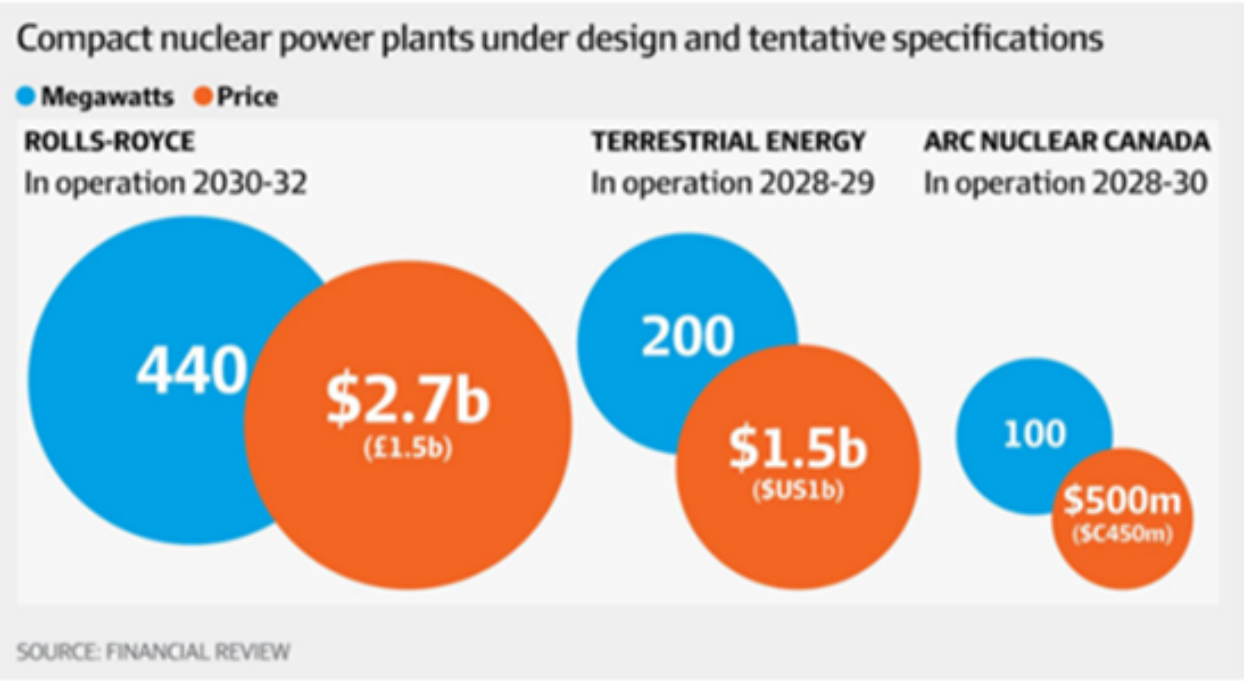
- Arguably lower capital costs and construction times.
- Given the modular design they may be portable and can be expanded as required.
- Can underpin renewables through a **"flexible base that offers strong load-following"**
- Provide synchronous generation that can provide essential system services.
- 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 the 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, former head of the Australian Nuclear Scientific and Technology Organisation and chair of 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".

SMRs seem likely to still come with high capital costs. In 2019 **Rolls Royce** proposed a 440MW plant with a reported price tag of $2.7 billion for Australia.

Figure 1: SMR designs and costs (2019)



Source: AFR, The Rolls-Royce option for Australian nuclear power, Aug 2019

LOCAL NEWS

There has been debate about the cost of NuScale's SMR which is proposed for the Utah Associated Municipal Power Systems' (UAMPS) Carbon Free Power Project (CFPP). The project was announced in 2015 and has since received US Government underwriting of US$1.4 billion to help de-risk the project.

Originally it was to have **12 x 50MW modules**, which was upgraded to 12 x 60MW (720MW), however it has since reduced to 6 x 77MW modules (462MW) with some of the original consortium members not proceeding. It planned to build a NuScale plant on, or near, the Idaho National Laboratory Site.

The NuScale CFPP overnight capital cost estimate (simplistically what it would cost to build a plant overnight or the estimated engineering, procurement, and construction costs) is US$3.6 billion (around $4.9 billion). But this is not the actual project cost, which would include costs such as financing and escalations. UAMPS's total project budgetary cost estimate is **US$6.1 billion** (around $8 billion), including the NuScale overnight capital cost, owners' costs, escalation, contingency, fees, warranty and capitalised interest. Compare that to the **estimated cost for the 660MW Kurri Kurri** gas-fired power station in NSW of $600 million.

The NSW Parliamentary Committee's report accepted it is difficult to estimate the cost of nuclear energy in a country like Australia because of the lack of a history of nuclear energy and received a wide variation in LCOE costs, with figures ranging from $325/MWh to $60/MWh. **The Federal inquiry** also found pinning down costs a challenge and released a table showing some of the cost estimates it received:

Figure 2: Selected nuclear cost estimates to House of Representatives Standing Committee on Environment and Energy, December 2019

	Friends of the Earth (Australia) SMR and 'large reactor' costings	Australian Nuclear Association and Nuclear for Climate Australia 1000MWe reactor costings	World Nuclear Association average costs for a nuclear reactor in the United States	NuScale Power capital cost estimate for Nth-of-a-kind SMR in the United States
Capital cost	n.a.	AU$6,200 per kW	AU$6,685 per kW	AU$5,248 per kW
Levelised cost	(Large) AU$150 to AU$253 per MWh (SMRs) AU$225 per MWh	n.a.	AU$140 per MWh	n.a.

Note: Each figure in this table may not be directly comparable and may rely on different data and assumptions. In addition, some figures represent capital costs per kW while others are levelised costs per MWh. Figures provided in $USD have been converted to 2018 $AUD, with the exception of NuScale whose AUD costing was provided by it at a 2019 rate (see footnote 102). Refer to submissions and Proof Committee Hansard from each organisation cited for further source information and details.

Source: Report of the inquiry into the prerequisites for nuclear energy in Australia

LOCAL NEWS

The Australian Nuclear Science and Technology Organisation - ANSTO - told the inquiry it was difficult to establish estimates for the LCOE for nuclear energy in countries that do not have existing nuclear industries.
Baseload or peaking?

Nuclear power plants operate around the world as baseload generators; they are not designed to respond quickly to follow changes in load and are likely to be uneconomic **operating in this way**. SMRs are predicted to respond faster than traditional nuclear plants, so could be a better fit with increasing amounts of renewable generation capacity. If nuclear is not flexible, it is not ideal generation for a rapidly transitioning grid.

Why is inflexibility a problem? Because Australia is bringing variable renewable generation online at the fastest rate 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 plant 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.

Even if the plant can be engineered to be more agile, the economics are still wrong. The future market will have large quantities of free surplus renewable energy for much of the time, interspersed with periods of shortage when the wind and sun die down. The appropriate complement to this is a plant with low capital costs and high running costs – the latter does not matter much, as the complementary plant will not need to run often.

In contrast, nuclear plants have very high capital costs and effectively a negative fuel cost: i.e. they actually cost more to run at partial than full load due to the wear on the machinery. This implies that in a system with a mix of renewables and nuclear, renewable surpluses would be managed by reducing the output of zero cost renewables rather than negative cost nuclear plants. So, if you start with a nuclear-based system, there is not much sense in building a lot of renewables, and vice-versa.

Given Australia has already adopted a great deal of variable renewable energy sources, the only complement for the future of our electricity market is flexible, dispatchable generation. The ideal sources are pumped hydro, batteries, and gas-fired peaking plants that can be converted to run on emissions free hydrogen once it is available.

You need a licence

The nuclear industry lacks a social licence in Australia. It has been said that for many Australians their four reference points for nuclear: Three Mile Island, Chernobyl, Fukushima and The Simpsons[i].

Australians have long felt a sense of unease about nuclear power so convincing them that nuclear is safe will be a challenge while the politics will remain fraught. A recent Newspoll in **The Australian** suggested there may be a shift in attitude with 25 per cent of 1545 voters saying they "definitely" supported developing a domestic nuclear industry with 36 per cent saying it should be considered, although a **Lowy Institute poll** found 51 per cent remain opposed to removing a ban on nuclear power.

LOCAL NEWS

DEVELOP DOMESTIC CIVIL NUCLEAR INDUSTRY

NEWSPOLL
EXCLUSIVE TO THE AUSTRALIAN

Question: The US or UK will supply the nuclear propulsion system to power the submarines; and Australia has not committed to developing a homegrown nuclear industry. In the future, do you think Australia should develop its own domestic civil nuclear industry, including new nuclear power stations in Australia to generate electricity?

		POLITICAL SUPPORT			GENDER		AGE			
	Total	Coalition	Labor	Green	Male	Female	18-34	35-49	50-64	65+
Definitely	25	34	18	15	33	18	19	24	29	30
Should consider	36	41	38	32	37	35	37	29	37	44
No	27	15	34	47	23	31	31	30	26	19
Don't know	12	10	10	6	7	16	13	17	8	7

This survey was conducted by YouGov between September 29 and October 2 with 1545 voters throughout Australia interviewed online. It is compliant with the Australian Polling Council Code and a methodology statement will be available within two days at https://au.yougov.com/results/apc. Copyright at all times remains with The Australian.

Source: The Australian, Newspoll: Civil nuke industry gains voter traction, Oct 2021

Regardless of recent polls well-resourced green/NIMBY opponents would certainly need to be contended with if any proposals were put forward. With nuclear currently banned in Australia legislative change would require a bipartisan shift at both a State and a Federal level to realistically get the go-ahead. A key recommendation of the Federal inquiry into nuclear power that prior informed consent from local communities should be a condition of approval for any nuclear power or nuclear waste disposal facility.

Other difficulties also need to be overcome. Australia would need a plan to deal with nuclear waste and the development of the necessary skills for a workforce to manage a nuclear industry. The regulatory framework to guarantee the safety of workforces, and the transport and disposal of nuclear waste, could take years to get right.

Conclusion

As with electrification this is an important debate but it should not detract from current work to manage the rapid shifts in energy supply.

Nuclear can be expected to continue to play an key role internationally, but for a country with no existing industry, it's difficult to see a plant being developed and it would certainly require government backing, both financial and through the right policy settings.

In the case of SMRs even where a nuclear industry exists, it will be at least the late 2020s before they come online, so their commercial value remains to be firmly established. Given the time it would take to establish and build a plant, it is likely other technologies will continue to advance.

LOCAL NEWS

Despite the AEC's position that existing nuclear technology is currently commercially unviable, we do not support the ban on using nuclear technology to deliver electricity. The AEC believes government should set in place a conducive regulatory and safety framework for nuclear generation so that if the market deems it has value in the future, it would be an available option. This is consistent with the SA Royal Commission which recommended removal of existing prohibitions on nuclear generation in Australia. The Federal inquiry recommended lifting the moratorium on nuclear energy in relation to Generation III+ and Generation IV nuclear technology, including small modular reactors.

Meanwhile, however, government should not be unduly distracted from the real challenges of the energy transition by what seems very likely a long shot.

[i] Blackout, Matthew Warren, Affirm Press, 2019

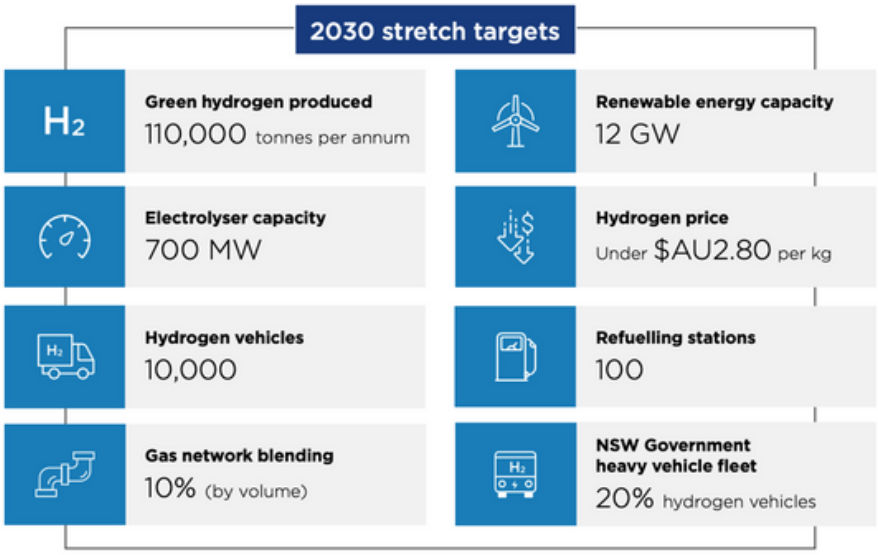
NSW HYDROGEN STRATEGY

By Terry Miller | 19 October 2021 | Source: NSW Govt Press Release

The NSW Government has released its NSW Hydrogen Strategy, which is subtitled "Making NSW a global hydrogen superpower."

The strategy will provide up to $3billion in support for the hydrogen industry by waiving government charges on green hydrogen production. Part of this funding is providing a 90% exemption to network charges for hydrogen electrolysers that connect to parts of the electricity network with spare capacity. Given the revenue cap regulation of network charges, it would appear that this exemption will inevitably be subsidised by other electricity consumers through prices higher than they otherwise would have been.

Shown below are the 2020 stretch targets for this strategy, including lowering the price of greenhydrogen to $AU 2.80 per kg. The current price for fossil fuel based hydrogen is around $AUD 2.40 per kg (source: sp global market intelligence).



The full strategy document can be read at the Source link above.

LOCAL NEWS

NT GOVT RELEASES PLANS TO SUPPORT SOLAR, BATTERIES AND GREEN HYDROGEN

By Giles Parkinson | 7 October 2021 | Source: Renew Economy

Photo credit: 5B

The Northern Territory government has unveiled plans for a massive renewable hydrogen zone, as well as a new rewewable energy hub, as it seeks to grab a major share of Australia's renewable hydrogen export opportunities and transition its local electricity networks.

The plans are laid out in three key documents released this week that are focused on what's needed to deliver on its promise to reach 50 per cent renewables by 2030, and to grow a multi-billion dollar market in renewable hydrogen that it hopes will replicate its success in LNG.

The documents make clear that the NT has some of the best solar resources in the world, particularly in the southern part of the territory. "Sunshine for sale", it boasts.

This has been long recognised, but the NT's efforts to reach 50 per cent renewables – first announced in 2017 – have been stalled by divisions over grid design and market rules, and how to accommodate new technologies into ageing

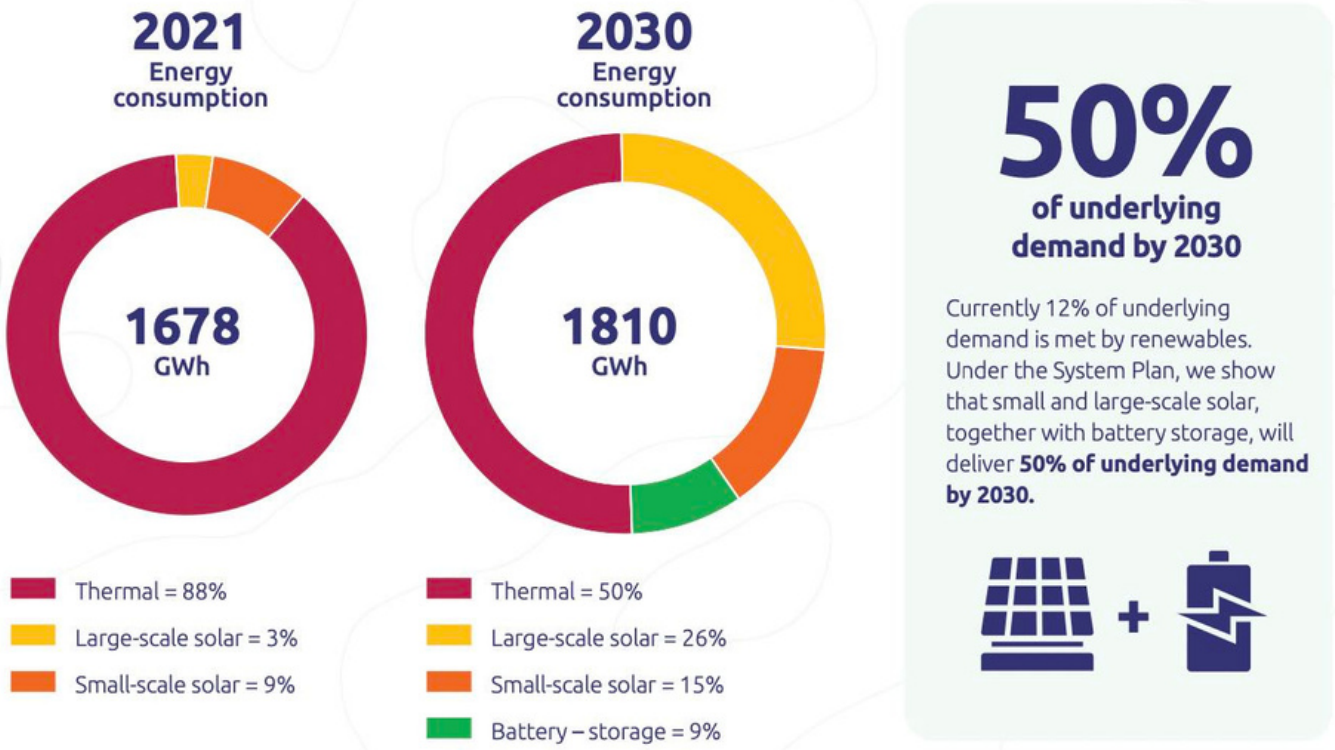
LOCAL NEWS

networks, and controversies over a series of blackouts.

So far more than 45MW of large-scale solar has been built, but not connected because the local regulators are scared of what might happen when they do. Some of the solar farms have been sitting idle for nearly two years, and legal action is being threatened over new rules.

The new document is recommending a three-stage process to facilitate the transition, and recognises that a lot of battery storage will be needed to accommodate solar, particularly as no significant wind resource has been identified.

Figure 6 - Change in generation mix by 2030



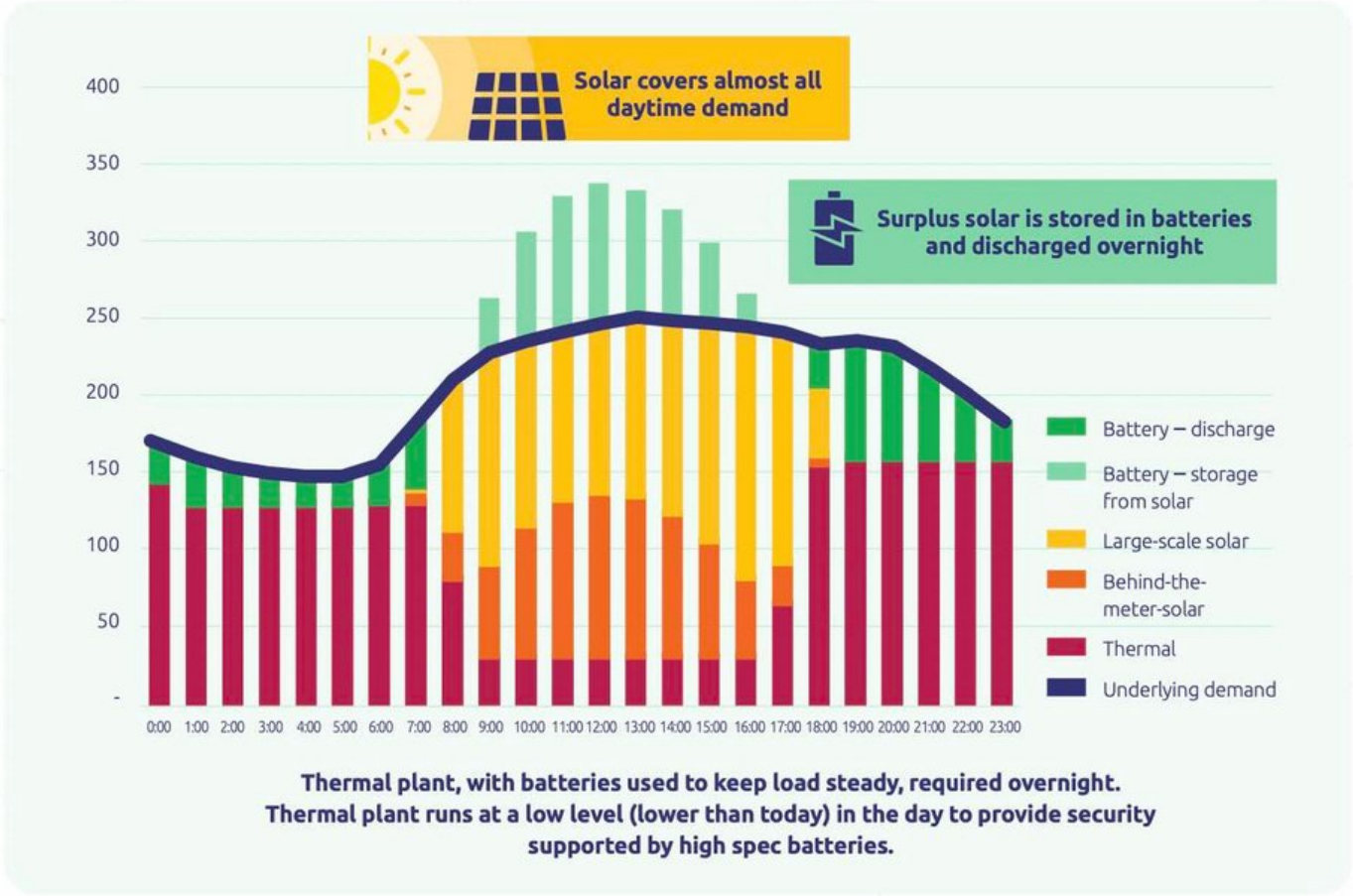
It now envisages an energy mix of 50 per cent renewables by 2030 coming from small-scale solar (15 per cent), large-scale solar (26 per cent), with battery storage (9 per cent), which will provide overnight storage and critical grid services.

