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Dear Ms Shaw,

Thank you for inviting Curtin University to provide a submission to the Inquiry into Microgrids and Associated Technologies in WA, being undertaken by the Economics and Industry Standing Committee - Legislative Assembly.

As you may be aware, Curtin University has proven capability in this area and is a key contributor to research in energy, power systems, urban planning and related fields. For example, Curtin research institutes and centres active in this space include the Curtin University Sustainability Policy (CUSP) Institute; Fuel and Energy Technology Institute; and Centre for Smart Grids and Sustainable Power Systems; and Bankwest Curtin Economics Centre.

Curtin also has significant expertise and capability in complementary research fields that present considerable leveraging opportunities in the deployment of microgrids and associated technologies in Western Australia. These include autonomous systems, big data and computational science, asset management, applied economics, logistics and supply chain management.

As an overarching statement, Curtin is of the view that microgrids[1] have considerable potential to bring benefits to network operators and end-users by providing an innovative approach to respond to emergent opportunities and challenges in the provision of electricity in WA. Microgrids are already used by network operators to improve the reliability and resilience of the electricity network in regional, rural and metropolitan areas. They may also enable the deferral/avoidance of expensive network upgrades in areas of rapid growth, or at the fringe-of-grid.

Microgrids may provide ancillary benefits, such as reducing fire risks by obviating the need for overhead power lines in areas of high fire danger. Additionally, microgrids may promote non-traditional forms of energy generation and trading, providing an economic benefit for customers with excess distributed renewable energy generation (for example, from residential solar photovoltaic systems).

However, the effective deployment of microgrids is reliant on a number of economic, regulatory, social and technical factors.

[1] It is noted that the term 'microgrid' may refer to different configurations of distributed generation (e.g. solar PV or diesel), energy storage, network connectedness, and scale. The submission may use the term 'microgrids' to refer to different applications and configurations, depending on context.

As detailed in this submission, much of Curtin's research activity in this area seeks to promote the deployment of innovative energy solutions, including microgrids, by better understanding and addressing these factors.

Increased deployment of microgrids and associated technologies (including battery storage) presents an opportunity for Western Australians to capitalise on our favourable position as a major producer of raw materials and rare earth elements required for the manufacture of batteries and electric vehicles. Curtin University is currently collaborating with Regional Development Australia, the Kwinana Industries Council and other partners to explore value-add opportunities in the WA lithium supply chain. The study is expected to be completed in the next two months, with the report to be publicly available.

For the longer-term, Curtin is actively involved in the development of Cooperative Research Centre (CRC) proposals that deal with different aspects of microgrids and associated technologies. The New Energy Industry CRC, led by Curtin, aims to realise economic opportunities by building Australian capacity along the new energy industry value chain. The Smart Sustainable Cities CRC focuses on opportunities for the development and adaption of technologies for sustainable cities.

Through these and similar collaborative research activities, Curtin is committed to working with Government, industry, community and research partners to maximise benefits associated with new energy technologies and systems.

Please refer to the attached submission for further input on the Committee's terms of reference. Should you require any additional information regarding the content of this submission or the research projects detailed herein, please feel free to contact my office at dvc.research@curtin.edu.au.

Yours sincerely,

Chris Moran
Deputy Vice-Chancellor, Research.

Curtin University Submission to the Inquiry into Microgrids and Associated Technologies in WA

The Committee will investigate and report on the emergence and impact of electricity microgrids and associated technologies in Western Australia, including:

a) The potential for microgrids and associated technologies to contribute to the provision of affordable, secure, reliable and sustainable energy supply, in both metropolitan and regional WA.

