

GREAT *for the* STATE

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Stedman Ellis
Chief executive
Future Battery Industries
Cooperative Research Centre
Photo: Gabriel Oliveira

EDITION 2

The future of energy

OUR PARTNERS – HELPING US SHAPE GREAT FOR THE STATE

Rob Gambitta

Partner,
KPMG



Western Australia's booming lithium sector looks set to continue with industry enthusiasm manifesting into huge investment and expansion opportunities. The state has been taking advantage of the growing global demand for this battery-making mineral resource for many years. With the establishment of new downstream processing facilities, and a new national lithium research hub in Perth, WA is poised to take an even larger section of the highly lucrative lithium value chain and green energy revolution. (See page 7) ■

Professor Eric F. May

Australian Research
Council Future Fellow,
The University of
Western Australia



About 1.5 billion people worldwide live without electricity and 2.5 billion people have no access to clean cooking or heating facilities. As developing nations look for help to develop cleaner energy alternatives, The University of Western Australia is working with a range of industry partners to find solutions. Examples include finding cheaper and cleaner ways to supply Liquid Natural Gas from WA's North West Shelf, developing electric vehicles that charge faster and have greater driving range, and finding ways to grow a new hydrogen export industry. WA is already a global leader in research and development for the energy and resources sectors. The competitive advantage of our geography, positioned on the Indian Ocean Rim, means we are in the box seat to provide solutions for the clean energy needs of our regional neighbours and beyond. (See page 9) ■

Professor Peter Leedman

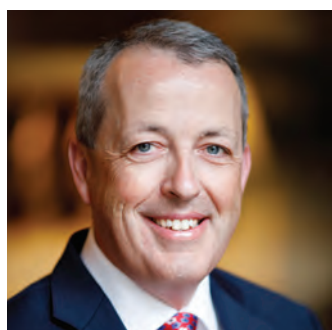
Director,
Harry Perkins Institute of
Medical Research



If we view future decisions in energy through a health lens would we be making different decisions about the projects we develop? Globally, the health impacts of mining and consuming a resource such as coal, for example, have been well-documented and we only need to look at the skies in major cities in a country like China to know that high pollution levels are deleterious for us. But are we considering enough the impact of our energy decisions here on global climate change and therefore on global health? The World Health Organisation has modelled the health impacts of climate change and the indicators are concerning. (See page 11) ■

Rob Slocombe

Group CEO
RAC
Photo: LILA PHOTO



Each time the topic of electrified transport is raised there is ferocious debate, yet the result is often little progress. The risk, if we continue down this well-worn path, is we will be unprepared to manage the impacts and opportunities of what is widely accepted as an inevitable electric future. Australia's economic and social outlook will become increasingly hinged to how we respond to the electrification of our transport network. Now is the time to move on from debating the when and the why, and start debating the what and the how. (See page 12) ■

The state is developing from a gas exporter to produce a range of energy commodities and technological innovations, with energy exports to potentially hit \$50 billion in a decade.

From gas to lithium, WA powering the world

Story by Matt McKenzie

One truism of a more globalised world is that regions which pursue and build their competitive advantages in international markets are richly rewarded.

Western Australia has benefited from a wealth of natural resources, but has also been at the cutting edge of developing technology and brainpower to harness those riches.

In 1984, Karratha became home to one of the world's earliest gas liquefaction plants, built by the Woodside Petroleum-led North West Shelf venture.

Today, there are five trains at the Karratha plant, with capacity of around 15 million tonnes of LNG a year.

Newspaper reports from the 1970s show Woodside faced challenges that will be familiar to many working on the latest generation of projects decades later.

One of two big problems was the federal government of then prime minister Gough Whitlam, which in 1973 had proposed building a refinery at Dampier to process petroleum, buying gas from Woodside at the wellhead.

A second was lobbying for the gas to be used at home and not exported.

"The export part of the shelf gas project has a foe: the Conservation Council of WA, which has begun a vigorous public campaign calling for an urgent reassessment of the export proposals," the *Canberra Times* wrote in 1979.

Even in those early days, WA was sparking innovation in LNG, with the Karratha trains the first to use air as a cooling agent rather than water.

A more recent example of WA's leadership is Shell's Prelude floating LNG operation, which is undergoing commissioning in the Browse Basin.

It was the first floating liquefaction project announced in the world, and the second to enter production.

In the period since the Karratha plant opened, new LNG operations have included Woodside's Pluto, Chevron's Gorgon and Wheatstone, and the aforementioned Prelude.

Gorgon and Wheatstone alone involved investments of about \$US88 billion (\$125 billion).

The economic impact is significant, and growing.

There have been \$127 billion of LNG exports in the past decade, according to the Department of Mining, Industry Regulation and Safety, while petroleum shipments in 2018 (including condensate and crude oil) were \$33 billion.

Business News estimates petroleum exports will be about \$42 billion when all LNG plants are at full capacity and the second train at Pluto LNG is in operation.