The remaining 50% of electricity generation will come from more efficient and agile thermal energy, replacing the existing less flexible plant, and including equipment that can be fuelled by renewable hydrogen.

This is what it imagines an average day to look like in 2030.

LOCAL NEWS

Figure 7: Generation each hour on a typical day in 2030



It is looking at 320MW of solar – 80MW from rooftops, 60MW committed large scale solar, and another 180MW of large scale solar from a new renewable energy hub.

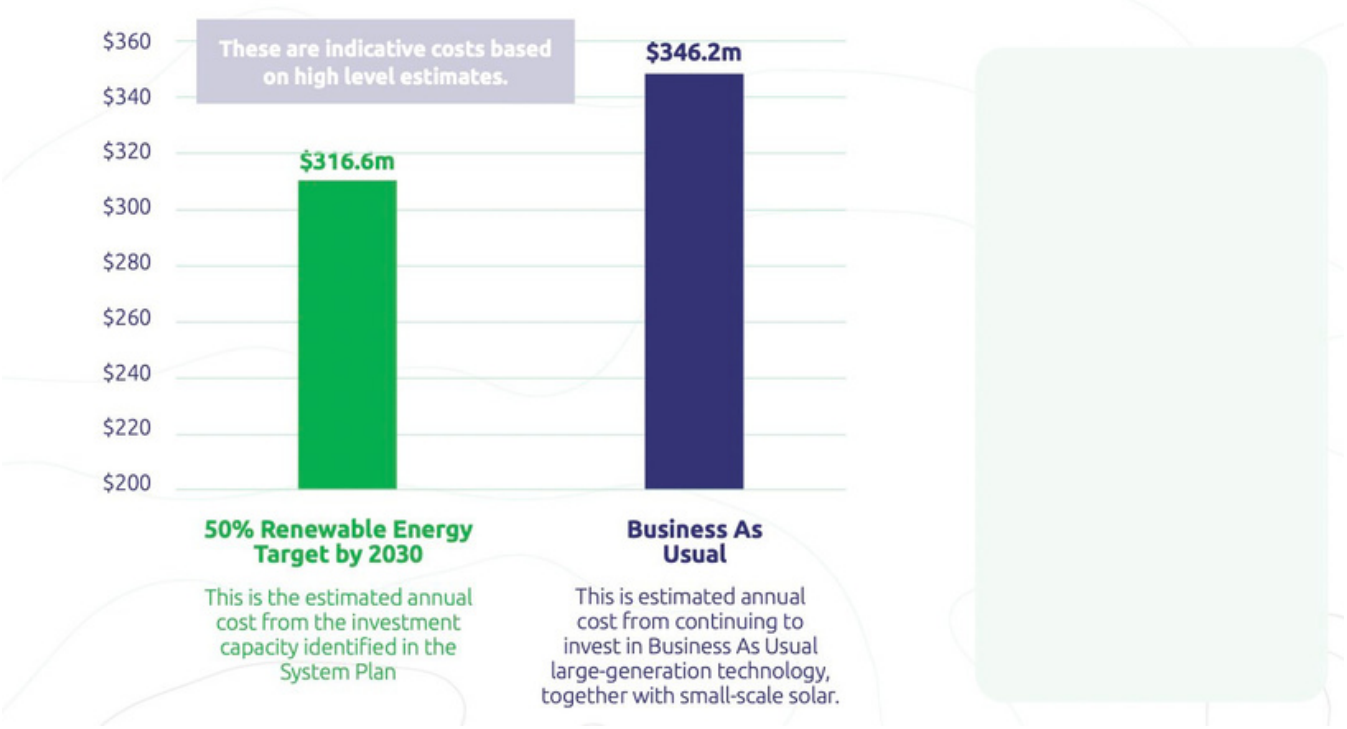
There will also be a need for more big battery storage – a total of 110MW. Homes and businesses will provide 10MW/40MWh, with utility-scale batteries providing another 100MW/560MWh; so it is planning batteries with up to six hours storage.

A further 100MW of "hi spec" batteries (and presumably short-term storage) will be needed for grid security. Virtual power plants and demand management will also play a role.

The rollout is expected to be steady over the next eight years, but the government says the good news is that it will result in cheaper electricity costs. It estimates savings of around $30 million per annum, compared to following a Business As Usual scenario, where ageing gas plants were replaced with the same technology.

LOCAL NEWS

Figure 8: Annual (net present value) costs of generation and network by 2030 (2020 real dollars - million)



But it hopes that the gas plants will not be burning fossil fuels over the long term, and will instead turn to renewable hydrogen, fuelled by vast arrays of solar panels – and possibly wind farms if the resource can be firmed up – from the southern part of the territory.

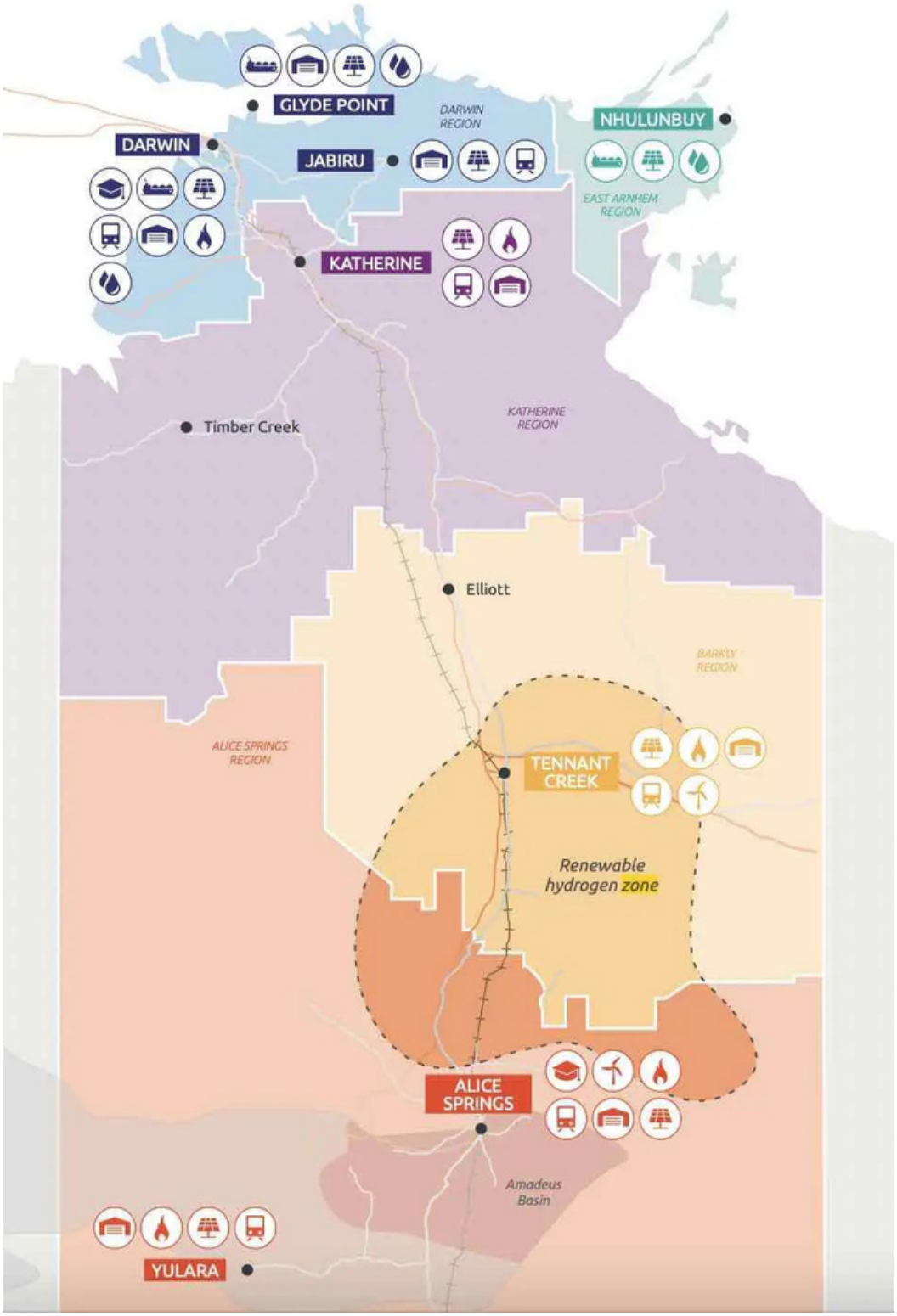
Sun Cable has already planned a massive solar farm of up to 20GW, and more than 40GWh of battery storage in the NT, primarily to provide cheap solar power to Singapore, but also to support low-carbon manufacturing and industries in the NT with cheap power.

It remains to be seen what role that massive project will play in the NT's own hydrogen plans, and its mission to reach 50 per cent renewables in the grid (given its sheer scale will be more than 20 times the needed capacity of the local network). The NT government recognises the long-term storage potential of renewable hydrogen and is looking at creating a "renewable hydrogen zone" that would stretch from around Tennant Creek down towards Alice Springs.

"Renewable hydrogen could be produced in arid regions of the Territory using either water capture technology, such as that being developed by Aqua Aerem, or utilising ground water resources where available," it says
"While hydrogen production is water-intensive, even export-scale production utilisation is comparable with other existing industrial water allocations.

"Renewable hydrogen could be produced in locations with the best wind and solar resources and then hydrogen transported to the deep-water port in Darwin in the form of ammonia or compressed hydrogen gas by truck or gas pipeline."

LOCAL NEWS


GLYDE POINT
DARWIN REGION
NHULUNBUY
DARWIN
JABIRU
EAST ARNHEM REGION
KATHERINE
KATHERINE REGION
Timber Creek
Elliott
BARKLY REGION
ALICE SPRINGS REGION
TENNANT CREEK
Renewable hydrogen zone
ALICE SPRINGS
Amadeus Basin
YULARA

LOCAL NEWS

AEMO RELEASES REPORT ON QLD CALLIDE POWER STATION FAILURE

By Australian Energy Market Operator | October 2021 | Source: AEMO

This report has been prepared under clause 4.8.15(c) of the National Electricity Rules (NER) in relation to a reviewable operating incident1 that occurred on 25 May 2021 in Queensland; it supersedes AEMO's preliminary report published on 2 June 20212 . The incident involved the trip of multiple generators and high voltage transmission lines in Queensland following an initial event at CS Energy's Callide C Power Station, leading to under-frequency load shedding and temporary synchronous separation between Queensland and New South Wales.

The aim of this report is to assess the adequacy of the provision and response of facilities or services during the event, and the appropriateness of actions taken to restore or maintain power system security. As such the report does not provide a complete analysis of the root causes of this incident or of the emergency response within the power stations except where it is relevant to the scope of AEMO's investigation. CS Energy is undertaking an independent investigation on these other matters.

This report is based on detailed analysis of data obtained from AEMO's systems, data provided by transmission network service providers (TNSPs), distribution network service providers (DNSPs), and other National Electricity Market (NEM) registered participants, and data from third-party sources. AEMO wishes to thank them for their contribution of data and subject matter expertise.

AEMO invited a panel of electrical engineering experts to review and provide feedback on AEMO's report and analysis of the 25 May 2021 event. The expert panel consisted of:
- Professor Simon Bartlett AM BE, BSc, FIEAust, FTSE, FAICD, MIEEE, CPEng.
- Mr David Bones BE (Elec) Hons, Executive Manager Risk, Assurance and Regulation, GHD.
- Mr Andy Wearmouth BE (Elec) MIEAust CPEng NER APEC Engineer IntPE(Aus), Merz Consulting.

AEMO is grateful for their time and expertise, which greatly assisted in the finalisation of this report and associated recommendations.

All times in this report are Australian Eastern Standard Time (AEST).

There is a list of abbreviations at the front of this document. Terms defined in the NER have the same meanings in this report.

Loss of Callide generating units

Callide Power Station (Callide) is a thermal power plant in central Queensland consisting of two 350 megawatt (MW) generating units at Callide B (B1 and B2) and 466 MW and 420 MW generating units at Callide C (C3 and C4 respectively). Callide B is owned by CS Energy and Callide C by a joint venture of CS Energy and Intergen. Both are operated by CS Energy. Immediately prior to the event Callide B1 was undergoing maintenance, Callide B2 was operating at 350 MW, Callide C3 at 424 MW, and Callide C4 at 278 MW.

LOCAL NEWS

At 1333 hrs on 25 May 2021, Callide C4 ceased exporting active power but remained connected until 1406 hrs3 . During this period, although SCADA data from Callide C power station showed unit C4 was still generating at approximately 278 MW, SCADA data from Calvale substation indicated unit C4 was absorbing approximately 50 MW and 300 megavolt-amperes reactive (MVAr) from the power system. During this period voltages at Calvale 275 kV substation remained healthy, operating close to nominal rated voltage.

At 1344 hrs, Callide C3 tripped from approximately 417 MW and CS Energy subsequently confirmed earlier indications that there was a fire in the Callide C turbine hall. At that time the CS Energy Trading Room, based on available information, also informed AEMO that both C3 and C4 units had tripped4 .

Post-incident investigation indicates the C4 unit boiler, turbine and field switch had tripped but not its generator circuit breaker, leaving the generator motoring asynchronously5 on the power system. Approximately 20 minutes later, at 1406 hrs, multiple events occurred in quick succession, negatively impacting the power system. This included tripping or unloading of nine major generating units, and disconnection of Calvale substation resulting from the tripping of multiple transmission lines.

Separation of Queensland region

The Queensland – New South Wales Interconnector (QNI) is the main interconnection between New South Wales and Queensland, with an import capacity to Queensland of approximately 600 MW. Prior to the event at 1330 hrs QNI was exporting approximately 396 MW to New South Wales.

The loss of the nine major generating units at 1406 hrs reduced supply in Central Queensland by approximately 2,300 MW, causing QNI active power flow to rapidly increase import to Queensland, peaking at approximately 1,064 MW before the interconnector tripped. After QNI tripped, the Queensland frequency dropped to approximately 48.53 hertz (Hz). In response, AEMO observed a net reduction in load of approximately 2,275 MW in Queensland and 25 MW in Northern New South Wales6 . Most of this load reduction was the expected result of the operation of automatic Under Frequency Load Shedding (UFLS) relays following the observed drop in frequency as generation and the interconnector tripped.

Subsequent impacts

After AEMO had given permission to restore all load, there were ongoing lack of reserve (LOR) conditions in Queensland, including actual LOR1 and LOR27 conditions and forecast LOR3 conditions. Actual LOR1 and forecast LOR2 conditions also occurred in New South Wales.

Following the event, 15 MW of Reliability and Emergency Reserve Trader (RERT) capacity was activated in Queensland. RERT activation is the subject of separate reporting by AEMO, as required by the NER8 .

AEMO's assessment

As this was a reviewable operating incident, AEMO is required to assess the adequacy of the provision and response of facilities and services and the appropriateness of actions taken to restore or maintain power system security9 .

AEMO's conclusions , recommendations and actions arising from its review are summarised in Table 1

LOCAL NEWS

Table 1 Summary of conclusions and recommendations

Findings	Recommendations and actions
The event has emphasised the critical impact of total loss of DC supplies to generator protection and control systems. Immediately following loss of DC supplies, AC station supplies also tripped, which was not expected.	• CS Energy to review process for maintenance work to: – Avoid unnecessary common mode risks for critical supplies when the generating unit or the generator transformer is in service. – If the nature of work is such that significant risks would remain, schedule such work during generating unit outages.
	• Power station operators to consider learnings from this incident including implications for protection designs, operating procedures and communication protocols. • AEMO to discuss with generators the need to: – Provide advice to AEMO when protection schemes and associated DC supplies are temporarily not fully duplicated due to maintenance outages or equipment failure, and – Establish agreed protocols for managing such risks similar to those already in place with TNSPs. • CS Energy's independent investigation into the root cause of this incident is ongoing. Once CS Energy's independent investigation is concluded the findings will be shared with AEMO. AEMO and CS Energy may identify additional recommendations based on the outcome of this independent investigation. • Pending CS Energy's independent investigation outcome, CS Energy to review the philosophy and risk mitigation measures designed into the protection systems installed at Callide C4. This review should focus on identifying any areas of inherent risk which need to be addressed.
The serious nature of the issue developing at Callide Power Station was not fully appreciated by AEMO, the TNSP and power station operating or trading staff, due to inconsistent observations and interpretation of the situation	• CS Energy has developed an operating protocol, which has been implemented by Powerlink, outlining the process by which, if required, the Callide B and C generator feeders are to be opened at Calvale substation on request from the power station operators. • Powerlink and CS Energy are implementing a mechanism to provide CS Energy with visibility of the 275 kilovolt (kV) generator feeder analogue values from Calvale substation. • AEMO, TNSPs and generators to review the emergency communications protocols and decision-making processes between control operators for similar events. This review will include: – A clear procedure to support the identification of potential motoring of generators and appropriate responses.

LOCAL NEWS

Findings	Recommendations and actions
	– Roles, responsibilities and communication channels to be used in emergency circumstances. – A process to assess apparent discrepancies between SCADA and site observations and to agree on action to be taken[10]. • Generators to investigate the feasibility on a risk reduction vs cost basis, of a suitably graded backup protection in power station switchyards (supplied from switchyard DC supplies) to disconnect generating units in cases of sustained motoring or uncleared major fault when generator protection has failed to operate. Generators should engage with the relevant TNSP as required.
The eventual fault on the Callide C4 unit was not detected by its own protection system and was eventually cleared by operation of line protection schemes remote from Calvale. The fault resulted in a severe voltage depression of unusual length and loss of multiple generating units in Central Queensland. Other generating units were subsequently lost as the voltage recovered swiftly leading to over voltage conditions due to the non-credible contingency event	• During review of this event, AEMO identified Trip to House Load (TTHL) settings implemented at Stanwell Power Station that impacted its ability to remain connected to the power system following voltage disturbances. The undervoltage trigger was removed in September 2021 to reduce the likelihood of Stanwell Power Station disconnecting following network disturbances. AEMO will review with Stanwell whether to re-establish this trigger with revised settings. • AEMO is reviewing the settings of similar TTHL schemes elsewhere in the NEM.
	• AEMO to assess impact on system resilience of generator protection settings that in this event led to loss of multiple generating units. • AEMO has requested further information on why Townsville Gas Turbine (GT) controller switched from 'load control' to speed control'. AGL's investigation into this behaviour is expected to conclude by the end of October 2021. • AEMO is investigating whether the tripping of the Yarwun CCGT cogeneration unit was consistent with expected performance in response to conditions at its connection point.
The severe loss of generation in Queensland led to excessive loading on the QNI which tripped and then reclosed as designed. During the brief separation of the Queensland region from the remainder of the NEM the frequency in Queensland fell sharply. Frequency stabilisation in Queensland was achieved through load shedding by the UFLS scheme, as designed, and assisted by primary frequency response from generation.	• As part of the ongoing routine review of UFLS performance, AEMO to review operation of UFLS in greater detail to confirm that individual UFLS load blocks operated as expected and assess whether the UFLS scheme: – Is likely to continue to remain effective as inertia falls and distributed generation grows in the Queensland region; and – Would have been as effective if similar events had occurred under different operational conditions.

LOCAL NEWS

Findings	Recommendations and actions
	Also as part of this review AEMO may propose to Jurisdictional System Security Coordinators (JSSCs)[11] that the allocation of load to specific UFLS blocks be reviewed to reflect the existence of more flexible industrial load. • AEMO to seek and review further information to more conclusively identify the causes for loss of load for reasons other than UFLS, to assess what risks this might pose in other circumstances.
AEMO has undertaken power system studies to assess system security. Results from these studies have not identified any periods over 30 minutes, during this incident, where the power system was not secure.	AEMO is continuing to benchmark and validate power system models against the observed performance of the power system throughout and following this event. Any notable findings may be separately reported.
In response to this incident automated protection systems operated in QLD (such as UFLS and voltage control schemes). In addition other manual processes were relied upon to support the response to this incident.	• Based on observations following this event associated with unusual operating conditions, AEMO recommends that TNSPs review appropriateness of current settings for voltage control schemes under low system strength conditions.
Initial reserve forecasts following the incident showed lack of reserve levels in Queensland over the evening peak which were which were lower than reserve levels that actually occurred. The forecast lack of reserve led to activation of RERT in Queensland.	• AEMO will Identify what changes, if any, are practical to improve the accuracy of reserve forecasts following this type of event, including improved visibility, and forecasting of the response of controlled loads.
The events at 1406 hrs resulted in approximately 359 MW of distributed photovoltaic generation (DPV) being disconnected from the power system due to the action of UFLS relays in Queensland and New South Wales. This is undesirable as it reduces the effectiveness of the UFLS scheme. The events at 1406 hrs also resulted in the disconnection of DPV due to inverter behaviour as outlined below – • QLD: ~119 MW of DPV disconnecting. • NSW: ~77 MW of DPV disconnecting. • SA: ~27 MW of DPV disconnecting. • VIC: ~11 MW of DPV disconnecting.	• In collaboration with NSPs, AEMO is undertaking a review of NEM UFLS schemes. This will identify when UFLS response is no longer sufficient at times of high DPV generation and explore remediation actions with NSPs. • The new Australian Standard AS/NSZ4777.2:2020, becoming mandatory from 18 December 2021, includes improved requirements for disturbance ride-through capabilities for DPV inverters. Over time, this should reduce the disconnection of DPV inverters in response to disturbances.

