Queensland University of Technology
response to the
House of Representatives
Standing Committee on Climate Change, Energy, Environment and Water
inquiry into the Transition to Electric Vehicles

About the Queensland University of Technology

QUT is a major Australian university providing real-world infrastructure, learning and teaching, and graduate skills to the next generation of leaders in industry, research and society. We are currently educating more than 50,000 students, including more than 9,000 across the Faculty of Science and Faculty of Engineering. As the university for the real world, QUT is well known for its strong links to industry, government and community.

We acknowledge the pivotal role that Australian universities currently perform, and will continue to perform, in promoting sustainability and developing renewable energy solutions. This includes globally competitive critical minerals and battery industries to support an electric vehicles (EVs) sector for domestic and export markets. These industries have high environmental, social and governance (ESG) credentials, as well as supply security, which can facilitate industrial and economic growth.

The university aims to tackle the global challenge of clean, reliable and affordable energy through a combination of strategy, campus operations, education, research, partnerships and advocacy. Indeed, our strategic plan, *Connections: QUT Strategy 2023-2027*, underscores this commitment to Sustainability and Environment.

The Faculty of Science

The Faculty of Science explores the frontiers of biological, physical and digital worlds to drive innovation and develop solutions to complex, real-world challenges. We deliver distinctive programs in biology and environmental science, computer science, earth and atmospheric sciences, information systems, mathematical and data sciences, and chemistry and physics. These programs are designed to meet industry demands for technological solutions that are data driven.

Within the School of Chemistry and Physics, our research programs specialise in: the study of particles, fields and radiation; the design, synthesis and characterisation of molecules and materials; and the implementation of molecules and materials in various applications. This includes the research of battery chemistry, battery materials and components, and battery development and testing, spanning a wide variety of applications, including EVs. We have nation-leading, state-of-the-art battery research and development prototyping, pilot-scale manufacturing, and validation and testing facilities. The School also works closely with the federal and state governments, as well as industry, to enable market entry of battery materials, components, products and systems.

The Faculty of Engineering

The Faculty of Engineering performs a crucial role in addressing societal challenges through research collaborations, especially in the areas of population aging, climate change and environmental degradation. With expertise in engineering, built environments and advanced technologies, the faculty delivers transformative education and research across the disciplines of

architecture and built environment, civil and environmental engineering, electrical engineering and robotics, and mechanical, medical and process engineering.

The Faculty prioritises employability, social mobility, inclusion, industry collaboration and impact through transformative learning experiences, as well as research partnerships that foster community impact, and a socially responsible, inclusive educational culture. This is achieved through authentic, transformative and industry-engaged learning experiences, which distinguishes the Faculty within the Australian university sector.

Research Strengths, Facilities and Collaborations
Global research problems are increasingly complex, requiring innovative solutions provided by interdisciplinary research teams and dedicated facilities. QUT is meeting this challenge by developing critical mass in areas where we have a comparative advantage or unique domain knowledge – including battery storage and systems.

The University has a multitude of research strengths that are relevant to transitioning towards a future EV ecosystem. Our research facilities are also connected to the Australian battery value chain, with select examples including the following:

- The Advanced Battery Facility (ABF): a complete vertically-integrated battery value chain at pilot-scale that can prototype, validate and test a diverse range of battery-active materials, cells and systems. This unique, nation-leading capability is key to scaling battery technologies and enabling entry into supply chains.
- The Queensland Energy Storage Technology Hub (QUEST Hub): a facility that enables co-location of industry with university partners to build, test and commercialise renewable technology products and systems including flow batteries, power conversion systems and enhanced safety lithium-ion batteries.
- The QUT Battery Testing Microgrid (BTM): a largescale test bed for deploying batteries to prove-out complete turn-key systems and control architectures in real world conditions, enabling adoption and grid integration for renewable technologies.
- Centre for Materials Science and the Centre for Clean Energy Technology and Practices: undertake real world focussed research on renewable energy transformation, including the development of green and safe electrolytes for batteries, battery recycling and repurposing, bio-inspired materials for sustainable energy production, and pilot-scale green hydrogen production.
- The Centre for Predictive Research into Speciality Materials (PRiSM): is a facility developed by Lava Blue Ltd and QUT that enhances the capacity of Queensland to produce critical minerals and renewable energy systems, strengthening the sovereign battery supply chain and minimising environmental impact.