A whole industry has emerged to service the plants and research how to make them as efficient as possible.

Numerous businesses and institutions are pushing a micro-scale LNG project in Kwinana, which will be valued about \$40 million, to further refine WA's competitive edge in gas production (see page 10).

WA's contribution extends beyond gas, with mining and refining of battery minerals, and potential production of hydrogen, the two other notable industries.

The rise of the green economy has been a big boost for WA, with batteries needed to store power for electric vehicles, households and utilities.

Increased production of batteries has meant rising demand for lithium, nickel, cobalt and graphite, all of which are used in components.

The state produced 43 per cent of the world's lithium in 2018, with concentrate exports worth \$1.6 billion.

There are five lithium refinery projects in the pipeline, with Tianqi Lithium, Covalent Lithium, Albemarle Corporation, Mineral Resources and Neometals all hoping to produce lithium hydroxide to ship overseas for battery manufacturing.

When all are in production, exports would be worth at least \$6 billion annually at current hydroxide prices, *Business News* estimates.

Research and development will get a big boost from the Future Battery Industries Cooperative Research Centre, which was recently awarded \$25 million of funding by the federal government.

Proponents of the centre hope it will contribute to WA moving even further along the value-added chain (see page 4).

At the other end of the spectrum, WA is also making advances in the use of batteries and storage in the grid, particularly through microgrids, which are mini-networks that can operate separately from main grids (see page 8).

Village Energy, Power Ledger and Horizon Power are among the businesses notable in this sector.

One industry still in its infancy is production of hydrogen, with a report by ACIL Allen Consulting predicting national hydrogen exports could hit \$2 billion in 2030 in a mid-case scenario.

A large part of that could be produced in WA, with one big business, Yara, already considering a hydrogen production facility near Karratha.

Hazer Group is a Perth-based company commercialising technology to transform natural gas into graphite and hydrogen, using iron ore as a catalyst (see page 6). ■

\$127.9bn WA's LNG exports in the past decade

\$33.8bn WA's 2018 petroleum sales

44.7mt WA's LNG exports in 2018

35% Increase in LNG export volumes in 2018

50.8% Share of LNG shipped to Japan in 2018

12 LNG processing trains in WA

\$1.6bn WA's lithium concentrate exports in 2018

539% Increase in lithium concentrate exports since 2016

5 Lithium refineries in the pipeline

\$USD15,000/t Sale price of lithium hydroxide

ON COVER

DYNAMIC Stedman Ellis says WA has the capability to move downstream in the battery production value chain.

Electric time for energy hopefuls

From resources projects to rooftops, the technological revolution under way in energy will have a lasting impact on Western Australia.

Story by **Matt McKenzie** Photo by **Gabriel Oliveira**

THE Shire of Bridgetown, population 4,670, is arguably the centre of the universe when it comes to supplying a growing global need for lithium, a metal used in batteries.

Just one mine, Talison Lithium's Greenbushes, produced 29 per cent of the world's lithium supply in 2017, or about 646,000 tonnes of concentrate.

Talison has plans to lift production to be close to 2 million tonnes per annum, with an investment of about \$840 million to build two production plants under way.

That expansion was going to enliven the region's economy, Bridgetown chief executive Tim Clynch said, adding to the existing mix of agribusinesses, lifestyle workers and retirees.

"(It's) the most significant economic impact for as long as any-

one can remember," Mr Clynch said.

"It's an exciting opportunity."

Talison had a policy of employing workers that lived within half an hour of the mine, and an extra 500 staff would be needed at the expanded operation, Mr Clynch said.

Together with family members, he estimated the bigger operation would bring about 700 people into the shire.

"It will maybe encourage new supporting industries to establish here ... we could see a greater range of light and service industries," he said.

"It'll be great for our commercial areas, shops and retail."

Battery minerals will spark activity in the community of Kwinana, south of Perth, too, with two lithium refinery projects in the pipeline there.

Tianqi Lithium, which owns 51 per cent of Talison, is building two processing trains that will produce 48,000 tonnes of lithium hydroxide annually.

Covalent Lithium, a joint venture between Kidman Resources and Chilean business SQM, is planning a 44,000tpa refinery.

Further investments include a nickel sulfate plant at BHP's existing nickel refinery.

Kwinana Industries Council chief executive Chris Oughton told *Business News* the battery minerals supply boom would be the most important boost for the area in decades.

"What we're seeing now, and the trigger is the Tianqi plant, this is a whole new generation, it's as important for the industrial area as its beginning," Mr Oughton said.

"We're seeing so much new

interest from around the world, and from within Australia."

He said a decision on a new outer harbour would trigger a wave of further investment.

In the December quarter of 2018, unemployment in the City of Kwinana was 11.6 per cent, according to federal data.

Mr Oughton said investment in new industry would provide opportunities for young people.