LOCAL NEWS

NT TRAGIC FATALITY HIGHLIGHTS DANGERS OF FAULTY SERVICE MAINS NEAR METAL ROOFS

By Terry Miller | 19 October 2021 | Source: ABC News

The article below describes the tragic death of an 11 year old boy in the Northern Territory, from an electrified roof. It would appear that the electricity service support pole or bracket became energised due to insulation failure on the service mains. The service bracket was reportedly supported by a steel guy wire anchored to the metal roof.

The news report states that the roof was not earthed "as required by Australian Law". This could be interpreted to read that all steel roofs are required to be earthed.
AS 3000 does not require all steel roofs to be earthed, although they do require structural steel framed buildings to be earthed. The house concerned could well have had a metal subframe. Moreover, the electrical connection, via the steel support wire, between the roof and the service bracket immediately invokes the requirement in AS3000 to earth the bracket.

This incident will undoubtedly draw attention to network operators' maintenance and inspection programs for services.

Coronial inquest into death of 11-year-old boy in Gunbalanya hears roof he was climbing was electrified to 240 volts | By Kate Ashton | 12 October 2021

The 11-year-old boy died in the West Arnhem Land community of Gunbalanya late last year.(Supplied: Department of Education)

LOCAL NEWS

Key points:

- A coronial inquest has begun into the October 2020 death of a boy after climbing the roof of a house in Gunbalanya
- The inquest heard electrical infrastructure at the house where he died had been poorly maintained
- It also heard that the roof had not been properly earthed

It took five days for investigators and community members to realise the roof of a home close to where an 11-year-old boy had been found dead was "live" and electrified with 240 volts, an inquest has heard.

Warning: Indigenous and Torres Strait Islander readers are advised this article contains the name of a person who has died.

Rory Wauchope-Dirdi's death after climbing a home in the remote Northern Territory community of Gunbalunya, 300 kilometres east of Darwin, is the subject of a coronial inquest that started in Darwin on Tuesday.

His family has described Rory as a happy-go-lucky boy who was a very fast runner, good at sport and hunting and attended school every day.

Rory was found dead lying on the beam of the home in October 2020.

Initial inquiries suggested he had died of positional asphyxia, which is when the position of the body prevents someone from breathing.

But investigator and NT police officer Brett Wilson told the inquest there had been some uncertainty about why that would have happened.

"There was a gap [between the roof and the wire mesh he climbed], it's not like he was stuck," he told the court. "We all sort of wondered why."

Darlene Anne Wauchope is the mother of the boy who died in the incident.(ABC News: Kate Ashton)

On Tuesday, the court heard that five days after the incident, Rory's older brother had attempted to climb the mesh wire of the house where Rory had been found and felt an electric shock.

"He was certain that the mesh [where his brother had been climbing] was sufficient for his brother to climb through," Counsel Assisting Kelvin Currie told the court.

"As he got near the top he put his head side-on through the space.

"As he did, he felt a sharp pain shoot through the right side of his head and down his neck."

LOCAL NEWS

The inquest heard Rory's brother had been taken to the clinic for a check-up but was otherwise fine, and the family had told investigators about the shock.

"They organised an electrician to inspect the premises the same day," Mr Currie told the court.

"The electrician found that the roofing iron had 240 volts running through it due to deterioration of the active cable servicing the premises and being in contact with the support cables to the metal riser, to which the aerial cable to the premises was attached.

"The issue for this inquest is how it was the infrastructure was so poorly maintained that the steel roof was live with 240 volts."

Pathologist finds evidence of electric shock

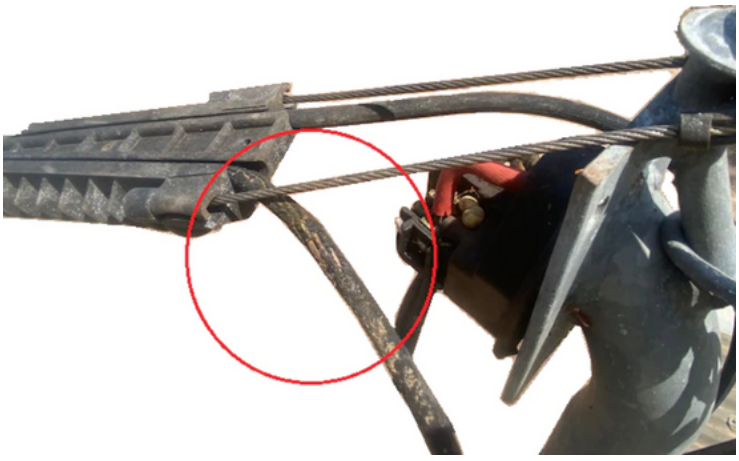
On re-inspection, the forensic pathologist was able to find evidence of electrical injury in the form of small blisters on his foot and a mark on Rory's leg.

"But very subtle injuries — I think it was a low-voltage shock that would have incapacitated him," the NT's chief forensic pathologist, Dr Marianne Tiemensma, told the court.

"It may have killed him on his own, but you can't discount the upside-down position."

Maintenance records limited and roof not properly earthed, court hears

The inquest heard that a subsequent investigation found the roof of the 25-year-old home had not been properly earthed as required under Australian law, and the service line, belonging to Power and Water, had become degraded, causing the roof to become electrified.



Preliminary investigations found the damaged insulation on an overhead powerline made contact with a stainless steel wire.(Supplied: NT WorkSafe)

Police investigators and representatives from a local Aboriginal corporation, Demed, which provides maintenance services to the house where Rory was found, were also unable to find records explaining who certified the electrics in the home.

"I spent weeks looking, it was just not there," Demed chief executive John Thomas told the inquest.

The inquest heard a subsequent audit by Demed found none of the nine or 10 land trust-owned homes it provided maintenance services to had been properly earthed.

It also identified another home where the Power and Water Corporation's service cable had begun to degrade, though the roof of that home was not yet electrified.

LOCAL NEWS

It also identified another home where the Power and Water Corporation's service cable had begun to degrade, though the roof of that home was not yet electrified.

John Thomas from Demed said all of those houses, including his own home, had since been fixed and were now properly earthed, but it was not something that was routinely checked by electricians.

"I didn't give it any thought I just assumed when it was constructed it was done [earthed] properly," he said.
"Even if it wasn't our responsibility, we would still fix it, because it's a tragic consequence if you don't, but we do take responsibility.

"I just wish we had picked it up before."

The inquest continues.

TRANSGRID ENERGY VISION

By Terry Miller | 19 October 2021 | Source: Transgrid media

“As the world responds to climate change and the cost of renewables plunges, the transition from a fossil fuel to renewable energy based power system is unstoppable. During this energy transformation, Australia’s patterns of electricity supply and demand will change dramatically.”

This is the introduction to the Foreword of Transgrid’s Energy Vision for the future energy landscape in Australia, and its role within it.

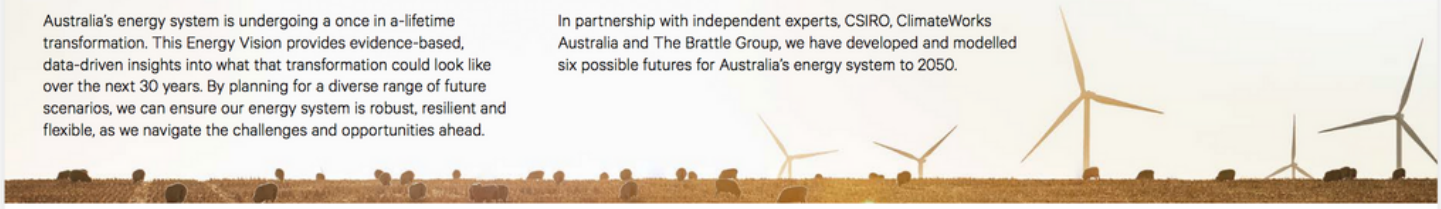
Here is the Executive Summary of the 73 page document, which can be read in full here.

LOCAL NEWS

Executive summary

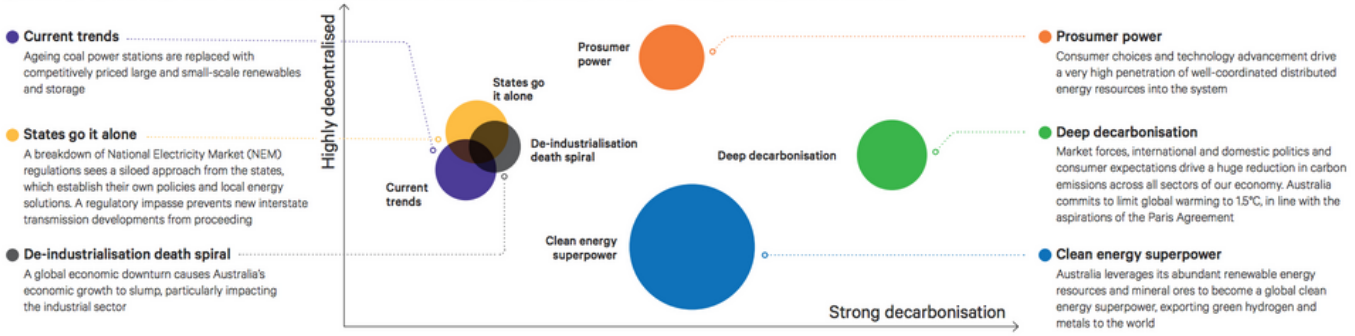
Australia's energy system is undergoing a once in a-lifetime transformation. This Energy Vision provides evidence-based, data-driven insights into what that transformation could look like over the next 30 years. By planning for a diverse range of future scenarios, we can ensure our energy system is robust, resilient and flexible, as we navigate the challenges and opportunities ahead.

In partnership with independent experts, CSIRO, ClimateWorks Australia and The Brattle Group, we have developed and modelled six possible futures for Australia's energy system to 2050.



Six scenarios for the future

Figure 1: Comparing scenarios against their level of decarbonisation, decentralisation and the underlying electricity consumption in 2050 (represented by the size of the bubble)



Current trends
Ageing coal power stations are replaced with competitively priced large and small-scale renewables and storage

States go it alone
A breakdown of National Electricity Market (NEM) regulations sees a siloed approach from the states, which establish their own policies and local energy solutions. A regulatory impasse prevents new interstate transmission developments from proceeding

De-industrialisation death spiral
A global economic downturn causes Australia's economic growth to slump, particularly impacting the industrial sector

Prosumer power
Consumer choices and technology advancement drive a very high penetration of well-coordinated distributed energy resources into the system

Deep decarbonisation
Market forces, international and domestic politics and consumer expectations drive a huge reduction in carbon emissions across all sectors of our economy. Australia commits to limit global warming to 1.5°C, in line with the aspirations of the Paris Agreement

Clean energy superpower
Australia leverages its abundant renewable energy resources and mineral ores to become a global clean energy superpower, exporting green hydrogen and metals to the world

Foreword | Executive summary | Drivers of change | Future energy scenarios | Key trends | Decarbonisation, jobs & costs | Our Vision | Power system implications | Appendix

Transgrid

Seven key insights

Our analysis has identified seven key insights for the future of Australia's energy system.

The transition to renewables is unstoppable

- The findings are clear – the transition towards a clean energy future is unstoppable.
- In all scenarios examined, renewable energy supplies the majority of the NEM's electricity needs by 2050. In five out of the six scenarios, renewable energy supplies more than 70% of the NEM's annual energy needs by 2035 and more than 90% by 2050.
- The economic viability of Australia's coal generators is being challenged by the influx of renewables. Our analysis indicates that, by 2030, with decarbonisation objectives aligned to a 1.5°C temperature trajectory, as much as 18GW of coal capacity could be withdrawn from the NEM – 13GW more than currently anticipated[1].
- The likely early retirement of coal generators highlights the critical need for an orderly, planned and just transition from coal, ensuring the energy system remains reliable, secure and affordable.

The power system will play a central role in achieving economy-wide decarbonisation

- The electricity system will play a central role in supporting Australia's decarbonisation, underpinned by a rapid transition to renewable energy and the electrification of road transport, industry and buildings.
- If the vast majority of Australia's vehicle fleet is electrified, as in **Deep decarbonisation**, almost 100TWh/year of energy demand could be added to the NEM by 2050, equivalent to half of the NEM's current annual demand. In this scenario, the electrification of industry and buildings is projected to add another 40TWh/year by 2050.
- Electricity generation currently accounts for 33% of Australia's greenhouse gas emissions[a]. Under our business as usual **Current trends** trajectory, the NEM's electricity system is projected to reduce its emissions 93% by 2050, while the remainder of the economy only sees a 7% reduction in emissions.
- To facilitate the **Deep decarbonisation** of Australia's economy, the electricity system is fully decarbonised by 2035. The remainder of the economy achieves an 87% reduction in emissions by 2050.
- In our business as usual **Current trends** scenario, we project 108GW of largescale wind, solar photovoltaics (PV) and rooftop solar capacity is required in the NEM by 2050. This increases to 159GW in **Deep decarbonisation**, and 417GW in **Clean energy superpower**.

The transmission system is a key enabler of Australia's energy transformation

- Surging demand for electricity, an influx of geographically diverse renewable energy generation and an increasingly important role for energy storage will reshape our energy system, requiring a significant expansion of the transmission network.
- The role of the transmission system remains crucial in all scenarios, moving 73-95% of all electricity consumed in the NEM in 2050 from largescale generators to distributors and large customers, even in scenarios with exceptionally high rooftop solar uptake.
- New interstate transmission interconnection will be critical to maintain the sharing of low-cost, secure and reliable electricity between states, providing $20 billion in savings to the energy system by 2050.
- Modelling suggests that 25GW of new inter-regional transmission is required NEM-wide by 2050 in **Current trends** and 47GW in **Deep decarbonisation**, to support the least cost evolution of our energy system.

> "A decarbonised power sector, dominated by renewable sources, is at the core of the transition to a sustainable energy future"
>
> *IRENA, 2018, Global Energy Transformation: A roadmap to 2050*

> "Spreading the use of electricity into more parts of the economy is the single largest contributor to reaching net-zero emissions"
>
> *International Energy Agency, 2020, Energy Technology Perspectives*

1. Based on announced retirement dates for coal generators, or at the end of their technical life, as recorded by AEMO.

LOCAL NEWS

Seven key insights

Distributed energy technologies and increasingly sophisticated consumers will play a key role in Australia's future energy system

- Rooftop solar capacity is projected to surge in the coming decades, increasing 3-9 times in the NEM, possibly to as high as 82GW by 2050.
- Distributed batteries in Virtual Power Plants and electric vehicles with Vehicle-to-Grid technology could provide 30% of the NEM's storage requirements in **Deep decarbonisation** and up to 80% in **Prosumer power**.
- The electricity sector must evolve to meet changing consumer expectations and leverage new distributed energy resource capabilities to support the ongoing stability of the electricity system.

Australia has a unique opportunity to harness its abundant renewable energy resources to become a global, clean energy leader

- Australia's abundant renewable energy resources, large landmass, significant mineral ores and good access to Asian markets could set us up to become a **Clean energy superpower**, exporting zero-emissions green hydrogen, metals, and other products and services to the world.
- As the cost of producing hydrogen from electrolysis falls, our modelling projects that renewable electricity becomes the dominant energy source for Australian hydrogen production, representing 94% of total hydrogen production in 2050.
- With appropriate support, the levelised cost of green hydrogen is projected to fall below $2/kg in the early 2030s, reaching $1/kg by 2050 at major hydrogen producing locations on the south and east coast of Australia.
- Our modelling projects that QLD dominates the production and export of hydrogen and green steel from the 2030s, followed by NSW and WA in the 2040s.
- By 2050, North Queensland and the Hunter Valley in NSW are projected to produce and export the largest quantities of hydrogen and green steel in Australia.
- Demand for electricity could surge in a **Clean energy superpower** future, increasing the NEM's electricity requirements six times by 2050.

Becoming a clean energy leader provides clear long-term benefits for Australians

- Efforts to support domestic and global decarbonisation will supercharge our economy, drive local job creation and lower energy costs for Australians.
- A **Deep decarbonisation** of the Australian economy supports 41,000 electricity sector jobs across the NEM this decade, 45% more than in our business as usual future (**Current trends**).
- A **Clean energy superpower** future supports 68,000 electricity sector jobs on average from 2030-50, more than twice the level of jobs projected in **Current trends**.
- Modelling suggests a significant proportion of new renewable energy and downstream hydrogen and green steel production jobs will be created in regional areas in **Clean energy superpower**, many in similar locations to where existing coal industries are located, such as the Hunter Valley in NSW.
- Our modelling shows these regions can be at the forefront of Australia's clean energy future. In an orderly transition of the energy system, no cohort of workers should be left behind. Communities should be provided every opportunity to harness the full potential of new export industries. Proper planning and investment in reskilling and upskilling is required.
- A **Clean energy superpower** future would deliver the lowest cost of electricity, 12% lower than **Current trends** over the period 2021-50.
- The decarbonisation of the Australian economy can deliver lower energy expenditure for residential consumers. Those with a single electric vehicle could be at least $900/year better off under a **Deep decarbonisation** scenario, when considering expenditure on electricity, rooftop solar, batteries and electric vehicles.

A new suite of technologies, services and products will be required to maintain safe, reliable and secure power system operations as the energy system transforms

- Maintaining power system security will become increasingly complex as the energy system transforms.
- Demand response, largescale storage, aggregated behind-the-meter batteries, flexible hydrogen electrolysis, and electric vehicles with Vehicle-to-Grid technology are likely to become increasingly critical to help balance our energy system.
- Modelling projects that 18GW of dispatchable storage capacity is required by 2050 in **Current trends**, and 33GW in **Deep decarbonisation**.
- Grid forming inverters are projected to play a crucial role in supporting energy security as synchronous generators are withdrawn.
- Our modelling suggests that inertia and system strength ancillary services will represent between 1-3% of total system costs.
- Australia is already experiencing the effects of climate change. Building a more resilient energy system is a critical task for the coming decades.

Efforts to support domestic and global decarbonisation will supercharge our economy, **drive local job creation and lower energy costs for Australians.**

Our vision for Australia's energy system

To guide Australia's energy transition, we need a clear vision for the future that we can collectively strive towards.

Our vision is for Australia to become a global clean energy leader, benefitting communities, the economy and the environment.

This vision is centred on three themes: a decarbonised economy, a transformed economy (with new export sectors) and a resilient and affordable energy system.

- We see optimal advantage for Australia represented through a combination of **Deep decarbonisation** (medium-term) and **Clean energy superpower** (long-term). These two scenarios bring together the economic and climate benefits captured through proactively embracing the energy transition and Australia's natural advantages to become a renewable powerhouse.
- Our analysis indicates that the transition towards a clean energy future can create immense opportunity for Australia – if we set ourselves on the optimal course. As a nation, we have the choice of how we respond to this transition, not whether it happens at all.

LOCAL NEWS

"DIGITAL TWIN": ONLINE SIMULATOR TO HELP WIND AND SOLAR FARMS CONNECT TO THE GRID

By Giles Parkison | 19 August 2021 | Source: Renew Economy

The Australian Energy Market Operator (AEMO) says it expects to make an on-line simulator available early next year to help developers of wind and solar projects prepare detailed and accurate models and prepare for the connection process.

The issue around modelling – and what impact a new wind or solar farm, or even a big battery – will have on the grid has been one of the most frustrating problems for the army of renewable developers and the grid owners and operators alike.

Developers have complained about the complexity, cost and lack of access to detailed information in preparing their modelling, while networks and AEMO have been frustrated with what they say has been some variable and occasionally poor quality modelling.

The modelling has been one of the reasons – along with the lack of grid capacity – for lengthy delays in the connection and commissioning process that have seen some projects having to wait a year or more even after construction has been finished.

Some issues, like more transparency over who is proposing what in which areas, have been addressed, and AEMO says it is now moving forward on a plan to build a cloud-based resource that will allow developers to test and tune power system models for their new generation projects.

It says the connection simulation tool, effectively a "digital twin" of the National Electricity Market, will be partly funded by the Australian Renewable Energy Agency's Advancing Renewables Program, and will help reduce risks, costs and time for connection approvals.

CEO Daniel Westerman says AEMO has connected 121 new projects in the past four years and there are some 97 gigawatts – includes 46GW of wind, 33GW of solar and 10GW of hydro – of project proposals in the pipeline.
"Our energy sector continues to move through its most extensive transformation in a century, leading the world in the uptake of renewable generation on a per capita basis," Westerman said in a statement.

"The connections simulator will give developers the option to utilise the wide-area power system information used by AEMO for the first time to evaluate their project models quickly and efficiently. This will help enable new generation and storage capacity into the power system."

Westerman said many wind and solar projects are located in weak parts of the grid, prone to poor system strength and thermal and capacity limits. This is presenting technical complexities, when combined with regulatory and project-specific issues, and is contributing to delayed connections. It requires strong modelling.