- Microgrids have the potential to contribute to the provision of affordable, secure, reliable and sustainable energy supply through:
    - Increasing local network resilience and reliability in areas with limited interconnectivity or redundancy (for example, the connected Kalbarri microgrid).
    - Managing local network loads through energy storage and dispatch to account for infrequent peak-load events. This may provide opportunities to defer investment in network infrastructure upgrades (for example, larger substations).
    - Providing users at the fringe-of-grid with secure and reliable power, and the potential to operate as a stand-alone power system (or community microgrid). Stand-alone power systems/microgrids could provide for the removal of long-feeder lines in rural WA that are expensive to maintain and replace, and which present some fire risks.
    - Potential for load smoothing and energy arbitrage (storing energy at times of low market prices and dispatching at times of peak demand); and
    - Reducing the amount of diesel burn required in islanded power systems, through hybrid diesel/PV and energy storage solutions.
- Microgrids could also provide solutions in non-standard contexts, for example in meeting the considerable (but predictable) electricity requirements of computing and data storage facilities associated with large-scale research and development initiatives like the Square Kilometre Array (SKA) and Murchison Widefield Array (MWA).
    - Microgrids based on distributed renewable energy could be established in regional areas, where appropriate greenfields sites are available. The cost of land and infrastructure are also lower in such areas. This combination could make regional microgrids attractive as enablers for large-scale computing and data storage facilities.
    - Such facilities could be ‘anchor customers’ for microgrid providers, providing an underlying secure cashflow that underwrites the development of capacity for smaller microgrid customers.
    - Such a concept could make a lot of sense in the corridor between Perth and Geraldton serviced by the NBN RBBP fibre that is connected to the SKA site in the Murchison. Since the SKA requires a large-scale data centre, perhaps this data centre (or centres) in regional areas could underpin a number of microgrids in the Midwest region
    - However, in order to attract such facilities and anchor customers, the cost per kilowatt hour from a microgrid would have to be competitive with the costs of electricity in other jurisdictions.
- The importance of microgrids, particularly in regional and remote areas, is reinforced by Horizon Power’s increasing strategic focus on the design and operation of microgrids in its 32 islanded power networks and its aim to become ‘the world’s best microgrid company’.

b) Opportunities to maximise economic and employment opportunities associated with the development of microgrids and associated technologies, including (but not limited to):

i. Development of raw material resources/primary commodities
ii. Research and development
iii. Design, engineering and construction
iv. Advanced manufacturing
v. ICT
vi. Ongoing asset operations

- The growth in demand for lithium and rare earth elements to manufacture batteries and electric vehicle components presents considerable economic opportunities for Western Australia over the short- and longer-term.
    - For example, Tianqi Lithium Australia recently commenced construction of a two-stage lithium processing plant in Kwinana, with commissioning expected in 2019[1];
    - Stage 2 will add 200 construction jobs to the project, with an overall workforce expected to peak at 500.
    - Once complete, the Kwinana plant will have a capacity of 48,000 tonnes per annum of high purity, battery-grade lithium hydroxide.
- Key factors underpinning these economic opportunities include:
    - **Resources**: Western Australia's lithium resources are ranked fifth globally and we host the single largest hardrock lithium deposit in the world (Greenbushes, 250km south of Perth)[2];
    - **Production**: Western Australia has been the world's largest lithium producer since 2013, accounting for 41 per cent of global production[2];
    - **Strategic Advantage**: due to our proximity to markets; lack of sovereign risk; robust compliance and licensing regime; environmental management; workforce capabilities; and
    - **Growing Demand**: for lithium and rare earth elements driven by uptake of lithium-ion battery storage technologies and electric vehicles.
- In order to understand the scale and breadth of these opportunities, Curtin University is collaborating with Regional Development Australia, Kwinana Industries Council and other partners to undertake a scoping study in the value-add opportunities for the lithium supply chain in Western Australia.
    - Among other things, the report will explore the requirements for further downstream processing of lithium and other relevant resources into products in the energy storage technology sector.
    - The focus will also include identifying other opportunities that exist to further enhance and secure Western Australia's natural resources for advanced materials.
    - This will allow increased value capture of WA's resources, provide significant new job opportunities and develop new industries.
    - The report is nearing finalisation and is expected to be publicly released in the next two months.

[1] Tianqi Lithium Australia, Media Release, 19 December 2017 - http://tianqilithium.com.au/wp-content/uploads/2017/12/MediaRelease-TianqiLithiumAustralia-19DEC17.pdf
[2] Geological Survey of Western Australia, Lithium: Investment Opportunities, January 2018 – Available from www.dmp.wa.gov.au

- For the longer-term, Curtin is leading in the development of a Cooperative Research Centre (CRC) proposal relating to the development of a New Energy Industry in Australia.
    - The CRC proposal includes partners from industry, Government, and the research sector and aims to maximise economic and industry development opportunities across the entire new energy materials supply chain.
    - The proposal is currently under development and will be submitted as part of the 20th CRC Selection round, in 2019.

- Opportunities for research and development in the area of microgrids and associated technologies are manifold. They include:
    - Research into new and existing energy storage technologies with the aim of improved cost-effectiveness, performance and environmental outcomes;
    - Value-addition throughout the new energy materials supply chain;
    - Data analytics on microgrid performance, asset management and system operation;
    - Optimisation and autonomous operation of microgrids and sub-components;
    - Social and policy factors affecting uptake and effective utilisation of microgrids;
    - Alternative energy generation and trading paradigms enabled by microgrid infrastructure, including blockchain technology platforms; and
    - Incorporation of microgids into urban planning frameworks.