"We've got a partnership with 17 high schools in our region, we're putting 250 year 10 kids through courses ... that can show these kids they can aspire to having a career in industry," he said.

"So much of our community down here doesn't know how to get a job in industry.

"Two thirds of (existing Kwinana workers) are in the baby boomers group, and are currently retiring.

"There's going to be a massive uptake of workers."

More than lithium

Rare earths and vanadium are two more examples of commodities that could play a role in the battery and renewables boom.

Vanadium Australia chief executive Vince Algar said a strong price for vanadium meant it was likely an older mining operation at Windimurra would be reactivated, while his company's project at Gabanintha was also a good chance of getting up.

Demand for the metal was driven partly by its use in steel but increasingly it would be powered by vanadium's use in batteries, where it is a competitor to lithium.

Mr Algar said the vanadium batteries were best for grid-level

The role of the CRC is to show people, to provide demonstrable evidence we can do some of these things - Stedman Ellis

applications, backing up renewables.

Northern Minerals is looking to move down the value chain after it has developed its rare earths mine in the Kimberley.

The rare earth metals include dysprosium, which is used in powerful magnets for electric cars and wind turbines.

Chief executive George Bauk said Northern would engage in an early stage of value adding, hydro-metallurgical processing to produce carbonates.

The company was researching the next stage of processing, separating the metals to produce oxides.

"We're looking to be as quick as possible getting into (separation), once we get our finger on the right technology, that's when you start looking at the next stage (producing metals)," Mr Bauk said.

"We've really got to encourage industry to go downstream, capture value, and the jobs that get into the cutting edge.

"(WA) has just got to be a bit more bullish and bold and have a go."

Downstream

Businesses, community groups and governments have signalled a strong interest in moving down the value chain of battery minerals, with lithium refining just a first step.

Other opportunities would include electro-chemical work, manufacturing anodes and cathodes, assembling batteries and recycling batteries.

Various reports have taken different positions on the state's likely competitiveness.

Probably the most thorough

analysis was the Chamber of Commerce and Industry of WA's November report, WA's future in the lithium battery value chain.

"While technically complex, the conversion of technical grade lithium, nickel and potentially cobalt chemical products to battery-grade products is not a major step from an economic perspective and is possibly viable in Western Australia," the report said.

"However, ... subsequent stages ... including cathode active material manufacture, have low barriers to entry, and are thus highly competitive, operating on relatively low margins.

"They are also variably energy intensive and would likely require the importation of various inputs.

"As such, it is unlikely that WA would be able to sustain a com-

petitive position ... beyond the manufacture of battery-grade precursors."

One man who will be at the forefront of the effort to sharpen WA's battery competitiveness will be Stedman Ellis, who is chief executive of the Future Battery Industries Cooperative Research Centre.

The centre, headquartered at Curtin University, will be a collaboration of 58 industry, research and government partners.

It was granted \$25 million of federal funding in April.

The next six months will be focused on establishing the centre, with a board and staff.

Some projects will potentially start this year.

"It's not just an opportunity about growing the value of what we're already doing," Mr Ellis said.

"Australia has got a strong

mining and minerals processing industry.

"Our research program can both make those activities more efficient ... and assist Australia and WA in capturing more foreign direct investment into that part of the supply chain.

"But there's a very real opportunity for Australia to move further down the battery mineral supply chain.

"The role of the CRC is to show people, to provide demonstrable evidence we can do some of these things."

That might be demonstrating laboratory-scale technology, or even at an industrial scale, he said, driven by the needs of the centre's partners.

Mr Ellis said he acknowledged downstream processing had

Continued on page 12

\$2bn

Potential value of
Australian hydrogen
industry in 2030



Left:

CREATIVE Andrew Cornejo is leading Hazer Group's development of hydrogen production technology.

Right:

CONVERSION Mingming Zhu with a reactor that converts syngas into methanol.

Hydrogen fires burning passion for innovation

Hydrogen is the most abundant element and WA could play a role in making the gas a big part of the world's energy supply.

Story by **Matt McKenzie** Photos by **Gabriel Oliveira**

Tokyo's 2020 Olympics could create a unique opportunity for Western Australian innovation off the field.

The city's government has an ambitious target to make the games a showcase for hydrogen fuel, including at the athlete's village and with a cauldron powered by hydrogen rather than conventional gas.

The bigger picture is that in 2016 Japan's Ministry of Economy Trade and Investment announced plans to spend nearly \$US1 billion (\$1.4 billion) on hydrogen fuelling stations for cars and residential fuel cells in the following four years.

Japan is the leader in hydrogen adoption, but South Korea and China are following, in the hopes the gas can be used as an electricity source and for fuelling vehicles.

A 2018 report by ACIL Allen

Consulting estimated Australian hydrogen exports could be valued about \$2 billion by 2030, and would supply 20 per cent of Japan's demand.