Testing will begin this month on a working prototype, with a staged rollout of the connection simulator expected at the end of 2021 and into 2022.

LOCAL NEWS

AUSSIE STARTUP CREATES WORLD'S MOST EFFICIENT SOLAR CELL

By Elle Hardy | 4 October 2021 | Source: Engineers Australia Create Digital

Australian startup SunDrive has created a commercial-sized silicon solar cell with 25.54 per cent efficiency using copper instead of silver.

Led by co-founders Vince Allen, an engineer, and David Hu, Sundrive's cell achieved an efficiency of 25.54 per cent — beating the old record of 25.26 per cent — in testing carried out by the Institute for Solar Energy Research in Germany. "We're only at the very early stages of where the industry can be, with only 3 per cent of the world's electricity currently coming from solar," Allen said in an announcement.

"If we want to get to 50, 60, 70 per cent and beyond, we're going to need a lot more solar cells and that's a massive challenge."

The world record holder back in 2014, and a former colleague of Allen's at the University of University of New South Wales (UNSW), Professor Martin Green told create that the breakthrough was exciting on a number of levels.

"It could be really important. The traditional way of extracting the current from the cell has been with silver, but last year, solar used 10 per cent of the world's silver supply, and the industry is growing quickly," he said.

Copper is about 100 times cheaper than silver, and it also requires lower processing temperatures, meaning less energy consumption to create cells.

"It's not a material that you want to have your industry dependent on, because it's used in jewellery and other commercial activities so that the price can become very volatile," he said.

"Vince has found another way of applying these metal lines to silicon cells that uses copper, rather than silver."

Ordinarily, silver is mixed into a paste and 'screen printed' onto a cell before being heated to about 750°C. The technology that SunDrive applied can't stand high temperatures.

"That's going to make it easier to get this other technology onto the market, because the cost of the silver is inhibiting," he said.

Hurdles to get to market

"It's not just the efficiencies SunDrive has been working on, but the durability issues that you need a new approach to satisfy," Green said. "Vince Allen has been doing work in that area, but that's not quite as exciting as the new efficiency record."

Green believes that SunDrive's copper breakthrough will certainly refocus attention on the metal in solar because of its obvious benefits.

LOCAL NEWS

"There are a lot of physical limits to efficiency, so 68 per cent is the limit for a solar cell. Presently, cells are made from silicon — the way you can get to these much higher efficiencies is by stacking cells made from different materials," he said.

Green added that his researchers have made cells that are 50 per cent efficient, but only at converting red light.

"The ultimate way to approach that 68 per cent efficiency is by having cells specialised to convert each colour of the photons. But for a silicon cell, the efficiency limit is about 29 per cent — so SunDrive is getting quite close to that," he said.

"THE INDUSTRY IS USING THE PERC CELL THAT WAS DEVELOPED AT UNSW, SO OVER 90 PER CENT OF THE CELLS MADE GLOBALLY ARE USING AUSTRALIAN INVENTED AND DEVELOPED TECHNOLOGY."
Professor Martin Green

The global race continues

Green said that UNSW held the efficiency record for 30 years, but the proliferation of solar companies means that universities are finding it hard to compete due to scale.

"The industry is using the PERC cell that was developed at UNSW, so over 90 per cent of the cells made globally are using Australian invented and developed technology," he said.

"We have a good reputation, so that makes it easy for people like Vince Allen to get attention when they come up with something like this, because Australia has such a reputation for being pioneers with technology."

Universities and firms in Europe, Asia, the United States and Australia are all continuing to compete for efficiency gains. In 2016, German think tank Agora Energiewende set an aggressive target of 35 per cent efficiency by 2050 for a module that uses unconcentrated sunlight, such as the standard solar cells used on family homes.

Last year, British researchers Oxford PV claimed that the next-generation of solar panels would be able to generate almost a third more electricity than traditional silicon-based solar panels by coating the panels with a thin layer of a crystal material called perovskite.

Green said that commercialisation of such breakthroughs can happen quickly, but manufacturers need to ensure efficiency doesn't come at the cost of durability.

"You've got to make sure that you're not jeopardising the extreme reliability by making a change," he said.

"That's the big hurdle. A company would have to do extensive testing under certain conditions to make sure they were satisfied that switching to a new technology like this wouldn't prejudice the durability of the product that they're offering their customers."

LOCAL NEWS

SOUTH AUSTRALIA'S HORNDALE BATTERY SUED BY AER FOR FAILURE TO PROVIDE STANDBY SUPPLY DURING QUEENSLAND KOGAN CREEK OUTAGE

By Nick Harmsmen | 23 September 2021 | Source: ABC News

The Hornsdale Power Reserve, near Jamestown, in South Australia's Mid North.*(ABC News)*

Key points:

- *The Hornsdale battery was built to provide more stability to the electricity grid*
- *The energy market regulator says it failed to help during a Queensland coal plant failure in 2019*
- *It says generators need to follow through with promised services*

South Australia's big Tesla battery is being sued for allegedly failing to live up to its promises to help rescue the power grid in the event of catastrophe.

The 150-megawatt battery was being paid to be on standby to pump energy into the grid at short notice in order to arrest a system failure in the event of a major power plant or transmission failure.

LOCAL NEWS

But the Australian Energy Regulator (AER) alleges it did not deliver as promised during a major Queensland coal plant failure in 2019, "creating a risk to power system security and stability".

The Federal Court legal action against owner Hornsdale Power Reserve comes months after the AER successfully sought financial penalties from wind farms for failures associated with South Australia's statewide blackout.

The Hornsdale battery, near the Mid North town of Jamestown, was built in response to the blackout, as a storage of energy in case transmission was again cut unexpectedly and as a way to stabilise power flow as more electricity comes from renewable energy.

It uses Tesla batteries after the company's head, billionaire Elon Musk, promised to provide them for free if a 100-day deadline could not be met.

Call for generators to follow through

The AER alleges Hornsdale Power Reserve — owned and operated by the French renewable energy company Neoen — failed to provide the services it was paid for by the Australian Energy Market Operator (AEMO) between July and November 2019.

AEMO first brought the alleged conduct to the AER's attention following a power system disruption at the Kogan Creek Power Station in Queensland in October 2019.

The Kogan Creek Power Station in Queensland's Western Darling Downs.(ABC News: Peter Lewis)

LOCAL NEWS

AER chairwoman Clare Savage said the AER was "sounding the alarm" on concerning behaviour in what is known as the frequency control market.

"It is vital that generators do what they say they can do if we're going to keep the lights on through the market's transition to variable renewable generation," Ms Savage said.

"We expect providers to be in a position, and remain in a position, to respond when called upon by AEMO.

"Failure to comply with the latest market ancillary service offer and AEMO dispatch instructions is in breach of the National Electricity Rules and may result in AER enforcement action."

REGULATORY MADNESS PROMOTES DIRTY DIESEL OVER RENEWABLE MINI GRID AT BROKEN HILL

By Giles Parkinson | 1 October 2021 | Source: Renew Economy

Silverton wind farm.

LOCAL NEWS

Transmission company Transgrid may have to cancel plans to build a world-first renewable energy mini-grid near Broken Hill, and be forced instead – by archaic regulations – to buy and maintain two ageing diesel generators to secure the power supply in the mining and tourism town.

The bizarre situation emerging in Broken Hill, where highly polluting fossil fuel assets are preferred over new clean energy solutions, is yet another example of the complete failure of Australia's energy regulations to keep pace with technology and the evolving climate crisis.

Decisions across the grid – be it for new regulated investments such as networks, or in the setting of market rules – are being distorted because the Howard government decided in the late 1990s to deliberately exclude environmental considerations from the then newly formed National Electricity Rules.

And the grid has been paying the price ever since, because the regulator and rule makers are unable to take environmental and climate benefits into account. And narrow economic theory is also not helping.

Broken Hill is a prime example. The city and the surrounding mining province are located at the end of a long (260km) single line, and is prone to frequent outages. Back up supply is currently provided by two 25MW diesel generators, but their owner, Essential Energy, wants to sell them, or close them.

Options are needed, and Transgrid last year released a detailed report which – somewhat surprisingly – found that a world-first renewable micro-grid based around a 200MW compressed air storage facility, using technology from Canada's Hydrostor and supported by Australia's Energy Estate, was the best option.

"This creates a wonderful opportunity to bring Broken Hill back up into the 21st century," Andrew Kingsmill, the then head of Transgrid's network planning, said at the time. "This is a prime example of the value of grid- scale storage in the future power system and a project with which TransGrid is proud."

But then the lawyers intervened, and it was decided that the Transgrid document, known as a PADR (Project Assessment Draft Report (PADR), had to be redone, to conform to the regulator's narrow economic assessments.

Under these rules, the 40-year diesel generators are assumed to be able run for another 20 years, and the cost of their purchase is assumed to be zero, because the purchase price paid by Transgrid is cancelled out by the payment to Essential and the reduction in that network's regulated asset base.

That means that buying the diesel generators and keeping these highly polluting and maintenance heavy machinery is now deemed to have a greater net economic benefit than all the alternatives, including the planned mini-grid and multiple big battery options.

Transgrid is clearly not happy about it.

"We have concerns that prolonging the use of fossil fuel technologies is inconsistent with the Sustainability Strategy of Broken Hill City Council or the general transition of the electricity sector to low emission technologies," it writes in its new report.

LOCAL NEWS

It also notes that the diesel turbines are one trick ponies. They can only operate in "islanded mode" and can't deliver broader, longer term market benefits, unlike the compressed air energy storage solution, which can store excess power from existing wind and solar farms, and provide incentives for more renewables and cheap power for new mining projects,

That means it can secure power for the Broken Hill region when the main transmission line is out of service, using local wind and solar resources, such as the 200MW Silverton wind farm and the 53MW Broken Hill solar farm.

At other times it will be able to store renewable generation from southern NSW that would otherwise be spilt, and make it available at other times.

Figure E-1: Summary of the estimated net benefits under the weighted scenario, base case I

The diesel generators are Option 2 (green), while the compressed air storage proposal is second on left, option 1A/5A (2).

Under the strict AER guidelines, the diesel generators win with net benefits of $302 million, (in green above), and just pip the compressed air storage option, which have net benefits of $278 million.

But Transgrid says the benefits could be even greater, because they could be scaled into a larger solution to accommodate potential new mining loads in the Broken Hill area.

This was the thrust of a study commissioned by Hydrostor and Energy Estate last year, which noted that its proposal – unlike the diesel turbines – could support more renewables in the region, and offer cheap power to encourage new mines.

LOCAL NEWS

Even the mayor of Broken Hill, population 17,000, was on board. "It will bring employment and energy security to our region and provide a new method of utilising mining infrastructure," Darriea Turley said at the time.

It's absurd, but it's the state of the Australian energy market, and these narrow parameters have been guiding decisions made by the AER, and the Australian Energy Market Commission in the assessment of the myriad rules of the market and major multi-billion dollar network investments.

Only the Australian Energy Market Operator, in its detailed 20-year blueprint known as the Integrated System Plan, has taken account of the need to reach zero emissions. But its blueprint is only a guide, and the federal government has all but ignored it.

ACT energy minister Shane Rattenbury is trying to rectify the situation, and in last week's meeting of state and federal energy ministers gained approval to work on ways to get the environment written into the rules.

"This is important for ensuring emissions intensity of generation is considered and reducing emissions is prioritised" in regulatory and policy decisions.

Transgrid agrees. It recently wrote to the AEMC arguing that the RIT-T (regulatory investment test) should be broadened to include other relevant quantifiable economic and environmental benefits.

This is particularly important for the major projects identified in AEMO's 20 year blueprint.

"Whilst it might be appropriate to apply a relatively narrow test for small scale augmentations or asset replacement, this is not appropriate for projects such as those in the ISP," it wrote.

"The widely recognised costs to the Australian economy of climate change are not included in the current cost-benefit analysis in the RIT-T.

"This means that under the current RIT-T, the economic benefits for ISP projects such as Project EnergyConnect (which is facilitating large amounts of renewable generation into the system) and HumeLink (in terms of both Snowy 2 as renewable power source as well as providing a pathway to market for renewable energy from Snowy and other generation in the area) are undervalued."

In relation to Broken Hill, Transgrid's head of delivery, Craig Stallan, said: "The narrowness of the Regulatory Investment Test produces suboptimal outcomes for the energy consumer and the wider community.

"Clean, renewable energy solutions become preferred when taking into account the full quantifiable economic and environmental benefits."

Hydrostor president Jon Norman told RenewEconomy from Canada on Friday morning that his company was pleased that its compressed air storage solution was deemed as the best non-diesel alternative, and it is considering its options it can bring to the table to make it the front-runner.

LOCAL NEWS

One option might be to buy the diesel plants itself, and then phase them out as the new storage system is built.
"We think there are a few pathways," Norman said. "Diesel is not really a viable solution long term, we do feel our project is a better overall long term solution."

Hydrostor in May signed a contract to build a massive one gigawatt storage facility in California, using technology that Norman describes as like a "giant air battery".

The technology uses off-peak renewable electricity to run a compressor that produces heated, compressed air, which is then stored in underground caverns. When needed, the compressed air is expanded through a turbine to generate electricity.

The situation is frustrating many parties, but it's not quite the end of the matter.

There will be further consultations – submissions are open to all parties until November 17 – and then Transgrid's regulation team will put together another document, known as a PACR (Project Assessment Conclusions Report) in the long and tortuous path to regulatory approval. That is due in March next year.

TORNADO TEARS THROUGH CENTRAL WESTERN NSW NEAR BATHURST

By Terry Miller | 19 October 2021 | Source: Essential Energy media

Looks like storm season is upon us.....

ELECTRIC VEHICLE NEWS

BRISBANE METRO: AN INNOVATIVE, ALL-ELECTRIC TRANSPORT SOLUTION

By Jonathan Bradley | 17 September 2021 | Source: Engineers Australia Create Digital Mag

Brisbane's Metro system will feature 60 new vehicles.

Upgrading Brisbane's system of busways has involved more than new vehicles or new lanes. The city's metro project is an innovative solution.

When Brisbane was announced as the host for the 2032 Summer Olympic Games in July, it confirmed for the world what locals had long insisted: the city's 20th-century reputation as a big country town was now long in its past.

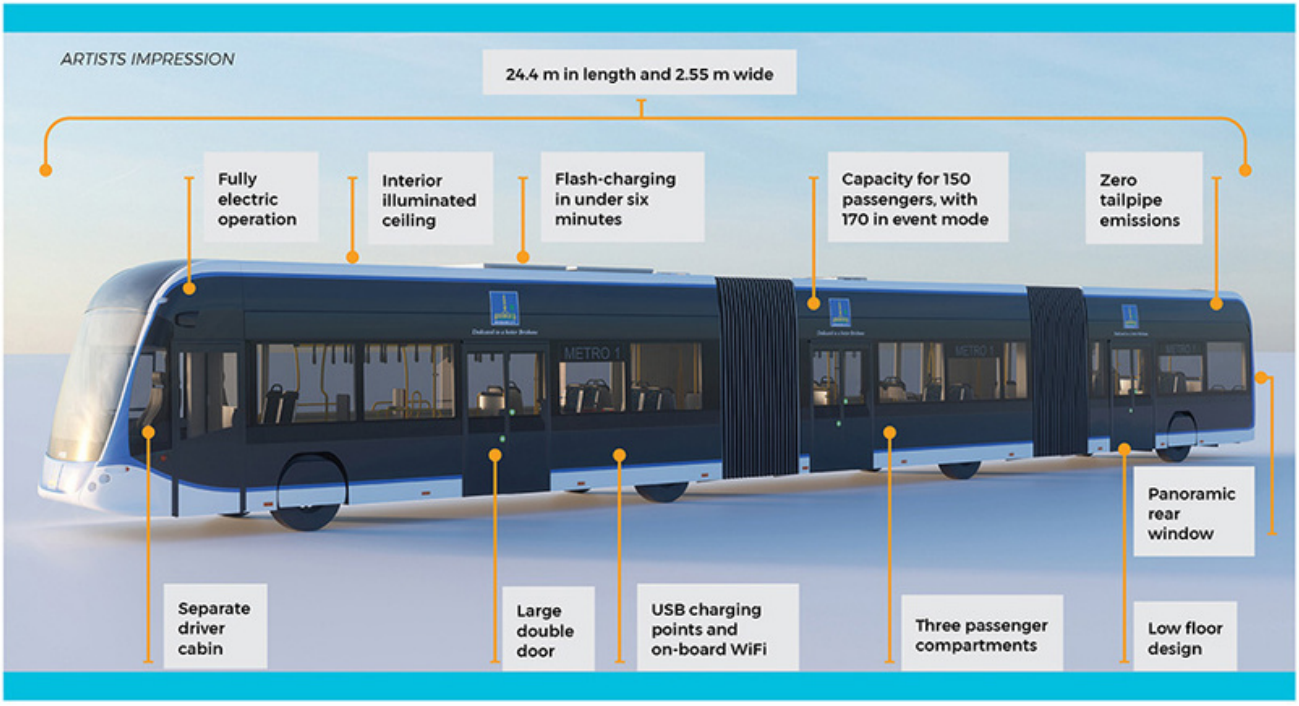
With a booming population that has now surpassed 2.5 million, the Queensland capital is changing rapidly, and that change has brought with it new demands on the city's infrastructure.

ELECTRIC VEHICLE NEWS

In response, Brisbane City Council announced in 2016 that it would introduce a new metro system to address constraints facing the city's current bus network. Opening in 2023, the Brisbane Metro will consist of 18 stations connected across two lines over 21 km.

Stretching from Herston in the north to Eight Mile Plains in the south and extending west to the University of Queensland in St Lucia, the network will consist of 60 custom-designed vehicles that will run entirely off electricity and have zero tailpipe emissions.

But transforming a city's transportation network also means solving some tricky engineering challenges, which is where Chartered engineer David Cox CPEng, Program and Commercial Manager, Major Projects, at Brisbane City Council comes in.



The vehicles are more like light rail carriages than traditional buses.

Getting Brisbane Metro ready to roll

A mechanical engineer and Queensland Chair of Engineers Australia's Risk Engineering Society, Cox has an executive role on the Program Leadership Team for the $1.2 billion project.

"Brisbane Metro's a transformational project in Brisbane City," Cox said.

"The busway's been operating for many years — since the early 2000s — and what Brisbane Metro seeks to do is upgrade the busway and introduce a new fleet of vehicles and some new operating modes to remove congestion and result in a better planned and better operating network."

ELECTRIC VEHICLE NEWS

The project is not just designed to improve the busway, but to integrate into other components of the city's transportation network, Cox said. This includes, for instance, the Cross River Rail project, due to open in 2024, which links the northern and southern sides of the city via a tunnel passing beneath the CBD and the Brisbane River.

"The two do work together to provide an improved transport network," he explained.

"Cross River Rail is being delivered by the State Government; Brisbane Metro by Brisbane City Council."

"BRISBANE METRO IS A TRANSFORMATIONAL PROJECT IN BRISBANE CITY."
David Cox CPEng

Originally, the plan was to convert the existing busway to light rail, but that soon shifted to something closer to a hybrid system: the new metro network would use "self-propelled rubber-tyred vehicles" rather than trams, but these would operate on a layout more like that of a light rail system.

"As the early feasibility studies progressed, it became obvious that [light rail] wasn't going to provide value for money and there was probably a better way," Cox said.

Each vehicle is 24.4 m long — more like a train carriage than an articulated bus, which measures about 18 m in length. The contract to produce these was awarded to Swiss manufacturer Hess. Testing of the first vehicles will begin next year.

Quick as a flash

As well as operating without tailpipe emissions, Brisbane Metro's vehicles have some other smart features — including the ability to recharge even while active on the network.

"This particular vehicle can operate 24/7 without needing to go back to the depot," Cox said.

"Obviously you need to change drivers, you need to clean the vehicle and do a few things like that, but the flash charging … does provide the opportunity for continuous operation."