- Curtin University is active in research projects to better understand how microgrids and associated technologies might be deployed at scale. Much of this research has been undertaken with industry, government and community stakeholders.
- Examples of current Curtin University research projects are provided in the following sections.

Curtin University Sustinability Policy (CUSP) Institute

Smart Cities and Suburbs Program – City of Fremantle Research Project
Curtin University, through CUSP, is leading an $8 million research project to assess how cities can use blockchain technology and data analytics to integrate distributed energy and water systems.

The research project, which received $2.57 million in Federal Government funding, is a collaboration between Curtin, Murdoch University, LandCorp, CSIRO/Data61, Cisco and Power Ledger. Curtin University has responsibility for project management duties and will carry out the research underpinning the project.

https://ministers.pmc.gov.au/taylor/2017/6-million-technology-projects-will-help-solve-practical-problems-perth

https://medium.com/power-ledger/australian-government-awards-grant-to-8-million-project-in-the-city-of-fremantle-using-the-power-2dbadfad50ae

CRC for Low Carbon Living
Curtin University, through CUSP, is an active partner in the CRC for Low Carbon Living. The CRC is a national research and innovation hub that seeks to enable a globally competitive low carbon built environment sector, with 45 partners from industry, government and research.

Curtin is the leader of the Western Australian 'Node of Excellence: Regenerative Cities and Regions', with a research focus on developing new models for building and precinct redevelopment to enable the established suburbs of Australian cities to be retrofitted more effectively and intensively.

http://www.lowcarbonlivingcrc.com.au/

White Gum Valley ARENA Project
Curtin University, in partnership with LandCorp, Western Power, CRC for Low Carbon Living Ltd, City of Fremantle and Balance Utility Solutions, is undertaking a research project to develop governance models to allow shared solar photovoltaics (PV), battery and monitoring systems to be used in medium density apartments. The governance models are being tested at 50 units of the White Gum Valley development in Perth.

https://arena.gov.au/projects/increasing-the-uptake-of-solar-photovoltaics-in-strata-residential-developments/

https://www.landcorp.com.au/innovation/wgv/

Knutsfort Precinct
Supported through the CRC for Low Carbon Living, Curtin is partnering with City of Fremantle and LandCorp to understand the next phase of large scale urban redevelopment. The Knutsford redevelopment district is a highly suitable demonstration area as it is ten times the size of White Gum Valley and contains a Western Power substation. Whilst the focus of this study is on low cost, low carbon distributed energy solutions, it will also consider broader integrated sustainability planning for water, waste and biodiversity.

http://www.lowcarbonlivingcrc.com.au/research/program-3-engaged-communities/rp3043-beyond-wgv-community-battery-storage

Centre for Smart Grids and Sustainable Power Systems

The Centre has a range of research activities in smart and sustainable grid applications and technologies that support the following goals:

- Smart distribution, including automation and advance metering;
- Utilising electric vehicles to increase grid reliability;
- Renewable energy and distributed generation;
- Diagnostics and monitoring of assets; and
- ICT enabled intelligent power systems.

Green Electric Energy Park
Curtin University has been operating the Green Electric Energy Park, in Bentley, for over five years, gaining a valuable understanding of the operation of microgrids in various states and configurations. The laboratory features state-of-the-art technology in renewable energy-based electric power generation including solar photovoltaic arrays, wind turbines, micro-hydro turbines and fuel cell stacks.

Data measured in real-time at the site is available digitally on workstation computers in lecture theatres via the Curtin local area network and over the internet for teaching and research purposes.

https://ece.curtin.edu.au/facilities/geep/index.cfm

Fuels and Energy Technology Institute

Curtin University's Fuels and Energy Technology Institute carries out fundamental research, technology development, demonstration and deployment activities for the development and commercialisation of innovative low-emission energy technologies. It is a primary focus of energy science and engineering at Curtin University. The research and development activities in the Institute cover both fossil fuels and renewable energy technologies, supported by the Australian federal government, WA state government, foreign granting bodies and industry partners in Australia and overseas.

Of particular relevance to microgrids and associated technologies are the research programs in fuel cell design, construction and optimisation; and energy storage, including the development of new ion conductors to be used as solid-state electrolytes in next-generation batteries.

http://energy.curtin.edu.au/research/

Bankwest Curtin Economics Centre

The impact of tariff structure changes on energy vulnerable households
This is a research project aimed at gaining a better understanding of the experience of energy vulnerable households under changes to electricity tariff structures. The research is a collaboration between Curtin University, WACOSS and Horizon Power and will examine the effect of different tariff structures on consumption behaviours. The resulting data and associated analysis will be unique in Australia given the regional location of the study, access to smart meters at every household in the location and nature of tariffs being tested.