WA has potential both as a hydrogen exporter, and developing technology for hydrogen production itself.

Perth-based **Hazer Group** is in the latter camp, refining a process to use iron ore as a catalyst to transform natural gas into hydrogen and graphite.

Hazer and **Mineral Resources**, which is a major shareholder in Hazer, have test reactors co-located in Kwinana.

If the system could be commercialised, it could be rolled out in countries such as Japan to produce hydrogen on site from natural gas or biogas, chief technology officer Andrew Cornejo told *Business News*.

Mr Cornejo said he hoped to have a commercial demonstration plant next year and a global footprint within five years.

It would be revolutionary for hydrogen production, he said, although there was still work to do on costings, which were dependent on sites.

For Mr Cornejo, it has been a long road.

He chose to research the technology at the University of Western Australia rather than pursuing a regular engineering job, and that led to the founding of Hazer in 2010.

"I always like being at the front of the curve, I like innovation," he said.

Aside from Japan, California and South Korea were among jurisdictions keenly embracing the potential of hydrogen, Mr Cornejo said.

Conversion

Transforming biogas into methanol as a precursor to hydrogen is the focus of **University of Western Australia** researcher Mingming Zhu.

The project received \$1.1 million from the Australian Renewable Energy Agency in August 2018.

Mr Zhu told *Business News* there was an early iteration of the technology already operating at Perth Airport, using timber waste from the East Metropolitan Regional Council and processing it into synthetic gas.

It is then used to produce electricity, with capacity of about 3 megawatts of power.

"That technology is already commercially demonstrated," he said.

"The syngas ... is only used on site, you can't take the syngas around.

"That's why we want to convert the syngas into methanol, you can easily transport it ... (it) can also be easily converted back to hydrogen for fuel cell use."

The process of converting the biomass into gas is known as pyrolysis. Mr Zhu said it worked well

in smaller scale, localised applications.

By itself, hydrogen needs to be at a very low temperature to be stored and transported in liquid form, about 100 degrees Celsius cooler than natural gas.

When the hydrogen is converted into methanol and ammonia, it can be more easily transported, then extracted at the destination.

"Hydrogen will be the ultimate clean fuel," Mr Zhen said.

"WA has the existing infrastructure for LNG ... we can easily convert to ammonia."

At **Curtin University**, researcher Guohua Jia has led a team that has developed a better way to use solar panels to power electrolysis of water, another process that is used to create hydrogen.

The technique uses nanocrystals made from elements such as zinc and sulfur, rather than traditional choices such as iridium and cadmium.

The latter groups of chemicals are less abundant, more expensive and more toxic.

But more needs to be done to take the developments out of the lab and into grid-scale hydrogen production.

Bigger

Numerous large businesses are running the rule over hydrogen.

In March, **Woodside Petroleum** joined a South Korean consortium, HyNet, to build and operate 100 refuelling stations in the country.

The company has said it expects to see at-scale hydrogen production around the world in 2030.

Yara Fertilisers and **Engie** have also announced a feasibility study on construction of a green hydrogen plant on the Burrup Peninsula, next to an existing ammonia plant.

About 28,000 tonnes of ammonia would be produced annually.

Australian Gas Infrastructure Group chief executive Ben Wilson said that business, which owns the Dampier to Bunbury Natural Gas Pipeline, was in early-stage discussions to 'offtake' renewable energy for potential electrolysis applications in WA.

Hydrogen could be blended into gas networks, both as a carbon-free energy source in its own right and as a potential method to store excess power, Mr Wilson said.

Once the energy is needed,

hydrogen could be released from the network and used to generate electricity.

The Dampier Bunbury Pipeline could easily operate with 5 per cent hydrogen blending, he said, while the local distribution system, operated by Atco, could handle much more.

Mr Wilson was bullish about the use of hydrogen for export.

"There's a real opportunity for WA to be a leader here," he said.

"The export potential that WA could seize, is pretty exciting actually.

"WA knows how to take gaseous fuels, liquefy them, put them on a ship and send them to Asia."

And there was a lot of potential for costs to come down, with increasing scale in manufacture of electrolyzers, much the same as the experience of solar, wind and batteries, he said.

In Jandakot, **Atco** has been developing a microgrid and electrolyser system to produce hydrogen, which it calls the Clean Energy Innovation Hub.

The company picked up a \$1.5 million grant for the technology from Arena, with the project costing about \$3.5 million all up. ■



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WA Leads The Charge In Battery Minerals

How do decarbonisation, electric vehicles, energy storage systems, and smart devices benefit Western Australia? They all involve modern li-ion battery production using minerals sourced in the state. WA has the components for modern battery technology, especially lithium. Lithium is an integral component of li-ion batteries, used in everything from smartphones to electric vehicles.

Just a decade ago, WA had just one lithium mine in operation. Now, our world-class resources sector, geographical proximity to Asian end-users, and around \$4 billion investment in lithium production, means WA leads the lithium value chain. In fact, it now contributes to over 50 percent of the world's lithium supply.