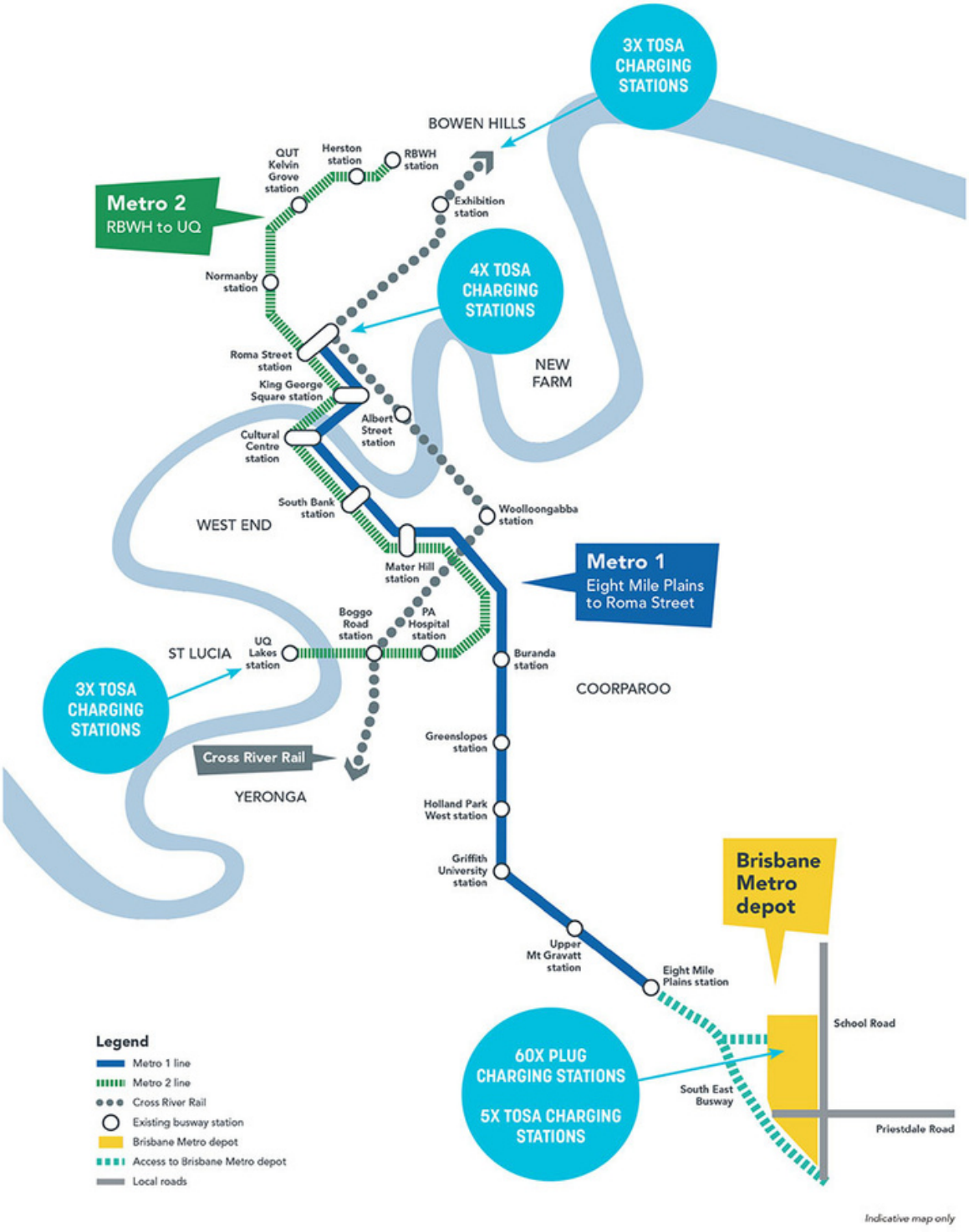
That flash-charging system is the innovation that permits the buses to operate without interruption. Delivered by Hess partner Hitachi-ABB, it incorporates 15 fast-charging stations of 600 kW at end-of-trip points, as well as 60 slow-charging stations of 50 kW at the depot.

"What the vehicle will do is it will go into a charging bay, and a pantograph will deploy automatically," Cox said.

"This only takes a few seconds, and then the vehicle will charge at 600 kW. It's about a thousand amps, the current, so it's a very fast charging process."

The advantage of this network is that the vehicles are fully integrated into the system.

ELECTRIC VEHICLE NEWS



BRISBANE METRO NETWORK MAP

The new Brisbane Metro, with charging stations indicated.

ELECTRIC VEHICLE NEWS

"It's not just a vehicle on its own; it's a vehicle that comes with a charging solution as well," Cox said.

"Each vehicle will run from one end of the route to the other and it can recharge in under six minutes and then run back to the other end and do so again and again.

"So the idea there is you can have continuous operation of this vehicle; there's no going back to the depot and plugging it in overnight."

"AS THE EARLY FEASIBILITY STUDIES PROGRESSED, IT BECAME OBVIOUS THAT LIGHT RAIL WASN'T GOING TO PROVIDE VALUE FOR MONEY AND THERE WAS PROBABLY A BETTER WAY."
David Cox CPEng

A Queensland concern

Although the system is based on existing technology used in Europe, the Brisbane Metro vehicles needed to be customised to ensure they suited the specific conditions of a Queensland city.

"It's not just a matter of picking up a European design and plonking it down in Brisbane," Cox said.

"There's a lot of work that needs to be done, firstly around converting it to a left-hand drive vehicle to a right-hand drive design vehicle [and] ensuring that Australia's design rules are complied with."

Also significant were concerns about climate. While the vehicles in Europe are not air conditioned, that was not a practical option for a system operating in Brisbane — particularly in summer.

"Another key difference is the speed," Cox mentioned.

Passing through the Adelaide Street Tunnel.

ELECTRIC VEHICLE NEWS

"The vehicles in Europe are generally used in congested inner-city areas on a shared roadway and typically have a speed of 50 up to 60 km an hour. In Brisbane's case, these vehicles will run on the dedicated busway and will be required to travel at speeds up to 90 km an hour."

As a result, the team had to reassure regulators that the system was safe and stable at that speed.

"The electric motors and the propulsion system certainly have the capability to do that," Cox said. "The actual performance of the vehicle and its ability to accelerate and reach top speed has never really been in doubt. It's about how do we ensure that it dynamically performs in a safe manner at that speed."

Although the vehicles themselves are innovative, the success of the network depends on its ability to integrate into the broader city.

"There's an infrastructure component, there's vehicles, there's the systems, there's the changing of the network in Brisbane City as well," Cox said. "And there'll be changes to policy and operations as well.

"It is a holistic solution."

"IT'S NOT JUST A MATTER OF PICKING UP A EUROPEAN DESIGN AND PLONKING IT DOWN IN BRISBANE."
David Cox CPEng

Accessibility matters

When it came to designing the vehicles to be used in the Brisbane Metro system, Cox wanted to ensure consideration was given to passengers with disabilities — and doing better than complying with minimum standards.

The team conducted manoeuverability tests to ensure accessibility in the design.

According to Brisbane City Council Public Transport Chair Ryan Murphy, the Brisbane Metro Accessibility Working Group was established in early 2019 to inform the design process.

"This engagement has covered key elements of the vehicle design, including the number and size of mobility-aided spaces," Murphy said.

"This has been informed by several stages of engagement, including physically taping out the dimensions of the vehicle to test manoeuvrability of mobility with council commissioning the manufacture of a scale-sized timber mock-up of the front section of the vehicle."

ELECTRIC VEHICLE NEWS

The team also used 3D design and virtual reality to ensure that the layout could accommodate passengers in wheelchairs. "We've used accessibility groups to come in and test the practicality of the design and give feedback," Cox said.

"It's almost been a co-design process with some of those accessibility groups, and that's actually made quite a few changes in the design process and delivered something that is different to what we originally anticipated."

MORE EVs,MORE CHARGING DEMANDS: HOW GRID OPERATORS CAN MANAGE

By Andy Bennett | 17 September 2021 | Source: EnergyTech

Distributed energy resource management systems (DERMS) are beginning to change the game for grid operators.

It is predicted that approximately 30% of all new cars sold in the U.S. in 2030 will be EVs, compared to 3.4% in 2021. This transition from gasoline and diesel to electricity will lower driving costs and reduce greenhouse gas (GHG) emissions. However, the electric infrastructure in place today will need to be managed to accommodate this net load growth while minimizing the costs and impact of EVs.

ELECTRIC VEHICLE NEWS

New residential home construction in the U.S. commonly uses a 100-amp or 200-amp electric distribution panel to supply HVAC, electric ranges, fans, pool pumps, lighting and other electrical equipment. While the number of homes supplied by a single utility distribution transformer varies, the utility typically provides a transformer that is somewhat smaller than the total service rating. This has been possible due to load diversity, where customers are not using all appliances and other loads at the exact same time. Of course, utilities cannot control individual customer behavior. Unrestricted and unpredictable activity, such as what might occur when multiple loads of EV charging come online on the same transformer, creates a major challenge to the assumption of load diversity.

How EV charging presents challenges

Home EV chargers typically use 32 to 50 amps. As certain neighborhoods (especially affluent ones) tend to add electric vehicles at a faster rate than others, it is not surprising to see multiple new charging loads on a single transformer, with dozens or hundreds on a distribution feeder. Now, when two or three customers are on a single transformer or 4,000 customers on a feeder arrive home at about the same time each night and plug in their vehicles, individual transformers and entire feeders can be stressed beyond their design ratings.

One way to deal with this is to install larger distribution transformers and resize utility feeder wires and equipment to ensure they can stand up to new load requirements. However, this would result in hundreds of billions of dollars in expenses to ensure the system is robust enough to handle an electric car in every home. This expense would ultimately be covered through increased customer rates, whether they own a car or not. Another solution may be to curtail all chargers on a feeder where loading of the feeder is an issue. This could result in EV owners being unable to travel with confidence due to limited or no certainty on what the charge state of the vehicle battery will be at any given time. Operators could consider an EV2G program, in which EVs provide their stored battery energy to the grid. In isolation, these programs offer a solution to demand response challenges. However, concerns around battery chemistry, warranties, and replacements as well as the high cost of offering two-way chargers that enable charging and discharging make EV2G programs a less-optimal short-term solution.

Solutions for utilities, operators, and customers

There are other ways to introduce EVs to the grid without rebuilding electric infrastructure. As most feeder loads follow a common varying load size (peak loads in the morning and late afternoons, low or lower loads at other times) a time-of-use rate could encourage people to charge their cars at times that minimize stress on the grid. Utilities can also provide rate-based or payment incentives to encourage EV owners to let them control their charging equipment directly. The EVs can then be utilized to ensure that everyone's charging requirements are met with minimal impact on the distribution system, transmission, and generators.

Aggregating EV charging into larger demand response (DR) programs can help achieve peak demand reduction and provide other grid services as needed. It's helpful to think of an EV charging DR program as part of a utility's larger efforts to manage integration of distributed energy resources (DERs).

Alongside increased adoption of EVs, utilities are facing challenges in managing other behind-the-meter DERs. Bringing more of these assets online and tapping into them as sources of decentralized, decarbonized energy is essential to lowering emissions and mitigating the damage of climate change. However, most current utility systems were not designed to cope with and manage this process.

ELECTRIC VEHICLE NEWS

This is where distributed energy resource management systems (DERMS) are beginning to change the game for grid operators. These intelligent, data-driven, customer-responsive, and flexible control systems can optimize the new grid edge, including diverse loads such as EVs, virtual power plants and solar + storage arrays while also working seamlessly with legacy assets. Through situational awareness, demand response management and load forecasting, DERMS enable operators to better manage EV charging on their grid. These platforms can deliver smarter insights to inform time-of-use rate programs and charging incentives, optimizing the use of these assets for owners and the utility at large.

EVs are promising for the environment and utility systems, even with some hurdles to overcome. As more of these vehicles hit the roads, utility operators must view them as grid assets and seek out ways current systems can switch gears and implement new programs that proactively assess and manage EVs as distributed resources.

Andy Bennett is CEO of mPrest, Inc., a developer of world-leading distributed asset orchestration and optimization software.

HUGE DEMAND FOR IONIQ 5 AS FIRST AUSTRALIAN BATCH SELLS OUT WITHIN HOURS

By Sophie Vorrath | 13 October 2021 | Source: The Driven

The first round of Ioniq 5 electric vehicles to go on sale in Australia – Hyundai's first-ever dedicated battery electric model – has sold out within hours of opening to online orders on Tuesday morning.

The carmaker confirmed on Wednesday that all 240 of the Ioniq 5s allocated to the Australian market had been snapped up in little more than two hours after ordering went live, with 170 $2,000 deposits taken on the $A71,900 (base price) EV through the Hyundai website.

"Online ordering went live at 9:30am AEDT. The load on the website led to some technical issues and the early suspension of the ordering process. The vehicle sold out in just over two hours," Hyundai said on Wednesday.

The clear display of strong customer demand offers a welcome sign of growth for the Australian electric vehicle market, which still has much catching up to do compared with other developed nations. The initial offerings of the Volvo XC40 Recharge was also quickly sold out.

For those customers who missed out, however, the evaporation of such a small initial allocation of Ioniq 5s would be little more than frustrating, with the timing for a second offering likely to be months away, according to Hyundai, possibly early 2022, once the company has a "clear visibility of supply."

ELECTRIC VEHICLE NEWS

"Very frustrating." Was the feedback from one customer, who shared his expeirence of "joining the early order rush" and narrowly missing out, including the technical difficulties and "early suspension" of the ordering process, as confirmed above by Hyundai.

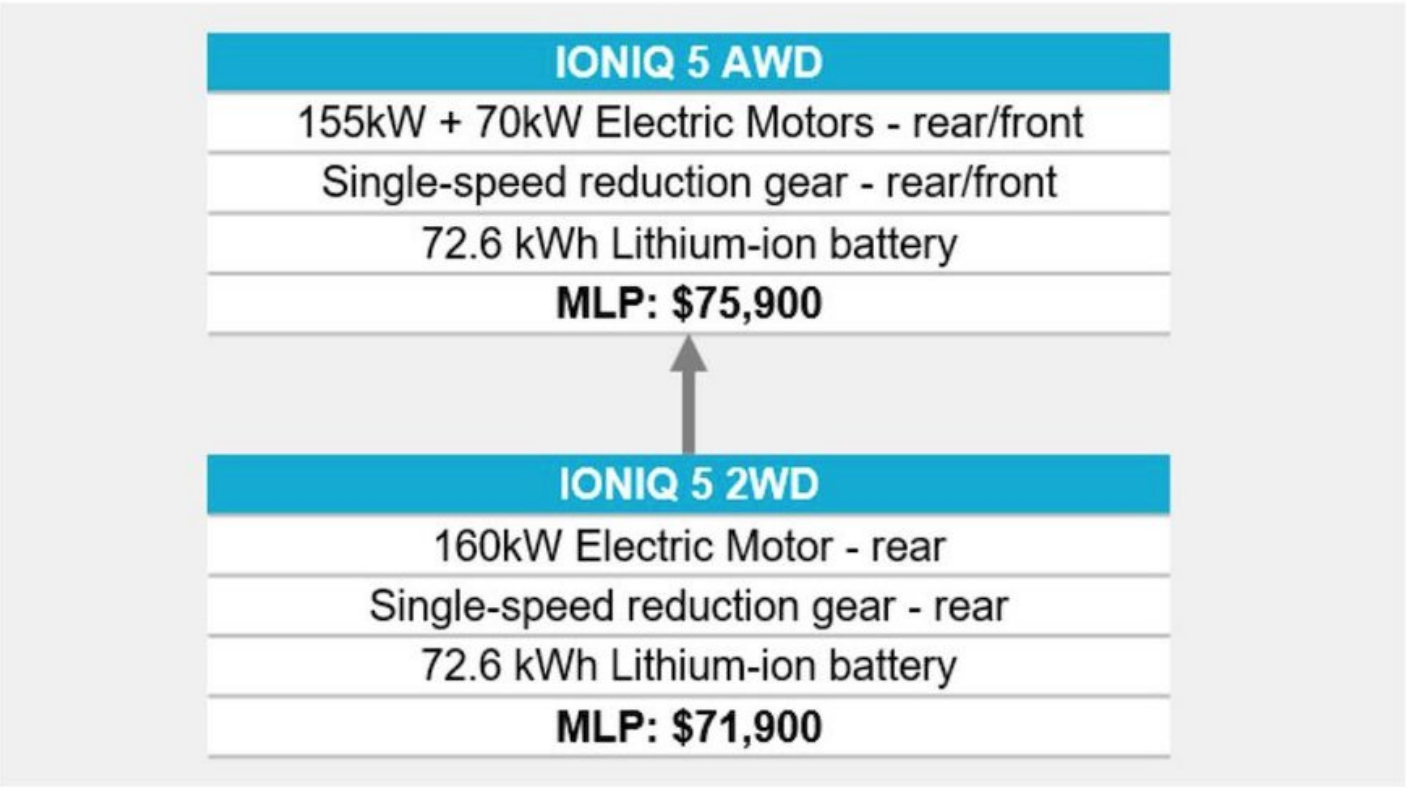
"But at least they shipped some to Australia, so that is a good thing," the reader said, noting a number of further positives from his experience, including a tow bar on the accessories list – "so 'someone we all know' will see that one can indeed have a good weekend away in an EV!"

Hyundai said customers who had missed out on this first batch would receive regular updates about the supply situation and timing for release of the next batch.

"We plan to only release vehicles for order once production has been scheduled, to ensure reasonable delivery timeframes for our customers," a spokesperson said.

So why the hot demand? Well, it is no surprise, really. Just last month Hyundai said it had been swamped by an unprecedented level of interest in the Ioniq 5 in Australia, with more than 10,000 would be customers registering their interest – and 100 paying a deposit giving them priority when bookings opened in late September.

As The Driven has reported, there is much about the Ioniq 5 to appeal to prospective electric vehicle drivers. Built on Hyundai's dedicated Electric-Global Modular Platform (E-GMP), it includes charging rates of up to 350kW, and ranges of 451km (2WD), and 430km (4WKD).



ELECTRIC VEHICLE NEWS

But one of the key attractions of the Ioniq 5 has been its vehicle-to-load (V2L) function, which allows customers to charge electric devices, such as electric bicycles, scooters, camping equipment, appliances in the home, or even another electric vehicle.

The "charger-on-wheels" also allows customers to charge high-power electric equipment via the vehicle's charge port, where the vehicle can provide up to 3.6kW of power.

"Luxuries" include seats trimmed in sustainable eco-processed leather, 12-way power front seats with 'Relaxion' (zero gravity) mode and memory function, a heated steering wheel, heated and ventilated front seats, heated rear seats, a vision glass roof with power sunshade, and a smart power tailgate.

"It is our great pleasure to introduce the futuristic IONIQ 5 battery-electric medium SUV, the first model from our IONIQ EV sub-brand," said Hyundai Motor Company Australia CEO Jun Heo on Wednesday.

"The powerful, long-range, ultra-fast charging IONIQ 5 represents the leading edge in zero-emissions battery-electric vehicles and is certain to delight our customers."

OPINION: THE INTERNAL COMBUSTION ENGINE IS DOOMED

By Daniel Gardner | 15 October 2021 | Source: Which Car

Thermal efficiency is consigning traditional cars as we know them to an inevitable electric future.

ELECTRIC VEHICLE NEWS

Beyond a basic first aid course I attended in 2003 and a talent for extracting particularly stubborn blackheads, I have no official medical qualifications. But despite this, I feel quite confident that I could perform a respectable angioplasty and it's all thanks to a Ford Escort. The car in question was an early Mk2 belonging to a college friend who was looking for maximum power on a typical minimal student budget. A deal was struck in which I would agree to flow the cylinder head in return for a dangerous amount of home-brew. Little did my mate know that if he simply cut out the middle man and pumped the 550 per cent proof moonshine into the Escort tank he would unleash more power than he could imagine. Nonetheless I got to work.

If you peer into the inlet or exhaust tracts of an unmodified Ford Crossflow cylinder head you'll see more meat than the Australian Butcher's Guild nude calendar. It's like Ford was deliberately trying to make its 1.6-litre four-cylinder asthmatic but the somewhat crude design makes it very easy for some fast gains. After a few hours hacking out the ports like the ventral plaque of a cheeseburger enthusiast and the addition of a basic air filter and exhaust upgrade, the Escort had about 10hp more to its name – a very respectable 12 per cent power increase.

Whether you're looking for extra power or improved fuel economy, developing better engines mostly comes down to the maximisation of volumetric and thermal efficiency. Improved volumetric efficiency gets more air (and therefore fuel) in, while more thermally efficient engines make better use of the energy liberated in each drop of fuel.

ELECTRIC VEHICLE NEWS

Take, for example that Ford Kent Crossflow of the 1970s. It used 1.6 litres of displacement to produce 63kW (pre Gardner Racing mods) but, through a series of evolutionary improvements, engine efficiency has advanced remarkably. The 1.6-litre you'll find under the bonnet of the Toyota GR Yaris makes 200kW. An F1 car with the same capacity will blow the dynamometer with 745kW.

But we're now levelling off that particular curve. Today's performance and efficiency improvements are incrementally smaller. Recently, Mazda introduced its Skyactiv-X engine. The heavily developed and refined engine uses a brilliant idea to enable the petrol engine to run as a spark-ignition engine under some circumstances but, when the conditions allow, it switches to a compression ignition cycle more like a diesel powerplant.

Other manufacturers like Jaguar/Land Rover, Audi and Mercedes are turning to complex compound supercharging that enlists a conventional turbocharger along with an electric supercharger to wring the most out of a combustion unit, with hybrid electric technology to iron out any wrinkles in the torque curve.

But while these cutting-edge innovations boost power and efficiency of a fundamental combustion engine principle, the proportional gains are minute compared with the performance and efficiency improvement I managed for the Escort engine with an air die-grinder in one hand and a homebrew in the other.

ELECTRIC VEHICLE NEWS

Continuously developing the efficiency and power of petrol and diesel engines is hard but, engineering challenges aside, presenting the business case for internal combustion as the best solution for vehicle propulsion is harder due to a simpler problem.

Petrol and diesel has a finite energy value and there are only so much that can be blasted out of each drop of fuel. For petrol it's 33.7 megajoules per litre, diesel does better with 36.9MJ/L. But even the most advanced and efficient engines are surprisingly wasteful. Even with hybrid technology and the world's most advanced hybrid turbos, the current F1 engines are only 50 per cent thermally efficient. A very efficient road car engine manages around 40 per cent, so more than half of the energy in every litre of fuel burnt is wasted, with little chance of radical change before the inevitable end of cars that are moved by pistons and cylinders. By way of comparison, EVs are around 60 per cent efficient at converting even coal-fired power to the wheels.

That's why, much as it pains me to write it, the internal combustion engine is doomed. Aside from increasingly strict emissions legislation, a simple chemical and technological truth is consigning our cars to an inevitably electric future.