This research is important as it provides an understanding of customer responses to different pricing incentives. In so doing, Horizon Power will be better equipped to optimise the utilisation of network infrastructure in islanded power systems in regional and remote WA.

http://bcec.edu.au/projects/impact-tariff-structure-changes-energy-vulnerable-households/

c) Key enablers, barriers and other factors affecting microgrid development and electricity network operations, including:

i. Regulatory barriers
ii. Technical factors
iii. Workforce planning and development
iv. Social factors
v. Electric Vehicles

- Curtin notes that the regulation of microgrids across Western Australia is context specific and varies across electricity supply areas (for example, the South West Interconnected System, Horizon Power's supply areas, and privately-operated microgrids operating under licence exemption regimes).
- However, as a general statement, there are a number of potential regulatory matters that would need to be addressed prior to the widescale deployment of microgrids and associated technologies in WA.
- These include:
    - Valuation and cost-recovery methodologies for microgrid-based network investment, where determined by an independent regulator;
    - Customer protection matters relating to right to network connection; supplier of last resort arrangements; multilateral trading arrangements (for example, peer-to-peer trading);
    - Safety standards of microgrid components and their installation (including battery storage);
    - How the provision of electricity through microgrids and stand-alone power systems is treated under reliability standards frameworks; and
    - Electricity pricing and the allocation of costs between parties.

- Technical factors and barriers to microgrid deployment include:
    - Cost effectiveness of energy storage technologies relative to other infrastructure options;
    - Decline in performance of components (including battery storage) over time;
    - A lack of smart-metering in the State that is required to efficiently utilise microgrid infrastructure;
    - Sizing of infrastructure relative to 'average' and 'peak' load. Microgrids and stand-alone power systems need to be built to cater for infrequent extreme peak load events, resulting in significant over-specification of components relative to 'average' use requirements. This increases the capital costs of these systems considerably, while reducing the effective utilisation of the assets.
        - For stand-alone power systems, tensions may arise from a customer's expectation of full reliability and unaffected usage patterns, whereas optimal system configuration (and cost effectiveness) might rely upon modified customer behaviours to reduce peak loads and better match generation and consumption profiles.

    - The tension between uses for distributed generation and storage and the creation of split incentives. In general terms, battery storage tends to be used for one function at any one time, and these uses are often mutually exclusive.
        - For example, if a customer chooses to dispatch energy in a battery for the purposes of self-consumption and tariff avoidance, then the battery will not able to perform an emergency stand-by function.
    - Where there are competing uses by different actors (i.e, customer vs network operator) the split incentives are more pronounced.
        - A customer may wish to use a battery to maximise self-consumption and avoid volumetric charges; whereas, a system operator may seek to dispatch that same stored energy at periods of peak load to improve network reliability.
        - The latter application potentially has a lower economic benefit for the customer, but a greater overall benefit for the system. (Who gets to choose and how is the other party treated?)
        - A similar situation might arise with an electric vehicle used to provide grid stability or other services (controlled by an external party). This function might come into tension with the customer's desire to use the electric vehicle as a mode of transport.
- Social factors that may influence the utilisation of services enabled by microgrids and associated technologies include:
    - Energy literacy and understanding of how costs associated with the provision of electricity (generation, capacity, transmission and distribution) are recovered from end-users.
        - This is important in the context of establishing the value of energy under alternative peer-to-peer trading platforms.
    - A lack of certainty regarding consumer protection matters raised above.
    - Consumer behaviours that can have a significant effect on the success and cost effectiveness of microgrids deployment, e.g. better matching fluctuations in demand and supply, reduction in peak demand.
    - As a related item, customer responsiveness to price (or other) incentives to align behaviours with desired usage characteristics.

d) Initiatives in other jurisdictions to facilitate the development, and maximise the value of, microgrids and associated technologies.

- Global Smart Grid Federation (Australia no longer appears to be a member).
- Significant microgrid deployment programmes have been pursued in Japan in the early 2000s, US (including military), UK (e.g. NINES), Greece (island project), Canada (project with GE and PowerStream).
- State of Victoria has just launched a demonstration project scheme with $10m in grant funding over four years to develop and implement state wide demonstration projects, using microgrid models. https://www.energy.vic.gov.au/microgrids