The Association of Mining and Exploration Companies forecast that the global lithium value chain will be valued at \$2 trillion by 2025. However, most downstream value-adding activities like refining and battery manufacturing currently occur in Asia, which seems a missed opportunity for WA. Around 90 percent of Australian battery minerals are refined in China, and China produces half of the world's li-ion batteries.

But WA has unique competitive advantages, and is ready to play a bigger piece in this value chain. By investing in domestic refining facilities

and battery manufacturing, WA can advance to the centre of the lithium supply chain, and foster a new wave of clean energy technology.

Some WA lithium producers are taking the lead – investing in battery-grade lithium hydroxide production, thus ensuring this step in the refining process happens in WA. An example is the near complete Tianqi lithium plant in Kwinana, which will be the largest lithium hydroxide plant in the world. A further four refineries are planned for WA in the next five years. Moreover, the Government has put \$25 million of Commonwealth funding to top up the \$6 million contribution from the McGowan Government to fund the Future Battery Industries Co-operative Research Centre (FBICRC) in Perth. The mandate of the FBICRC is to grow Australia's competitiveness in the global battery industries value chain.

Our state has potential to become a significant manufacturing hub for li-ion batteries and battery packs, for global automotive and grid-scale markets, through partnering with leading Asian and Western manufacturing businesses.

Rob Gambitta
Partner, KPMG



VANGUARD

Stephanie Unwin says Horizon has the opportunity to experiment.
Photo: Gabriel Oliveira

HORIZON
POWER



Spearheading move to power off grid

The battery minerals boom may have captured the public's imagination, but WA is also at the vanguard of applying batteries and other technologies at the consumer level.

Story by Matt McKenzie

Because we've got a lot of isolated, regional communities, traditional ways of providing power won't work - Stephanie Unwin

Western Australia's regional communities are an unexpected place to find a revolution in the operation of power grids, yet they are the perfect testing ground for new technology.

The implications of success could be massive, with WA potentially able to export ideas to developing countries where millions in remote areas have poor access to electricity.

State government-owned electricity supplier **Horizon Power** is rolling out microgrids in Onslow and Carnarvon, and standalone power systems near Esperance, among other projects.

A microgrid is a small grid that can operate separately from a large-scale network, with decentralised generation, storage and management.

Standalone power systems are units designed to power a single customer off grid, usually with solar panels, storage and a back-up diesel generator.

Horizon chief executive Stephanie Unwin said the microgrids and standalone systems were ideal for regional areas because they could be

rolled out much more cheaply than huge networks of poles and wires.

The Esperance region will be home to 13 standalone power systems that will replace a 54-kilometre stretch of Horizon's grid by the end of the year.

Perth-based **CPS National** was given the contract in March to roll out the system, which will also deliver improved reliability.

"We might well be ... the first utility that's actually stripped the wires," Ms Unwin told *Business News*.

"We get to experiment a little bit ahead of other utilities in bigger grids because we've got a lot of isolated, regional communities; traditional ways of providing power won't work.

"You can't put poles and wires everywhere across a 2.6 million square kilometre state ... you need some quite novel solutions to get cost-effective power to these places."

In Onslow, Horizon is adding more rooftop solar panels and batteries across the town's grid, backed up by a gas generator.

A 1 megawatt grid scale solar farm and 1 megawatt-hour battery are under construction.

In February, **Western Power** also announced a rollout of standalone systems, picking **BayWA r.e Solar Systems** and **Hybrid Systems Australia** for the work.

The contractors will assemble systems on 57 sites, with Western Power estimating it will save \$6 million compared with a traditional refurbishment.

Nearly 2,000 more systems could follow.

BayWA managing director Durmus Yildiz said the installation was at the cutting edge globally in concept and execution.

"Not everywhere in the world, is the desire 100 per cent there yet (to roll out these systems)," Mr Yildiz said.

"Australia is probably the best place to start, and Southeast Asia.

"We have a large grid network, and some of these networks are operating in isolated locations, which makes it quite expensive to bring conventional power solutions to them."

Participants in the installation program would learn how best to optimise the systems, he said.

Export

Horizon's Ms Unwin said she saw potential for local businesses to take WA's experience developing microgrids overseas.

"We are pretty innovative at coming up with great solutions (in WA)," she said.

"There's definite opportunity for solutions like this in places where energy (demand) is not best met by the old centralised way."

Asia has particular potential.

But she said a competitive advantage was important, in Horizon's case, that was a desire to service remote communities.

One example of the technology being taken overseas is **Village Energy Group**, which was co-founded by three former Horizon employees.

The company plans to roll out hardware and software for microgrids in Indian remote communities.

Village was granted \$750,000 by the federal government's Accelerating Commercialisation program in January.

Matrix

There are other WA businesses hoping to make an impact at the retail level.