ELECTRIC VEHICLE NEWS

NEW MELBOURNE BUS FRANCHISE TO INTRODUCE 36 ELECTRIC BUSES BY 2025

By Joshua Hill | 6 October 2021 | Source: The Driven

IMAGE SOURCE : Transdev Melbourne

Melbourne-based transport operator Kinetic is to introduce 36 electric buses to the Metropolitan Bus Franchise, covering about a third of the city's public bus network, after winning a long term contract with the state government.

Victorian Minister for Public Transport Ben Carroll announced on Tuesday that Kinetic had been awarded the 9.5-year contract worth $A2.3 billion to operate the network, which will begin on 31 January 2022.

The Melbourne Metropolitan Bus Franchise (MMBF) operates 30% of Melbourne's public transport bus services with 49 routes servicing Melbourne's eastern, south-eastern, and western suburbs, as well as the CBD. The MMBF also operates 134 school services as well as six depots and an operational control centre.

Kinetic operates 52 bus contracts across Australia and New Zealand, including the SkyBus service, which operates airport express services from Tullamarine into Melbourne and its surrounds – as well as similar airport services in Hobart, Brisbane, and Auckland.

Kinetic's successful tender includes the commitment to introduce 36 fully electric buses to the MMBF by mid-2025 and a promise that at least one of every four new buses introduced will be locally built battery electric buses.

It has also committed to replace more than half the franchise fleet – 341 of the 537 buses – with low or zero emission vehicles over the 9.5-year term of the franchise. And, in line with ensuring buses are locally made, Volgren's Dandenong South facility will make the buses, supporting local jobs and economy.

Kinetic already has a fleet of electric buses running in New Zealand, and expects its fleet of electric buses to grow to 60 over the next 12 months across both New Zealand and Australia.

"We are jump starting our push for a zero-emissions bus fleet in Victoria to benefit the environment and help build our engineering, design and manufacturing expertise in these emerging technologies," said Carroll.

"The roll out of 36 electric buses early on in this partnership will accelerate our pledge for all new buses from 2025 to be zero emissions and, importantly, will contribute to the learnings of the three-year Zero Emissions Bus Project."

ELECTRIC VEHICLE NEWS

ABB LAUNCHES THE WORLD'S FASTEST ELECTRIC CAR CHARGER

By ABB | 30 September 2021 | Source: ABB News

- Can deliver 100km of range in less than three minutes
- Only charger designed explicitly to charge up to four vehicles at once
- Ideal for refueling stations, urban charging stations, retail parking and fleet applications

ABB is today launching an innovative all-in-one Electric Vehicle (EV) charger, which provides the fastest charging experience on the market.

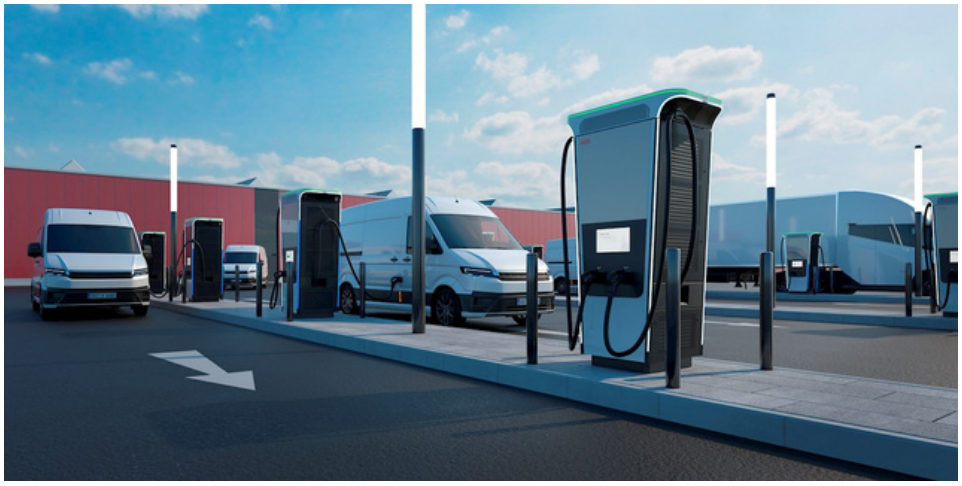
ABB's new Terra 360 is a modular charger which can simultaneously charge up to four vehicles with dynamic power distribution. This means that drivers will not have to wait if somebody else is already charging ahead of them. They simply pull up to another plug. The new charger has a maximum output of 360 kW and is capable of fully charging any electric car in 15 minutes or less, meeting the needs of a variety of EV users, whether they need a fast charge or to top their battery up while grocery shopping.

"With governments around the world writing public policy that favors electric vehicles and charging networks to combat climate change, the demand for EV charging infrastructure, especially charging stations that are fast, convenient and easy to operate is higher than ever," said Frank Muehlon, President of ABB's E-mobility Division. "The Terra 360, with charging options that fit a variety of needs, is the key to fulfilling that demand and accelerating e-mobility adoption globally."

"It's an exciting day for ABB, who as the global leader in electric vehicle fast charging, is playing a key role in enabling a low carbon society," said Theodor Swedjemark, Chief Communications and Sustainability Officer at ABB. "With road transport accounting for nearly a fifth of global CO2 emissions, e-mobility is critical to achieving the Paris climate goal. We will also lead by example by switching our entire fleet of more than 10,000 vehicles to non-emitting vehicles."

Available in Europe from the end of 2021, and in the USA, Latin America and Asia Pacific regions in 2022, Terra 360 is designed with the daily needs and expectations of EV drivers in mind. Leveraging the rich field experience gained by ABB E-mobility's large installed base, the Terra 360 delivers speed and convenience along with comfort, ease-of-use and a sense of familiarity.

ELECTRIC VEHICLE NEWS



As well as serving the needs of private EV drivers at fueling stations, convenience stores and retail locations, Terra 360 chargers can also be installed on an organization's commercial premises to charge electric fleet cars, vans and trucks.

Its innovative lighting system guides the user through the charging process and shows the State of Charge (SoC) of the EV battery and the residual time before the end of an optimal charge session. The world's fastest EV charger is also wheelchair accessible and features an ergonomic cable management system that helps drivers plug in quickly with minimal effort.

As well as serving the needs of private EV drivers at fueling stations, convenience stores and retail locations, Terra 360 chargers can also be installed on an organization's commercial premises to charge electric fleet cars, vans and trucks. This gives owners the flexibility to charge up to four vehicles overnight or to give a quick refill to their EVs in the day. Because Terra 360 chargers have a small footprint, they can be installed in small depots or parking lots where space is at a premium.

Terra 360 chargers are fully customizable. To personalize the appearance, customers can 'brand' the chargers by using different foiling or changing the color of the LED light strips. There is also the option to include an integrated 27" advertisement screen to play video and pictures.

ABB is a world leader in electric vehicle infrastructure, offering the full range of charging and electrification solutions for electric cars, electric and hybrid buses, vans, trucks, ships and railways. ABB entered the e-mobility market back in 2010, and today has sold more than 460,000 electric vehicle chargers across more than 88 markets; over 21,000 DC fast chargers and 440,000 AC chargers, including those sold through Chargedot.

ABB high-power chargers are already being deployed around the world through the company's partnerships with international charging operators such as IONITY and Electrify America.

To explore ABB's electric vehicle charging technology, visit www.abb.com/ev-charging.

ABB (ABBN: SIX Swiss Ex) is a leading global technology company that energizes the transformation of society and industry to achieve a more productive, sustainable future. By connecting software to its electrification, robotics, automation and motion portfolio, ABB pushes the boundaries of technology to drive performance to new levels. With a history of excellence stretching back more than 130 years, ABB's success is driven by about 105,000 talented employees in over 100 countries. www.abb.com

HISTORY LESSON

BRILLIANT MATHEMATICIANS HAVE BEEN AROUND FOR QUITE A WHILE
MEASURING THE EARTH'S CIRCUMFERENCE IN 300 BCE

Source: City University New York

Determining the earth's size

By the fifth century BCE, the Greeks had firmly established that the earth was a sphere. Although they knew it was a sphere, they didn't know how big the sphere was.

The philosopher Plato (400 BCE) declared the earth's circumference to be 64,412 kilometers (40,000 miles). Some 150 years later, the mathematician Archimedes estimated it to be 48,309 kilometers (30,000 miles). It's not known exactly how Plato or Archimedes arrived at their calculations, but Plato's measurement was off by sixty percent and Archimedes' by twenty percent. At least they were making progress.

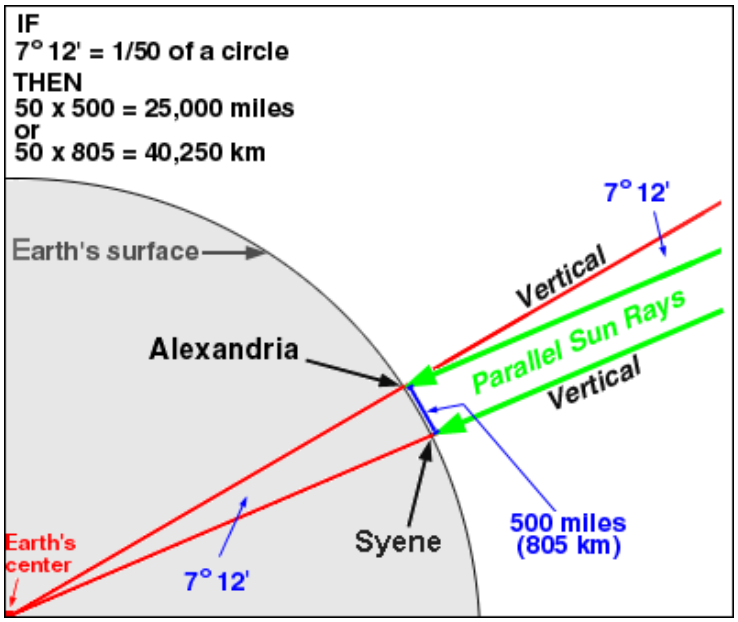
Observations and calculations by two later Greeks, Eratosthenes and Posidonius, finally resulted in accurate estimates of the size of the earth.

In the third century BCE, Eratosthenes, a Greek librarian in Alexandria, Egypt, determined the earth's circumference to be 40,250 to 45,900 kilometers (25,000 to 28,500 miles) by comparing the Sun's relative position at two different locations on the earth's surface. Because of differences in translations or interpretations of his records, and his own methodological errors, the exact figures are in dispute. Today, the earth's circumference is usually accepted to be 40,096 kilometers (24,901 miles). If you take the lowest estimate attributed to Eratosthenes, his error was less than one percent—a phenomenal calculation.

Eratosthenes' methods

Eratosthenes determined the earth's size by observing known phenomena and applying basic arithmetic and geometry to them. Here's how he did it.

HISTORY LESSON



Eratosthenes' methods were simple but effective. All he needed to know was the distance between two locations and what percentage of a circle this distance constituted.

While in Syene, Egypt (known today as Aswan), he noticed that the sun's rays shone directly down a well, casting no shadow at all. From this, he concluded that the sun was directly overhead at Syene. On the same date in Alexandria, a rod perpendicular to the ground cast a shadow that was 7° 12' from perpendicular.

Eratosthenes then divided 360° by 7° 12' and determined that 7° 12' was 1/50th of a circle. Now all he had to do was find the distance from Syene to Alexandria and multiply it by 50 to get the earth's circumference.

Many scholars believe Eratosthenes measured the distance by measuring a single pace and then counting the number of paces from Syene to Alexandria. While this is possible, it is just as likely that he counted the revolutions of a wheel with a known circumference, since this was a common method of measurement in both Egypt and Greece. Either way, he probably hired someone or enlisted a slave to accomplish the task. The distance figure he used was 805 kilometers or 500 miles.

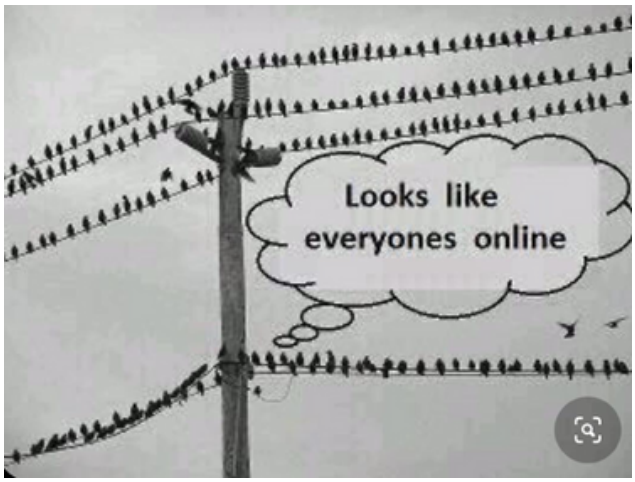
Next, he multiplied this distance by 50 to get 40,250 kilometers (25,000 miles). Today, most scientists set the earth's circumference at 40,096 kilometers (24,901 miles). This gives Eratosthenes' estimate less than a one percent error—an excellent approximation of the earth's circumference.

Eratosthenes' errors
Syene is not on the Tropic of Cancer, where the sun's rays are directly overhead during the summer solstice. It is actually 37 kilometers (23 miles) north of the Tropic of Cancer.
Alexandria is not due north of Syene and the distance between them is not 805 kilometers. The actual distance corresponds to an angular measurement not of 7° 12', but rather of 7° 30'.
All in all, it's amazing that his calculations came as close as they did to the earth's true circumference.

Posidonius used the stars to determine the earth's circumference. He observed that a given star could be seen just on the horizon at Rhodes. He then measured the star's elevation at Alexandria, Egypt, and calculated the angle of difference to be 7.5 degrees or 1/48th of a circle. Multiplying 48 by what he believed to be the correct distance from Rhodes to Alexandria (805 kilometers or 500 miles), Posidonius calculated the earth's circumference to be 38,647 kilometers (24,000 miles)—an error of only three percent. The exact details of his methods are not known, but we do know the distance he used was incorrect and the fact that Rhodes is not due north of Alexandria would result in computational errors. Although his measurements were flawed, he was lucky because the errors canceled themselves out and he arrived at a fairly accurate calculation of the earth's circumference.

HISTORY LESSON | HUMOUR BREAK

In the second century CE (Common Era) in Alexandria, a philosopher named Claudius Ptolemaeus, or Ptolemy, revised Posidonius' calculations and set the earth's circumference at 28,985 kilometers (18,000 miles)—an error of nearly 28 percent. Because of Ptolemy's contributions to geography and cartography, his circumference was used throughout the Renaissance. It is believed that Christopher Columbus used Ptolemy's number to plan his voyage to the Far East. Everyone knows how that voyage ended—Columbus bumped into a continent that was hiding in the 28 percent error.



Transmission line design 101

Please email bulletin submissions to the editor – editor@eesa.org.au

INTERNATIONAL NEWS

Inertia Is a Growing Challenge for the Grid, But There Are Solutions

By R&D Quick hits | Source: EPRI Journal

An EPRI studylooks at the potential impacts of reduced inertia on frequency stability in the world's electric power grids and reviews emerging solutions.

Turbines, generators, and motors in fossil, nuclear, and hydro power plants spin at speeds proportional to grid frequency. The rotational energy of these massive devices provides significant inertia that can counteract changes in grid frequency due to disturbances. For example, if one power plant in a region goes offline, grid frequency will decrease. Other spinning generators can respond by speeding up slightly to resist the frequency shift and stabilise the grid.

Because solar energy plants don't have any moving parts (and thus inertia), the power system's inertia declines as solar penetration grows—potentially leading to rapid frequency changes. If left unchecked, such changes can cause electricity service interruptions. Wind generation likewise does not contribute inertia because most modern wind turbines transmit energy through power electronics and are not connected directly to the grid. According to the EPRI study, smaller, islanded grids already face inertia-related challenges. Grid operators in Ireland and Nordic countries regularly adjust power plants' output based on predictions that low inertia will cause service interruptions.

"These operators are monitoring inertia on a second-to-second basis and re-dispatching power plants to maintain frequency stability," said EPRI Principal Project Manager Aidan Tuohy.

The study identifies numerous potential technological, operational, and market-based solutions for grid operators, such as:

- Controlling the inverters of solar and wind power plants and battery energy storage systems to provide frequency support during disruptions
- Requiring an inertia "floor" or minimum that results in the operation of additional spinning generators
- Compensating generators for providing inertia to encourage them to stay online

According to the study's authors, these and other solutions need to be evaluated for their effectiveness in maintaining grid stability. In addition, operators need more real-time data on the impacts of reduced inertia along with analytical tools to evaluate those impacts.

Key EPRI Technical Experts:
Aidan Tuohy, Adrian Kelly
For more information, contact techexpert@eprijournal.com.

INTERNATIONAL NEWS

Energy Storage to Count On

By Chris Warren | 7 July 2021 | Source: EPRI Journal

In separate studies, EPRI and NERC highlight areas of concern regarding long-term battery performance and reliability.

At the end of 2020, 12 states had goals to achieve 100% renewable or net-zero emission electricity generation. The states vary in geography, climate, and population, ranging from Maine in the northeast to Louisiana in the southeast to California in the west and the Hawaiian Islands in the Pacific. And it's not only states making deep decarbonization commitments. Nearly 300 large corporations have made a pledge to go 100% renewable, and a number of utilities, like Xcel Energy, Dominion Energy, and the Sacramento Municipal Utility District (SMUD), have committed to net-zero electricity.

The blueprint for achieving these ambitious clean energy targets varies from state to state and organization to organization. But they all share a common feature: energy storage will play a prominent role. With so much intermittent wind and solar generation being added to the grid, storage is critical for maintaining reliability.
Grid-scale batteries are being increasingly deployed. According to Wood Mackenzie, 3.5 gigawatt-hours of battery energy storage were installed across the United States in 2020. For context, in the prior six years, a total of 3.1 gigawatt-hours of battery storage went into operation. Most of this growth was due to large-scale systems deployed by utilities.

The increasingly important role battery storage is expected to play in the power system of the near- and longer-term future raises important questions about the technology's performance and reliability. Utilities, regulators, and other industry stakeholders are looking for assurances that they can count on these assets to perform when they're needed, especially in the absence of a significant track record.

"We anticipate storage is going to be a bigger and bigger part of our operations," said Steven Baxley, research and development manager for Southern Company. "Battery storage projects have so far been mostly pilots, but we are on the cusp of beginning commercial projects on the regulated and wholesale sides of our company. We want to understand whether the systems perform according to our specifications long term, whether they will be reliable, and what O&M (operations and maintenance) issues may be of concern over time."

There may very well be reasons for concern. An initial EPRI analysis of battery performance metrics reported by manufacturers has revealed some discrepancies. While these discrepancies don't immediately affect the ability of storage systems to deliver vital services, they may have significant impacts on their long-term performance.

EPRI Delves into Performance and Reliability

For the past three years, EPRI has been working to investigate the performance of batteries deployed in the field as part of its Energy Storage Performance and Reliability Data Initiative. During the recently completed first phase of research, EPRI monitored and collected data on numerous battery storage systems deployed in different locations, ranging in power capacity from 6 kilowatts to 1 megawatt. The systems were intended for various applications, such as residential and utility substation support. All the systems—with the exception of one vanadium redox flow battery system—are lithium ion batteries, the predominant technology being installed across the world today.

INTERNATIONAL NEWS

To assess energy storage performance and reliability, EPRI tracked two critical metrics and compared them with values reported by the manufacturers. One metric, state of charge, is the remaining capacity in a battery expressed as a percentage of its fully charged capacity. An accurate measure of a battery's state of charge is essential, because it indicates whether the battery can deliver the energy, flexibility, and reserves needed by grid operators. For example, the state of charge measurement tells an operator if a storage system has enough energy to compensate for potential drops in wind and solar generation—a common and expected scenario in power systems with a high penetration of renewables.

Accurate measurements are also needed so that storage systems can be reliable participants in wholesale electricity markets, which have high performance standards. In addition, they can inform grid planners on the extent to which storage systems may help reduce peak demand and thereby avoid investments in powerlines, transformers, and other traditional grid infrastructure.

The second energy storage metric, state of health, is a measurement of system degradation. It is commonly expressed as the maximum state of charge available in a system at a particular time relative to its original capacity. As lithium ion battery storage systems are charged and discharged over time, their available energy capacity decreases, and their efficiency declines. Storage operators need accurate state of health data to determine whether their assets are performing to their specifications, associated performance guarantees, and warranty commitments. Accurate data also informs planning for maintenance, battery replacements, and other downtime.

"When manufacturers sell storage systems, they provide performance and lifetime expectations, but these may differ from actual performance because of unexpected degradation in real-world conditions," said Steve Willard, an EPRI technical executive leading the Energy Storage Performance and Reliability Data Initiative. "Accurate state of health measurements over time can help storage owners and operators get ahead of unexpected changes in performance."

Discrepancies in Battery Performance Metrics

On the surface, the state of health and state of charge metrics may appear straightforward, similar to a fuel gauge or odometer on a vehicle. But they are not as simple. The state of charge of a lithium ion battery can't be measured directly and instead must be estimated by measuring parameters like voltage, temperature, and current. Similarly, the state of health is rarely measured directly. Standard testing approaches take the battery out of operation, fully discharge it, and then recharge it. By measuring the energy that enters and leaves the battery during the discharge and charge cycle, it's possible to quantify the battery's remaining energy capacity. Many owners and operators may not be able to collect such measurements at regular intervals, because they need their storage systems to deliver certain benefits. EPRI plans to develop and test methods that owners and operators can use to estimate state of charge "on the fly."