Power Ledger uses blockchain to provide a platform for consumers to trade electricity.

It has been supported by RAC's BetterLabs Venture Fund.

With Synergy, Western Power and Curtin University, Power

Ledger is trialling the platform at a residential complex in White Gum Valley.

Another business, **Iron Matrix**, was co-founded by former oil and gas analyst David Morgan.

Iron Matrix is developing technology to build houses clad in solar panels.

The blocks clip into each other like Lego to form a structure, with steel underneath to provide reinforcement.

A prototype house was built in Bullsbrook.

"You're basically replacing an existing (construction) material with a solar panel," Mr Morgan said.

"We designed it ... specifically for the dimensions of a standard solar panel."

He said solar panels were now cheaper than plywood.

The Iron Matrix blocks would be built by robots, flat-packed for shipping and could be assembled by hand.

"The combination of those things means we've got a structure that in a large part gets paid for by the energy it produces in its lifetime," Mr Morgan said.

"The international implications are extremely exciting.

"If you can build Ikea furniture



57 Standalone power systems being rolled out by Western Power

then you can build an Iron Matrix structure."

This year, the company hopes to complete a Series A financing round, and be in construction

of further demonstration projects.

Mr Morgan said export markets such as Africa and Asia would also be targeted. ■

BOLTED IN Iron Matrix has built a test house in Bullsbrook.
Photo: Iron Matrix

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The future of energy



Western Australia has a critical role to play in driving the world's energy future. Currently, about 1.5 billion people worldwide live without electricity and 2.5 billion people have no access to clean cooking or heating facilities. Limited availability to reliable, large-scale energy greatly restricts living standards and entrenches inequality. To overcome such energy poverty, developing nations will utilise whatever available resources they can. However, while all forms of energy when used at scale have

environmental impact, some forms are significantly better than others. Given its vast endowment of multiple energy resources, WA can make a substantial contribution to solving this global grand challenge.

The University of Western Australia works closely with the key industries responsible for delivering energy to billions of people in a region spanning the Indian Ocean to north-east Asia. The largest contribution to solving the future energy grand challenge will come from WA's liquefied

natural gas (LNG) industry. For example, China is committed to using more natural gas to reduce its dependence on coal and lower CO₂ emissions. The vast reserves of natural gas located off WA's coast are central to that strategy; however significant technical challenges must be overcome to produce them cost-effectively. Having worked closely with the gas industry for over 30 years, providing education and technical solutions in offshore engineering, natural gas processing and LNG production,

UWA established in 2018 the Chevron-Woodside Chair in Long-Subsea Tiebacks to help develop and deploy the engineering solutions required.

Electric vehicles and hydrogen will also play an increasingly important role in meeting the world's energy demand with the least environmental impact. Experts at UWA are also making important contributions in these areas, for example through the renewable energy vehicle project in which technologies for fast battery charging enables multiple ve-

hicle types to be powered with zero emissions. The Future Energy Exports CRC bid led by UWA aims to help grow a new hydrogen export industry able to meet Japan's emerging demand for de-carbonised energy. These initiatives are the latest examples from a sustained track record of significant contributions to the future of energy.

Professor Eric F. May
Australian Research Council
Future Fellow
UWA

Seven ways WA stays top in traditional fuels

Almost half of the growth in the world's energy demand in 2018 was fuelled by gas, according to the International Energy Agency. Consumption of coal, oil and nuclear power rose too. WA has both enormous commodity reserves and a workforce with the smarts to unlock these resources.

Exploring efficiency

Kwinana will be home to a \$40 million small-scale LNG plant designed to accelerate adoption of research across the energy industry. Chevron, Shell, Hyundai Heavy Industries, National Energy Resources Australia and the University of Western Australia are among the organisations backing the Kwinana plant, which received \$10 million in funding from the state government in early April.

UWA Chevron chair in gas process engineering Eric May told *Business News* it would be a world-first facility for the industry. "(The) function is not to make LNG specifically, but rather be there as national infrastructure for industrial-scale research and development and demonstrating new technology," Professor May said.

"The oil and gas sector has quite a long time (lag) for new technology to get adopted because the scale of the industry is so large that the risk associated with anything new is very big.

"This is a barrier to innovative small companies and even larger ones."

Trialling ideas to increase throughput at plants was one example of potential uses.

"No one wants to test with a large plant, (but) with a small one ... if it doesn't actually work that's fine," he said.

A second area of interest would be preventing freezing in processing plants.

"We've been looking a lot at stopping LNG plants from having heart attacks," Professor May said.

"These are big refrigerators; the gas has come from a natural source and its full of impurities ... it can freeze out and cause blockages."

An additional benefit was that it would help educate and train the LNG workforce on a live plant. Professor May said the university was also working with a wider consortium to bid for a Future Energy Exports Cooperative Research Centre. A federal funding decision on that is expected later this year.