Battery operating systems continuously report state of health and state of charge values to owners, but the vendors of these systems often don't explain how they are calculated. "They are coming up with these values within a proprietary black box, and we don't know what they are assuming," said Willard.

After monitoring the storage systems deployed in the field for three years, EPRI found some notable discrepancies between the values it calculated and the values that the vendors were reporting. For example, one of the systems under investigation operated for a year and a half while regularly reporting that the state of health was 99.5%. EPRI's measure was 96.5%, which translates into a degradation rate that is seven times faster and a lifetime that is potentially many years

INTERNATIONAL NEWS

shorter. Additionally, EPRI research has revealed that battery systems have displayed state of charge values that fluctuated faster than is physically possible.

A Move Toward Standards

There is consensus among utilities, regulators, and other power industry stakeholders that such discrepancies are problematic, given the prominent role storage is expected to play in grid operations and electricity markets. Indeed, a recent report on grid-scale energy storage by the North American Electric Reliability Corporation (NERC) highlighted a lack of uniformity in storage performance data as a key challenge. As an important first step toward addressing this challenge, NERC and the Institute of Electrical and Electronics Engineers (IEEE) are developing standards and guidelines for reporting storage metrics.

EPRI's research findings, field data, and approaches to assess state of health and state of charge are informing these standards. An expanded EPRI database of information on the performance of storage systems operating in the field can inform the standards as well. EPRI also worked with Sandia National Laboratory to develop a guide about the performance and reliability data that could inform relevant standards and procurement specifications.

Standards for reporting performance data are not new in the electricity sector. For decades, NERC has required operators of traditional electric generating equipment such as transformers, circuit breakers, and fossil fuel-powered generators to report performance data through a program called Generating Availability Data Systems (GADS). "A working group develops reporting standards, and NERC has a database where asset owners and operators have to report metrics—such as forced outage rates—that show how well the asset is running," said Willard. "NERC recently developed reporting requirements for wind generators, and they're about to finish developing requirements for big solar PV farms."
EPRI is expanding its storage performance database by incorporating data from national laboratories, universities, utilities, and other institutions. "We need a lot of data for robust independent verifications of the metrics reported by vendors," said Willard.

EPRI researchers are also developing tools that storage owners can use to assess system degradation and performance as well as report equipment failures and the amount of time it takes for repairs. The idea is to enable owners to conduct these assessments without having to take their systems out of normal operation. The tools draw on the latest research and powerful computational techniques. Last fall, the Energy Storage Integration Council, EPRI's open industry collaborative forum, released a publicly available tool that supports uniform data collection for tracking storage operational activities.

"When a system fails, operators often have to wait weeks for the vendor to come and repair it," said Willard. "Deploying a megawatt-scale storage system can cost millions of dollars, and taking it offline for a few days can mean a significant loss in value. These delays are reflective of a nascent market."

As utilities deploy more storage around the world, they need more real-world performance data.
"We are eager to learn how these systems will operate and perform in terms of degradation and reliability in different conditions," said Baxley. "Our wholesale business will operate some systems in the desert of California, and our regulated business is planning systems in the Southeast. We want to understand any differences in performance in these regions with different conditions. As we move toward the renewable future everyone is envisioning, it's critical to know if storage is reliable."

INTERNATIONAL NEWS

When Is the Right Time to Invest in Battery Energy Storage?

By Carlos Nieto - ABB | 8 October 2021 | Source: Energy Tech

Here, Carlos Nieto, Global Product Line Manager for Energy Storage at ABB's Packaging & Solutions division, asks: when is the right time to invest in battery energy storage and what are the key specifications when specifying it?

For industrial and commercial suppliers, there is an ever present need to reduce capital expenditure while making electrical systems more efficient and robust. When it comes to power consumption, this board-level demand translates to a tug of war between investing in a full system upgrade, including substations, or updating existing infrastructure to shave peak demand.

The future energy task is a complex one, especially for industry. On the one hand, there is the issue of maintaining prosperity and substantiating new growth, with many commercial and industrial businesses seeking to recoup losses incurred on account of national shutdowns and unprecedented operational disruption enforced during the pandemic.

At the same time, there is a pressing need to lessen environmental impact. As leading economies look towards a more sustainable post-pandemic recovery, the emerging new normal will see higher energy costs, along with new decarbonized industry standards and government demands. The result is increased onus on the environmental measures which can drive efficiencies and optimize energy consumption levels while helping to futureproof and maintain greater links to the wider world.

Fortunately, the electrification market has responded with a plethora of innovative technologies which can balance the need for sizeable carbon reductions while keeping costs and disruption to a minimum for industrial and commercial suppliers. One such example is battery energy storage.

Although not new, commercial and industry energy storage systems, otherwise referred to as 'behind-the-meter', are quickly coming to the fore as a way for businesses to manage energy costs by leveraging peak shaving, load shifting and maximization of self-consumption. Another big benefit is that these systems can provide critical backup power, preventing revenue losses due to production outages which can all too quickly go into the thousands – with power outages in the U.S. alone costing the economy $150 billion annually.1

However, inherently it can be difficult for industrial and commercial premises to determine the exact point at which battery energy storage will prove most beneficial.

Looking at the most common scenarios, to begin with it may be a simple business case for the industrial or commercial business — its energy bills have become higher, and there is a need to be more tactical about the way energy is used on the grid to reduce cost. Say, for example, it has recently extended its infrastructure, such as an automaker which has installed EV charging to promote wider adoption and is seeking to offset the additional cost brought on by the according large peak loads. For others, it may be that their utility contract has changed to incur higher demand charges and they

INTERNATIONAL NEWS

want to negate this while safeguarding from future price hikes. Either way, investment in battery storage makes complete commercial sense.

There is also the proactive approach, whereby a business will be seeking to reduce its carbon footprint as part of a wider decarbonization strategy, most likely having already invested in other green assets such as solar, and thus energy storage enables further environmental gains. Or it could be about energy independence, where the business has installed various distributed energy sources on site to negate reliance on the grid – hereby energy storage effectively offers 'the glue' that can connect individual fuel sources together.

A final and equally compelling case for battery energy storage is in business climates where an interruptible power supply is paramount. As aged grids become increasingly unreliable, deviations and other disturbances to electrical supply are more common. For a busy factory or manufacturer, the result of even a few minutes downtime can be huge in terms of the loss to productivity – worse still in remote circumstances, such as a mining business, resuming operations can take days, even weeks. Take, for example, the mining sector in Zimbabwe which loses up to $10 million annually due to crippling power outages that affect production and viability of the industry.2 Hereby, energy storage can be critical in ensuring its 'business as usual' even in the event of a grid failure.

Should the argument for energy storage appear conclusive, the next concern is specifying the most suitable solution for each individual business' needs.

Here, the first consideration should be safety. Any industrial or commercial provider has a duty of care to ensure safe and secure working conditions for personnel and other maintenance staff, so it is incredibly important the energy storage solution, which they will most likely be working near to, is built to the highest safety standards. This is even more pertinent given that the acceleration of infrastructure will mean these types of installations may come to be located in the public domain, such as parking lots, where children, the elderly and other vulnerable members of society may be present.

Thus, choosing from a reputable manufacturer who has a proven track record in this area and can guarantee all key standards are met is imperative. Key concerns should be that the solution has been factory-tested and pre-engineered to reduce risk —and contained in a lockable enclosure to prevent unauthorized entry and protect components from vandalism.

Scalability must also be accounted for. As the world moves towards future decarbonization, it is becoming increasingly difficult for commercial and industrial users to predict what loads they may require a year from now, never mind in five years' time when new technologies may have been brought into the mix. In this vein, the ability to grow, support commercial objectives and scale up as needs increase is essential when specifying any type of battery energy storage investment.

Alongside this sits the digitalization piece. From monitoring and controlling operations to optimizing efficiencies and the analytical power of data, through to the introduction of artificial intelligence and machine learning, digitalization is becoming paramount in enabling the insights needed to make better decisions about energy savings and emissions. Energy storage plays a part in this by enabling users to control use based on new digital knowledge — so any system must not only complement the current infrastructure but support the smart building vision.

INTERNATIONAL NEWS

Finally, it may sound obvious but choosing the right supplier can pay dividends. At ABB, for example, we realize that specifying a battery energy storage solution can come as a minefield for busy largescale businesses. That's why we work closely with our customers to not just specify the most suitable solution, but ensure they are comfortable in their investment and that it aligns to their long-term strategic goals. This forms part of a long-term partnership approach designed to support each pivotal point in their decarbonization journey.

There is no escaping it; industry 4.0 is happening all around us, as renewables and alternative forms of distribution continue to become embedded in the grid. While this brings new complexity for industrial and commercial businesses, it also provides an opportunity to reimagine their sustainable strategy and take advantage of innovation. With benefits that include sizeable carbon savings, power supply reliability and an effective bridge between the current need and our carbon neutral future, surely it's time to give energy storage the green light?

1 https://www.energy.gov/ne/articles/department-energy-report-explores-us-advanced-small-modular-reactors-boost-grid
2 https://www.chronicle.co.zw/power-outages-cost-mining-sector-millions/

Recycled concrete and captured CO2 make new building material

By E&T editorial staff | 8 October 2021 | Source: E&T Magazine

Researchers from the University of Tokyo have developed a new building material with considerably lower carbon emissions than conventional concrete. The material shows promise as a construction material of the future, especially in places with limited natural resources.

Concrete is the most-used artificial material. The concrete industry is vast and it is estimated that around seven per cent of CO2 emissions come from the manufacture and use of cement (the main component of concrete) alone. A large proportion of this is due to the use of calcium, which is normally obtained by burning limestone and which is essential for the reaction between cement and water to form concrete.

Considerable research efforts are already underway to find alternative ways of making concrete or similar construction materials more sustainable.

Now, the University of Tokyo researchers have demonstrated a method for combining waste concrete and captured CO2 to create a usable form of concrete called calcium carbonate concrete.

Inspired by the way some aquatic organisms harden into fossils over time, Professor Ippei Maruyama wondered if the same process for forming hard calcium carbonate deposits from dead organic matter could be applied to concrete. Maruyama saw this as an opportunity to investigate a less carbon-intensive way of performing the same function as in the formation of concrete from cement and water.

"Our concept is to acquire calcium from discarded concrete, which is otherwise going to waste," said Maruyama. "We combine this with carbon dioxide from industrial exhaust or even from the air. And we do this at much lower

INTERNATIONAL NEWS

temperatures than those used to extract calcium from limestone at present."

Calcium carbonate concrete cannot replace typical concrete at present; it is not quite as strong as typical concrete, though for some construction projects, such as small houses, this would not be a problem. At present, only small blocks a few centimetres in length have been made.

"It is exciting to make progress in this area, but there are still many challenges to overcome," said project manager Professor Takafumi Noguchi.

As well as increasing the strength and size limits of calcium carbonate concrete, it would be even better if we could further reduce the energy use of the production process. However, we hope that in the coming decades, carbon-neutral calcium carbonate concrete will become the mainstream type of concrete and will be one of the solutions to climate change."

Recently, another group of researchers from the University of Tokyo demonstrated a new method of producing concrete without cement. Their technique offers a means for the construction industry to reduce its carbon emissions, as well as offering potential for building on the Moon and Mars.

6 reasons why energy transmission & distribution utilities need Digital Twin technology

By Petri Rauhakallio | 20 September 2021 | Source: Geospatial World

Digital twins – as with any new technology, they can create as many questions as they do answers. This fact creates a natural resistance to the concept, especially among senior utility executives who are used to the old ways and need a compelling case to invest in new ones.

What is a Digital Twin? Is it just a fancy name for modelling? And why do many senior leaders and engineers at power transmission & distribution (T&D) companies have a gnawing feeling they should have one?
But ultimately it comes down to one question: is this a trend worth our time and money?

The short answer to that one is: yes, if approached intelligently and accounting for utilities' specific needs. This is no case of runaway hype or an overwrought name for an underwhelming development – Digital Twin technology can be genuinely transformational if done right. So – here are six reasons why in five years no T&D utility will want to be without a Digital Twin.

Also Read: Application of Digital Twin technology goes beyond cities and AEC

Smarter asset planning

A Digital Twin is a real-time digital counterpart of a utility's real-world grid. A proper Digital Twin– and not just a static 3D model of some adjacent assets – represents the grid in as much detail as possible, is updated in real-time and can be used to model 'what if' scenarios to gauge the effects in real life. It is the repository in which to collect and index all network data, from images, to 3D pointclouds, to past reports and analyses.

INTERNATIONAL NEWS

With that in mind, an obvious use-case for a Digital Twin is planning upgrades and expansions. For example, if a developer wants to connect a major solar generation asset, what effect might that have on the grid assets, and will they need upgrading or reinforcement? A seasoned engineer can offer an educated prediction if they are familiar with the local assets, their age and their condition – but with a Digital Twin they can simply model the scenario on the Digital Twin and find out.

The decision is more likely to be the right one, the utility is less likely to be blindsided by unforeseen complications, and less time and money need be spent visiting the site and validating information.

As the energy transition accelerates, both transmission and distribution (T&D) utilities will receive more connection requests for anything from solar parks to electric vehicle charging infrastructure, to heat pumps and batteries – and all this on top of normal grid upgrade programs. A well-constructed Digital Twin may come to be an essential tool to keep up with the pace of change.

Also Read: Digital Cities – Digital Twins for Connected City Infrastructure

Improved inspection and maintenance

Utilities spend enormous amounts of time and money on asset inspection and maintenance – they have to in order to meet their operational and safety responsibilities. In order to make the task more manageable, most utilities try to prioritize the most critical or fragile parts of the network for inspection, based on past inspection data and engineers' experience. Many are investigating how to better collect, store and analyze data in order to hone this process, with the ultimate goal of predicting where inspections and maintenance are going to be needed before problems arise.

The Digital Twin is the platform that contextualizes this information. Data is tagged to assets in the model, analytics and AI algorithms are applied and suggested interventions are automatically flagged to the human user, who can understand what and where the problem is thanks to the twin. As new data is collected over time, the process only becomes more effective.

Also Read: Still hanging from ropes for your bridge inspections? Try 'Digital Twin' instead

More efficient vegetation management

Utilities – especially transmission utilities in areas of high wildfire-risk – are in a constant struggle with nature to keep vegetation in-check that surrounds power lines and other assets. Failure risks outages, damage to assets and even a fire threat.

A comprehensive Digital Twin won't just incorporate the grid assets – a network of powerlines and pylons isolated on an otherwise blank screen – but the immediate surroundings too. This means local houses, roads, waterways and trees.

If the twin is enriched with vegetation data on factors such as the species, growth rate and health of a tree, then the utility can use it to assess the risk from any given twig or branch neighboring one of its assets, and prioritize and dispatch vegetation management crews accordingly.

INTERNATIONAL NEWS

A with expansion planning, inspection and maintenance, the value here is less labor-intensive and more cost-effective decision making and planning – essential in an industry of tight margins and constrained resources. What's more, the value only rises over time as feedback allows the utility to finesse the program.

Also Read: Digital Twin — a revolutionizing technology for telecom networks

Automated powerline inspection

Remember though, that to be maximally useful, a Digital Twin must be kept up to date. A larger utility might blanche at the resources required to not just to map and inspect the network once in order to build the twin, but update that twin at regular intervals.

However, digital twins are also an enabling technology for another technological step-change – automated powerline inspection.

Imagine: a fleet of sensor-equipped drones empowered to fly the lines almost constantly, returning (automatically) only to recharge their batteries. Not only would such a set-up be far cheaper to operate than a comparable fleet of human inspectors, it could provide far more detail at far more regular intervals, facilitating all the above benefits of better planning, inspection, maintenance and vegetation management. Human inspectors could be reserved for non-routine interventions that really require their hard-earned expertise.
In this scenario, the Digital Twin provides the 'map' by which the drone can plan a route and navigate itself, in conjunction with its sensors.

Also Read: What are the key benefits of using Digital Twin?

Improved emergency modelling and faster response

If the worst happens and emergency strikes, such as a wildfire or natural disaster, digital twins can again prove invaluable. The intricate, detailed understanding of the grid, assets and its surroundings that a Digital Twin gives is an element of order in a chaotic situation, and can guide the utility and emergency services alike in mounting an informed response.

And – once again, the Digital Twin's facility for 'what-if' scenario testing is especially useful for emergency preparedness. If a hurricane strikes at point X, what will be the effect on assets at point Y? If a downed pylon sparks a fire at point A, what residences are nearby and what does an evacuation plan look like?

Also Read: Ho Ho Ho! Advanced 3D, Digital Twin technology to guide Santa Tracker to Space Station

Easier accommodation of external stakeholders

Finally, a Digital Twin can make lighter work of engaging with external stakeholders. The world doesn't stand still, and a once blissfully-isolated powerline may suddenly find itself adjacent to a building site for a new building or road.

As well as planning for connection (see point 1), a Digital Twin takes the pain out of those processes that require

INTERNATIONAL NEWS

interfacing with external stakeholders, such as maintenance contractors, arborists, trimming crews or local government agencies – the Digital Twin breaks down the silos between these groups and allows them to work from a single version of the truth – in future it could even be used as part of the bid process for contractors.

These six reasons for why digital twins will be indispensable to power T&D utilities are only the tip of the iceberg; the possibilities are endless given the constant advancement of data collection an analysis technology. No doubt these will invite even more questions – and we relish the challenge of answering them.

The Future Of Power Sector Is In P2P Transactions Behind-the-meter

By Perry Sioshansi | October 2021 | Source: EEnergy Informer October Issue

Perry Sioshansi in the October edition of the EEnergy Informer writes that the electric power business has traditionally been dominated by a few big players generating and transmitting undifferentiated commodity kWhs to millions of passive consumers in a one-way flow across a vast delivery network. This picture, as everyone knows, is changing – slowly in some places and rather fast in others – with increasing focus on the behind-the-meter (BTM) space as prosumers generate much of what they consume via rooftop solar PVs and prosumagers invest in BTM storage, including electric vehicles (EVs) – nothing but massive batteries on wheels – topics frequently covered in this newsletter. What used to be an academic curiosity is increasingly the future of electricity business. But how will transactions BTM become part of the future?

In a paper titled New Transactions in Electricity: Peer-to-Peer and Peer-to-X published in the latest issue of Economics of Energy & Environmental Policy (EEEP), Jean-Michel Glachant and Nicolò Rossetto, both at the Florence School of Regulation (FSR), point out,
"Peer-to-peer (P2P) and peer-to-x (P2X) open up a new world of transactions in the electricity sector. We have already seen in the past business-to-business (B2B) with the wholesale markets, opening around 1990, and business-to-consumer (B2C) with the retail markets, opening around 2000."The authors continue:

"Peer-to-x transactions have already grown in real life and will continue to grow because
electricity consumers realise, or will soon realise, that their own production, consumption and storage devices can be mobilised to trade on traditional electricity markets, or on new markets derived from them – referencing prior edited volumes by this newsletter's editor. The uptake of P2X is particularly fuelled by the deployment of individual storage units and the spread of a new type of 'consumption device and storage unit' on wheels: the electric vehicle (EV). When EVs are coupled with a garage storage unit and a rooftop PV panel, peers become fully equipped prosumagers, owning an entire local electricity system capable of doing many new things. At least three forms of P2X transactions are currently being implemented around the world or are visible on the horizon: peer-to-system, peer-to-grid, and peer-to-system with an integrator."

INTERNATIONAL NEWS

Specifically, Glachant & Rossetto note (slightly edited) the two key features of these new transactions:

- "First, a particular set of players are involved. They are small in size and non-professional on both the supply and the demand side. This is why we call them 'peers'. This represents a striking novelty because the electricity industry has traditionally been dominated by the opposite: big and fully professional players.
- Second, the involvement of behind-the-meter activities and various combinations of them with in-front-of-the-meter activities. This is an equally striking novelty, because electricity grids and markets are deeply regulated in front of the meter and necessarily much less or not at all BTM. With new activities and new players involved, we are indeed facing a new world of electricity transactions."

After examining typical forms of transactions, the authors point out that 4 are likely to be practical, which they identify as

- P2P with a third party;
- P2P within a community;
- Peer-to-grid; and
- Peer-to-system with an integrator.

Three critical functions are essential for the new world of P2P and P2X to flourish:

- A matching loop, as small players cannot sell or buy from other peers so easily;
- A pricing mechanism, as existing wholesale and retail markets exert pressure on incentives for activating peers; and
- A delivery loop, as peers must deliver via existing grids and system operators, except when trading entirely within private networks.

Glachant & Rossetto note that
"A pricing mechanism has to be adapted to these typically very small quantities of goods and to their intermittent delivery by the seller when the product traded is electricity from a renewable energy source. The typical unit size of the good on the sellers' side is a few kWh with a notional reference price of a few euro cents (on average, one kWh is worth five euro cents in organised European wholesale markets). The supply is intermittent by nature (as it is renewable energy) and is also subject to another type of variability: the seller's own self-consumption. The pricing mechanism has to adapt to all these particularities of the supply while taking into account the varying value that buyers attribute to electricity at different times of the day, week or year."