Stability

An important but often overlooked strength for WA and Australia is its political stability.

That is one reason why the state has continued to attract a high level of resources investment, even as costs go up.

Western Australia ranked third of 83 regions in the world in the Fraser Institute's 2018 survey of mining jurisdictions.



Woodside's investment plans

Two big gas fields off Western Australia's coast have remained untapped for decades because of their remoteness, Scarborough and Browse.

But in a testament to WA entrepreneurship, both could be unlocked by Woodside Petroleum in the next decade, with the two projects worth a combined \$35 billion.

In the case of Browse, gas will be piped 900 kilometres from north of Broome to be processed at the existing North West Shelf facility near Karratha, filling an expected capacity gap.

For Scarborough, there's engineering work under way, with a multi-user pipeline across the Carnarvon Basin planned.

Gas would be liquefied at an expanded Pluto plant (photo), also near Karratha.

Between the two plants, production would be roughly 25 million tonnes per annum, more than Nigeria's total output in 2017.

In addition to the economic impact of the investment, there's research work being undertaken about the most effective way to construct such a massive pipe.

The Centre for Long Subsea Tiebacks at the University of Western Australia was launched late last year, with Chevron and Woodside as partners.

The centre is intended to improve understanding of hostile deep sea conditions and support the economic feasibility of remote offshore production.

Nuclear potential

Western Australia has never exported uranium, although the state has about 226,000 tonnes of known uranium deposits.

To put the number in context, global production was 62,000 tonnes in 2018.

Nuclear-powered electricity production grew by 3.3 per cent in 2018, mainly as a result of new capacity in China and the restart of four reactors in Japan, according to the International Energy Agency.

Government policy has been restrictive about uranium production, although the four projects which have been given approval will be allowed to proceed, if prices permit.

The approved projects include Toro Energy's Wiluna, Vimy Resources' Mulga Rock and Cameco's Yeelirrie.





Marine fuel

Perth's LNG Marine Fuel Institute is taking the lead on advocating for the use of LNG in shipping, as international regulators tighten emissions standards. One Chinese study found that 24,000 premature deaths in East Asia annually could be linked to air pollution from ships, according to the institute. About 80 ports around the world are building capacity to fuel LNG-powered ships. Woodside's marine-powered supply vessel, the Siem Thiima (photo) was built in 2016. There were about 550 LNG-powered vessels in the world in 2018.

Massive reserves

Western Australia has 70 trillion cubic feet of conventional gas reserves, according to the Department of Jobs, Tourism, Science and Innovation. There's a further 270tcf of onshore shale and tight gas which may be economical to extract in future. To put that in context, the Browse project contains about 14tcf.



Curtin's coal study

At Curtin University's Fuel and Energy Technology Institute, work is under way on improving solar collectors and bio-mass generators. There's also research to improve the efficiency of coal, with a team led by associate professor Hari Vuthaluru (photo) winning a \$1.1 million grant from an Indian utility last year. A large number of India's coal plants are 'subcritical', meaning less than 35 per cent of the energy they produce becomes electricity. The Curtin team will sharpen up the efficiency of coal boilers to get the best energy output out of the rock, and the lowest emissions, catering to different coal chemistries.

"We're halfway through," Mr Vuthaluru said. "We've built a comprehensive model and trained people in India with that model. "(We've) identified some hotspots and why they're occurring in a real plant, we're trying to see how best we can control those problems. "That's one way to actually improve the efficiency, there might be some areas where heat is not getting utilised properly for the generation of steam." He said the next step for the project would be lab testing Indian coal to use in model parameters for predicting issues like ash deposition. ■

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Energy choices and health: a fine balance

Fortunately in our country we can be fairly confident that considerations about our energy future factor in direct environmental impacts but should we be going further and considering a wider climate change perspective and subsequent impact on our own health?



The two are closely intertwined; the health of our environment, locally and globally, and the impact on human health. Climate change has significant medical consequences.

Globally, cities with poor air quality are recording increasing rates of related poor health conditions.

And yet it is easier to see the direct link between smoking and lung cancer than it is to see how steadily increasing air pollution is causing a variety of diseases.

Doctors and most patients understand the effects on human health of diet, stress,

lack of exercise, interrupted sleep and common diseases but we have less understanding of the effects of pollution and climate change on our health.

However, if we view some of the direct impacts of climate change identified by climate scientists through a health lens, such as increasing global temperatures, rising sea levels and extreme weather events then we see increases in the spread of disease-causing bacteria, poorer air and water quality and food security challenges.

Extreme weather events expose us to heatwaves and

flooding and each event sets up the potential to alter the geographic distribution of illnesses.

Whether impacts from the energy sector are direct, such as from an oil spill or indirect from ecosystem changes, the human tolerance for environmental change has limits.

We know that when temperatures increase doctors see patients suffering the symptoms of heat stress, dizziness from reduced blood flow to the brain and vomiting.