As for the delivery loop, they note that it "... is the last critical component without which P2P and P2X simply cannot work," unless "... a community (is) established within a private network, be it inside a multi-level building or a multi-building property or any other ambitious micro-grid or mini-grid."
The authors are adamant when they write (emphasis added),

"There can be no doubt that a new world has been born for electricity transactions. It is a
world combining new players, which are of a consumption unit size and non-professional nature with new products or services originated from behind the meter. With these two dimensions to deal with, these new transactions are still looking heterogeneous and have not yet crystallised into regular forms of business models and governance. This is presumably because they are demanding a sophisticated frame to work, which is made of three elements: a matching loop, a price mechanism and a delivery loop. These transactions therefore seem very sensitive to many constraints and to the actual behaviour of strongly positioned decision-makers like regulators, grid operators and market operators.

INTERNATIONAL NEWS

However, peer-to-peer and peer-to-x transactions are gradually getting a more favourable 'political economy' regime in the electricity systems where prosumers and owners of electric vehicles are numerous."

Moreover, they note that:
"... the future of this new world of transactions is still widely open and that this world can only grow. People who saw the birth of electricity wholesale markets in the 1990s and of electricity retail markets in the 2000s remember the diversity and heterogeneity of those new forms of trade at their start. The variety of forms in new transactions and the uncertainty about their evolution in the future should not surprise but attract more attention. It could even become true that the 'business-to-business' and the 'business-to-consumer' worlds might finally learn how to create a 'peer-to-business' form of integration as the peer-dominant business model."

As highlighted in related articles in this issue, opportunities to trade among customers and to transact between customers and various aggregators and smart enablers promises to shift the balance of power, no pun intended, to behind-the-meter space.

New Transactions in Electricity: Peer-to-Peer and Peer-to-X
JEAN-MICHEL GLACHANT and NICOLÒ ROSSETTO
Economics of Energy & Environmental Policy, Vol. 10, No. 2. 2021
http://www.iaee.org/en/publications/eeeparticle.aspx?id=379

CIGRE NEWS

Energy price formation in wholesale electricity markets

By Adam Keech, Convener of WG C5.28, and Natalie Tacka, Secretary of WG C5.2 | 6 September 2021 | Source: CIGRE

Introduction

The structure of wholesale electricity markets impacts how prices are formed, and how accurately prices reflect the true cost of serving load. As the dynamics of the electric power sector change – especially the characteristics of the generation mix – there is a need to evaluate whether pricing mechanisms are adequately valuing wholesale electricity.

Working Group C5.28* is examining how energy prices are formed in the various electricity markets around the world — with a focus on wholesale energy markets. The group has gathered information about pricing mechanisms as they exist today and is examining if these mechanisms are working as desired. For example:

•are energy markets providing incentives for desired operational behaviours?
•Are out-of-market (uplift, make-whole and parallel) payments impacting desired price signals?
•Are there attributes not currently valued in energy markets – like flexibility or environmental externalities – that should be considered in price formation?

After evaluating the current energy pricing landscape, the Working Group will discuss potential enhancements that could more accurately reflect the true cost of wholesale energy.

Survey

The Working Group will be publishing its results later this year and this paper provides their early findings.

The Working Group developed a survey, which has received seventeen responses from countries or markets (where there is more than one market in a country).

The seventeen countries or markets that responded to the survey are:

- Australia
- Brazil
- Canada (Ontario)
- Chile
- Colombia
- Estonia
- France
- Gulf Coast Cooperation Council
- India
- Japan
- Netherlands

CIGRE NEWS

- Norway
- Philippines
- Russia
- Spain and Portugal (joint response)
- United States (ERCOT, MISO, NYISO, PJM)

Market Models and Price Formation

The market models of the responding countries tend to fall into three general categories:

1. Locational Marginal Pricing (LMP) models
2. Zonally priced models
3. Uniform pricing models

The survey sought to identify the pricing methodology for the market that is most closely tied to real-time system operations. This is different by each country/region. For example, some countries only have real-time markets, others only have day-ahead markets, and some have both.

LMP Models- Russia, Australia (subject to change), Philippines, United States (ERCOT, MISO NYISO, PJM), Chile:

The LMP-style models are generally characterised by real-time energy markets that are closely tied to real-time dispatch. In these models, security constraints within the network itself are modelled in both the dispatch and pricing and as a result these markets have nodal prices that reflect the cost of energy and the impact of network limitations.

Some things that differ across these models are the structure of supply offers that are used to derive prices. Specifically, US market models that utilise LMP only include a portion of generator costs in the calculation of the price. This can lead to the need to uplift payments to ensure the markets are not confiscatory and further parallel payments such as capacity payments. This can be contrasted with models such as Australia where supply offers represent the "all-in" cost of a resource and therefore there is less of a need for uplift payments or parallel payments.

More information is being gathered on these types of models.

Zonally Priced Models – Spain, Portugal, Estonia, France, Netherlands, Norway:

Zonally priced models are markets that are implemented by various countries in the EU. Responses for these market models focus on Day-ahead Market pricing, as real-time trading in these markets does not result in price changes. In the EU model, network constraints are modelled and optimised but only between countries rather than within them. Therefore, each country has a uniform price but each country's price may be different from another country's.

Prices in these models are derived by bids and offers submitted by market participants that are optimised in a manner that maximises overall welfare while reflecting the inter-tie constraints between each country.

Because these models do not tie market prices directly to the real-time operation of the market, the cost of actions taken by the Transmission System Operator to maintain real-time reliability are recovered through uplift payments from

participants.

Uniform Pricing Models – Brazil (subject to change), Colombia, Gulf Coast Cooperation Council, India, Japan, Canada (Ontario):

This group of models contains several respondents whose country or region has one single uniform price. The market-clearing mechanisms in these models differ by region and more information is currently being gathered on the specifics of each model at this time.

Because these models do not tie market prices directly to the real-time operation of the market, the cost of actions taken by the Transmission System Operator to maintain real-time reliability are recovered through uplift payments from participants.

Parallel Payments

The paper will also explore parallel payments made in the various countries and regions. These payments include various payments made to market participants such as capacity payments to support market reliability, reserve payments to participants to provide reserves to the market and uplift payments which may be for the impact of constraints on participants or for other reasons. The Working Group is examining the range of these payments, their purpose and their impact on the operation of the markets.

While more information is being gathered about parallel payments at this time, the Working Group believe that there is a linkage between the philosophy behind the price formation methodology and the need for parallel payments.

Market Performance and Drivers of Change

Finally, the paper will look forward at potential drivers of future change in the price formation processes in each of the countries or markets. The survey results provided a range of potential drivers. Several common ones include:

- Carbon abatement policies
- Integration of nascent technologies including electric vehicles and storage
- Addition of new grid services into the co-option energy market
- Demand-side participation changes
- Changes driven directly by the regulator

Final Thoughts

A key finding from the analysis of the surveys to-date is that successful markets can be designed in a variety of ways and that the price formation methodology is dependent on the priorities of the regions. LMP-based markets tend to focus on conveying the physics of the system and cost of electricity through their pricing whereas zonal and uniformed priced models tend to have broader pricing regions to facilitate trading between market participants.

Both models can and have been implemented effectively depending on the priorities of the region.

*Working Group C5.28 is convened by Adam Keech (US) and has members from seventeen countries.

CIRED UPDATE

To the attention of the CIRED National and Liaison Committees

Dear All,

On behalf of the CIRED Technical Committee, I am pleased to invite your Committee to submit proposals of preferred subjects for the 2023 conference to be held in Rome on 12-15 June 2023 –https://www.cired2023.org/.

I would greatly appreciate if you could send me your proposals **by 22 October 2021**, at the latest.
I warmly thank you in advance for your collaboration.

Best regards,
Michele DELVILLE (Mrs)
CIRED Secretariat
c/o AIM
Rue des Homes, 1
B-4000 LIEGE (Belgium)
Tel. : +32 4 222 29 46
Mob. : +32 497 28 56 29
www.cired.net

(Note: Any ideas would be welcomed and can be sent to the editor of the EESA Bulletin before the due date for consideration.)

2 & 3 JUNE 2022

CIRED Porto (Portugal)
Workshop 2022

E-mobility and power distribution systems

CIRED workshops on specific topics are organised in Europe every two years between CIRED main conferences. In 2022, the workshop will address **"E-mobility and power distribution systems"**. It will be organised on 2-3 June 2022 in Porto, Portugal.
A call for papers will welcome **abstracts until 12 November 2021.**

The workshop will address 3 themes:

1. Planning, development and operation of power distribution systems accommodating E-mobility
2. Equipment and components for E-mobility integration in power distribution systems
3. Community involvement, regulatory challenges and business models associated with E-mobility – integration of E-mobility in smart cities and smart power distribution systems

CIRED PAPER

Important Dates
12 November 2021
Abstracts submission deadline
17 December 2021
Abstracts notification of acceptance
11 February 2022
Full papers submission deadline

DIELECTRIC STRESS: DESIGN AND VALIDATION OF MV SWITCHGEAR

CIRED Paper 771 | Madrid June 2019

ABSTRACT: Medium voltage switchgear is a key component within electrical power distribution networks. It is designed and tested for safe and reliable operation under various operating conditions. Medium voltage air-insulated switchgear (AIS) and gas-insulated switchgear (GIS) have to be validated according to the requirements of international standards like IEC 62271-1 and IEEE C37.100.1 for instance. The dielectric design is optimised with an extensive use of simulation and experimental test validations required by standards, customers specifications or defined by the manufacturers of switchgear for their own quality criteria. That ensures insulation reliability in various applications and operating environments.

The first part of this paper concerns dielectric stresses of switchgear during its operational life under real network conditions. The second part of this paper concerns dielectric design and validation of MV AIS switchgear depending of environmental conditions (humidity, salt, dust...) and in particular the impact on insulation ageing and potential degradation. Insulation techniques (GIS and AIS) and testing procedures are discussed. The degradation of the external insulation of AIS is demonstrated and can be mitigated by the choice of a higher value of the dielectric BIL or power frequency withstand (example for 12 kV rating: 95 kV BIL instead of 75 kV BIL or 42 kV instead of 28 kV 50 Hz). On the other hand, no additional margin on the dielectric withstand is necessary for protected insulation (GIS).

DOWNLOAD PAPER

MENTORING PROGRAM UPDATE

Get to know our 2021 Mentors

By Aditi Sachdeva, EESA National Council Young Professional Member & Mentoring Program Coordinator | October 2021

Ash Gupta

Senior consultant
S&C Electric Company

Q What do you find most rewarding about the work you do?	Q What skills are important for the work you do?	Q How have you found the transition to working online and the change in your work-life balance?	Q What is the most interesting project you are/have worked on?	Q Have you started any new hobbies/interests over the last few months?
Helping renewables' developers achieve grid compliance and helping utility customers look at reliability from the customer's perspective are the most rewarding aspects of my work.	Having the skills to manage projects both from a technical and financial perspective are important in my line of work.	The transition has been fairly straight forward in terms of running power studies, but I do miss my time out on site!	Providing regulatory advice to Scottish Power has been very interesting as I have been able to leverage my experience in the Australian regulatory environment and apply it overseas.	Work-life balance has greatly improved as I have been able to swap out the commute for other activities such as reading, going for a swim, or riding my bike.
Q Who/what inspires you?	**Q How do you relieve stress on busy days?**	**Q If you could learn a new skill in an instant, what would it be?**	**Q Have you read/heard any great books/podcasts lately?**	**Q Do you have any advice for current students looking to enter your field?**
In my day-to-day, my colleagues inspire me as they are generous with their time and efforts, especially during the difficult phase of a project. More broadly, listening to all the folks who give EESA webinars are a great source of inspiration as well.	A quick 20-minute jog on busy days helps me instantly de-stress and get some fresh air as well.	I find 'deep learning' fascinating, and I would love to be able to pick it up and explore how it can improve the lives of power systems engineers.	I just finished 'When Breath Becomes Air' by Paul Kalanithi. This is unfortunately not a light read and reminds you of how fragile life can be, especially relevant today given COVID-19's enormous death toll.	Find 50 companies who you want to work for – this will allow you to not limit yourself into thinking that your career only must follow a particular path – be open minded and ready when the opportunity presents – master the elevator pitch.

MENTORING PROGRAM UPDATE

Matthew James

Senior Protection Engineer
Essential Energy

Q What do you find most rewarding about the work you do?	Q What skills are important for the work you do?	Q How have you found the transition to working online and the change in your work-life balance?	Q What is the most interesting project you are/have worked on?	Q Have you started any new hobbies/interests over the last few months?
Having the opportunity to work through challenging projects from start to finish and see the fruit of that work in service on the electricity network. It's one of the upsides of working for a utility in that you get exposure to not only the design phase but also the construction/commissioning phase and ongoing operation of the asset.	The ability to engage with others, the ability to weigh up different factors (risk, cost, operational requirements) and determine the most appropriate solution, attention to detail, good documentation skills and a willingness to learn and be flexible.	As with most things there have been pros and cons. I don't miss the commute and working from home provides a lot more flexibility which is great when you've got young kids. On the other hand, having small kids at home can sometimes be a distraction but overall, I've found it to be a positive thing especially if it can be balanced with opportunities to work from the office as well.	I recently looked after the protection requirements for a 90MW solar farm. Not only was it technically complex but it also required engagement with several different parties and working through the generator connection process with AEMO.	I brought an electronic drum kit last year and started learning to play which is something I've wanted to do forever.
Q Who/what inspires you?	**Q How do you relieve stress on busy days?**	**Q If you could learn a new skill in an instant, what would it be?**	**Q Have you read/heard any great books/podcasts lately?**	**Q Do you have any advice for current students looking to enter your field?**
I'm inspired by stories of people who haven't been afraid to take risks to realise their dreams. Engineering I think can have a natural aversion to risk but at the same time many of the world's greatest innovations were started by engineers who weren't happy with the way things had always been done. It's easy to look back and see new technology as a natural progression but someone had to take a risk at some point to enable that progression.	Spending time outside with the kids helps me find that balance between work and home, but in terms of my work environment I find that sometimes it's helps to break a stressful task into smaller pieces and focus on getting through those smaller tasks one by one. It provides a way to get that sense of satisfaction and morale boost from completing something and alleviate the stress that comes from not knowing where to start or that feeling that you're getting nowhere.	Programming or a new language.	The last book I read was Anthony Bourdain's "Kitchen Confidential". It's a wild insight into Anthony's early career and the world of cheffing in general.	One piece of advice I would give is to not be afraid to put your name in front of people. This applies not only when applying for jobs but also when you start a new job. It sounds cliché but it's easy to assume that companies won't have a position for you if they haven't advertised or that someone won't have time to talk because they're too busy, but you would be surprised. Getting in contact with a company or person that works in a field you're interested in could lead to some great opportunities or experience.

UPCOMING EVENTS

EESA Technical site visit to Hitachi ABB Power Grids

FRIDAY, 29 OCTOBER 2021 | VIC | VIEW EVENT



Overview:
Hitachi ABB Power Grids are the industry leader in high voltage solutions and products. For decades, the Victorian head office in Lilydale has specialized in power quality products and solutions for the domestic and global markets, manufacturing capacitor banks, capacitor switches, and energy storage solutions to enable its customers, to operate more efficiently and with less environmental impact. Read more.

Time: 9 AM - 12 PM AEST

Location: 88 Beresford Road Lilydale Victoria, 3140

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

Managing Power Quality: Emission allocation requirements for loads and renewable generation

3 - 4 NOVEMBER 2021 | NAT | VIEW EVENT

Overview:
Managing Power Quality: Emission allocation requirements for loads and renewable generation
A Continuing and Professional Development Course presented by the Australian Power Quality and Reliability Centre (APQRC). Read more.

Time: All day

Location: Online

Cost: $1,770.00

Reaching 100% Renewable

WEDNESDAY, 10 NOVEMBER 2021 | QLD | VIEW EVENT

Overview:
Reaching 100% Renewables – Lessons from the world's largest grid forming energy storage projects.

- What is grid forming energy storage and virtual synchronous machines
- What services can this technology provide
- Real world results including from Dalrymple BESS
- Next steps and future applications

Read more.

Time: 3:30 - 5 PM AET

Location:
26 Reddacliff Street, Newstead 4006
OR Online

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

UPCOMING EVENTS

South Australian H.V. Power Network in Transition

THURSDAY, 11 NOVEMBER 2021 | SA NT | VIEW EVENT

Overview:
This presentation provides an update on current and future technical challenges for the H.V. transmission network in South Australia as we move closer to 100% renewable generation in the state. This covers issues like voltage control, system strength, variability of renewables, firming of generation, the impacts of harmonics and future issues such as preparing for electric Read more.

Time: 6 PM AET

Location: Online

Cost:
EESA members: $0
EA members: $0
Non-members: $10

Cattle Hill Wind Farm and Lake Echo Site Visit

SUNDAY, 14 NOVEMBER 2021 | TAS | VIEW EVENT

Overview:
JThis is a unique opportunity to visit two renewable power stations in one day – Cattle Hill Wind Farm and Lake Echo Hydroelectric Power Station. EESA will be guided through each site by engineers working on that power station. Family members are welcome (please contact meeting organiser if additional visitors will be accompanying EESA members).... Read more.

Time: 10.30 AM - 2 PM AET

Location: Cattle Hill Wind Farm, Waddamana TAS

Cost:
EESA members: $0
EA members: $10
Non-members: $10

Engineers Australia Inaugural Climate Smart Engineering Conference

16 - 17 NOVEMBER 2021 | NSW | VIEW EVENT

Overview:
Engineers Australia will host its inaugural Climate Smart Engineering conference on 16–17 November 2021.
With attendance online or in person at the Hilton in Sydney, this conference will enable engineers to explore the relevant risks and opportunities, to network and to hear first-hand from business, finance, government and engineering leaders.
Engineers will be pivotal... Read more.

Time: Two-day event

Location: Hilton Sydney
488 George St, Sydney NSW 2000
Or Online

Cost:
See prices here.

UPCOMING EVENTS

EESA QLD Chapter Ten-Pin Bowling

TUESDAY, 23 NOVEMBER 2021 | QLD | VIEW EVENT

Overview:
Come and join EESA QLD's last social event of the year!

A night of ten pin bowling and networking paired with drinks and finger food.

Run, don't moonwalk. Save those victory moves for the night and get these tickets before they sell out!

Time: 6 PM AET

Location: Kingpin Chermside
MM33/949 Gympie Rd, Chermside QLD 4032

Cost:
EESA members: $30
EA members: $40
Non-members: $40

The Next Generation Technology Project | Showcase & Awards

WEDNESDAY, 24 NOVEMBER 2021 | WA | VIEW EVENT

Overview:
The WA Chapter of the Electric Energy Society of Australia is calling for entries for the EECON2021 National Poster Project Competition for the 2021 Next Generation Technology Project Showcase & Awards, as part of EECON2021. There are two prize categories: Undergraduate (Bachelor Degree) and Postgraduate (Master's Degree and PhD). Two major sponsors... Read more.

Time: 1 PM - 4.30 PM AWT

Location: Western Power Corporation, 360 Wellington St Perth - Ground Floor Auditorium

Cost:
Free

EECON 2021

22-24 NOV | PAN PACIFIC PERTH

EARLYBIRD PRICES NOW AVAILABLE
BOOK BEFORE SEPTEMBER TO GET THE BEST DEAL

EECON 2021 IS NOW AVAILABLE BOTH IN PERSONS, IN PERTH OR AS A VIRTUAL ATTENDEE

REGISTER HERE!

PROGRAM SNAPSHOT

PROGRAM HIGHLIGHT

WA Minster for Energy Hon Bill Johnston MLA is invited to open the Conference.

Violette Mouchaileh, Executive General Manager, Emerging Markets and Services AEMO will deliver the opening keynote address: **Evolution and Challenges in our Electricity Industry.**

TECHNICAL TOURS ANNOUNCED

**Spaces available to full ticket holders only*

WESTERN POWER CONTROL CENTRE

ATCO HYDROGEN RENEWABLES CENTRE

PLATINUM SPONSOR

BRONZE SPONSOR

CONFERENCE SPONSORS & EXHIBITORS

EECON SPONSOR | APD ENGINEERING

For over 22 years, APD Engineering have been providing innovative & full in-house specialist engineering solutions to power, telco and water utilities, renewable energy proponents, mining and construction companies.

We are a leading engineering firm with an experienced workforce of over 250 staff and 11 office locations spanning across Australia and New Zealand. By being accredited with every Australian power utility, APD brings with it trusted and respected experience and best practices.

Our team has a wealth of knowledge and a proven track record of supporting AEMO, NSPs and renewable energy developers to successfully connect over 5GW of wind, solar, battery storage and hydrogen projects to the transmission and distribution networks across Australia.

Our HV Substation, Transmission Lines, Control and Automation teams have also successfully completed numerous complex brownfield upgrades, renewable farm integrations as well as multiple large scale grid augmentations.

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

EESA

THANKS TO OUR EECON SPONSORS

PLATINUM

APD ENGINEERING

SILVER

Worley energy | chemicals | resources

Advisian Worley Group

BRONZE

HITACHI ABB

HORIZON POWER

SEL

synergy

CONFERENCE SPONSORS

ATCO

DULHUNTY POLES

DYNAMIC RATINGS

FGC

GHD

MACLEAN ELECTRICAL

S&C

western power

Woodside

EXHIBITORS

APD ENGINEERING

API The Australian Power Institute

BOUNDARY POWER

CSE Uniserve a CSE global company

DULHUNTY POLES

SystemCORP by FUNDAMENTALS

TYREE TRANSFORMERS

MACLEAN ELECTRICAL A DISTRIBUTION NOW COMPANY

safearth SPECIALIST ELECTRICAL ENGINEERS

SEL