We know doctors at the front line of extreme weather emergencies see patients

with burns from uncontrolled fires, with cholera from bacteria in contaminated food or water and an increase in mosquito-borne diseases.

The World Health Organisation (WHO) reports that between 2030 and 2050, climate change is expected to cause approximately 250,000 additional deaths per year, from malnutrition, malaria, diarrhoea and heat stress.

The impact on mental health is a whole other area to consider.

While the WHO also reports that the least able to cope will be the developing countries

with weak health infrastructure, the energy policy choices we make here will impact the global environment.

The health impact of future decisions in energy are critical considerations for policy makers.

Professor Peter Leedman

Director, Harry Perkins Institute of Medical Research

Continued from page 5

Electric time for energy hopefuls

been difficult in WA, but there had been some successes, such as in alumina refining.

He said he had been excited by the potential to support the creation of new industries.

"What strikes me as really unusual and attractive about this opportunity is the alignment of the players," Mr Ellis said.

"There's a degree of urgency around Australia grasping this opportunity, (and) there's a lot of competition around the world to capture the value in the global supply chain for batteries."

Murdoch University is among the local institutions involved in the centre, and has a long history in battery research.

In the 1970s, Murdoch's Jim Parker worked on lithium and bromide batteries, research that made it into the corporate world through ZBB Technologies, a business which was ultimately unsuccessful.

Now, work at Murdoch includes developing alkaline leaching to replace the existing sulfuric acid leach process used to refine lithium.

End user applications of batteries would also be in the research centre's remit, Mr Ellis said, working in collaboration with businesses such as Synergy and Horizon Power.

One question would be whether battery storage is more effective at the utility level or in individual households.

"Australia is at the lead as much as any country in the world with how we're deploying batteries in our grid," he said.

"We can develop technology and expertise we can export as well."

(It's) the most significant economic impact for as long as anyone can remember

- Tim Clyne

Applying change

Government-owned power retailer Synergy is at the sharp end of technological progress, with the business an example of how utilities around the world are changing their business models.

Chief executive Jason Waters told *Business News* it was difficult to know exactly how the industry would look in 20 years because change would be led by consumers.

But he expected electricity would be cleaner and there would be downward price pressure.

The company is running a range of programs trialling different technologies to see what works for customers.

An example was the Power Bank battery near Mandurah, where households with rooftop solar could effectively store power centrally.

There's a similar trial running at Alkimos.

"Both offer remote storage rather than home-based storage, (they) enable customers to virtu-

ally store their power," Mr Waters said.

"I'm looking forward to seeing what the customer preferences are in that space, there's possibly benefits from grid-based storage for customers, as opposed to home-based storage.

"There may be benefits to the grid (too) ... as opposed to the benefits just being locked down behind the meter."

The alternative model was the virtual power plant model, with the company working on potential trials.

"(The VPP will) aggregate, behind the meter, batteries through centralised control to make them all operate in sync as though they are a large grid-connected battery," he said.

Other opportunities were creating choice in billing arrangements, such as through time-of-use metering, or an arrangement similar to a mobile phone plan.

That would be enabled by a planned roll out of advanced meters in WA, which the state government announced in late April. ■

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Electrifying the transport network



The electrification of our transport network — a future where electric vehicles (EVs) abound — will be central to a looming shift in how we move around our cities and regions, and how we manage the health of our communities.

In 2011, approximately 2,500 Australian deaths were attributed to air pollution, at an estimated economic cost of \$11 billion.

Tailpipe emissions from Australian vehicles are, per capita, 44 percent higher than the average of other OECD nations, with 43 million tonnes being emitted from cars on Australian roads each year.

Vehicle electrification will play a major role in reducing harmful vehicle emissions. This is something RAC continues to champion, including through the RAC Electric Highway®, a network of 11 fast-charging stations

between Perth and WA's South West. The Electric Highway allows EV owners to traverse more than 520km of the State unencumbered by range anxiety — the fear of inadequate electric vehicle charging infrastructure preventing continuous travel.

The move toward electric vehicles is complex. As with any change of this magnitude, many challenges exist. The availability of charging infrastructure (and the time to charge), reform of motoring taxation, and the transition of employment along the various transport supply chains are all key. An active market for electric vehicles themselves is also critical — the lack of EV choice in the Australian market remains a major issue and more must be done to support and expand the range and to increase consumer demand through smart incentives and market signals.

All of this must also be underpinned by an ongoing transition to a cleaner power grid, which means having a sensible plan to transition to more renewable electricity sources.

These challenges are considerable, and they will not be overcome overnight. Therefore, we must recognise the inevitability of the change needed in the transport sector and act now to ensure we are best prepared to embrace the benefits of an electric future.

Most important is that we approach this pivotal moment seriously and enthusiastically. To do otherwise — to delay or to distract — would deny West Australians the option of a healthier and more convenient future.

Rob Slocombe
Group CEO, RAC