Response to the inquiry into the transition to electric vehicles in Australia
The University welcomes the opportunity to provide a response to the House of Representatives Standing Committee on Climate Change, Energy, Environment and Water (the Committee) inquiry into the transition to electric vehicles (the Inquiry).

We support the broad purpose of the Inquiry, and its intention to understand the resources, systems and infrastructure that Australia will require to support a higher proportion of EVs. Specifically, we use this submission to support the existing domestic manufacturing capacity that is required for the electrification of mining, public transport (e.g., buses and trains), caravans and trucks. We acknowledge that while this transition will impact traditional vehicle stakeholders, the opportunities presented by these EVs, and renewable technologies more broadly, represents significant potential for the research and manufacturing sectors in this country.

The transition to EVs will require a diverse, yet well-coordinated, collection of priorities, which the Committee has highlighted in its terms of reference. While there are other pertinent aspects to the areas being considered by the Committee, QUT will focus on the specific issue of supporting growth in Australian battery industries.

5. Opportunities for expanding EV battery manufacturing, recycling, disposal and safety, and other opportunities for Australia in the automotive value chain to support the ongoing maintenance of EVs

Background

Australia has committed to achieving net-zero emissions (NZE) by 2050. Decarbonisation of the global economy requires reindustrialisation and an associated shift towards renewable energy and electrification. This represents significant challenges for Australia that will require strategic focus, collaboration and solutions across multiple sectors. However, these challenges also present a wealth of opportunities for Australia to supply the materials and products needed, both domestically and internationally, to enable the clean energy transition. The global battery market alone is expected to grow at an unprecedented rate, potentially attracting USD$262b in investment between 2021 and 2030.[1]

Governments worldwide are swiftly taking steps to expand their economies by boosting renewable technology (RT) manufacturing to supply the large demand generated by the clean energy transition, including EVs. The abundance of critical minerals and renewable energy resources in Australia positions this country uniquely to supply RT products, with enhanced supply security and ESG credentials, into global markets. Further, Australia can improve the cost competitiveness of RT manufacturing and recycling by utilising our abundant supply of renewable energy. Onshoring the manufacture of key technologies is critical to fortifying energy security in Australia and developing safe and specialised systems to enable the electrification of our mining operations, public transport, caravans and trucks, as well as the integration of renewable energy generators (REGs) into our electricity grids. For Australia to capture the immense value available to us by participating in these emerging markets, it must move quickly with strategic focus on high value export commodities and products with high domestic uptake. To benefit from this anticipated investment, it will be necessary to support the entire battery industry value chain in Australia, including the development of an appropriately skilled workforce, critical minerals processing and advanced manufacturing industries.

Current Opportunities

Through our existing research strengths, QUT is contributing to a variety of research facilities within the field of battery research, all of which have a direct relevance to the EV ecosystem. These research facilities highlight institutional capacity in the exploration, development and commercialisation of strategic EV battery technologies. We welcome the opportunity to provide the Committee with additional information about these facilities, or to enable site visits should that assist the Committee in its deliberations.

- **The Centre for Predictive Research into Speciality Materials (PRiSM)**

  Lava Blue Ltd, a privately funded critical minerals project developer, has been collaborating with QUT since 2018 on developing processes for manufacturing battery-grade materials. PRiSM is a $10M pilot plant facility located in Redlands that provides an essential step in the commercialisation of fundamental research to develop and demonstrate novel mineral processing routes to manufacture various high purity, battery-grade materials.

- **Advanced Battery Facility (ABF)**

  Located in Queensland, the ABF is led by Associate Professor Joshua Watts, Director, QUT Energy Storage Research Group (ESRG), at the Banyo Pilot Plant Precinct. The facility serves as a comprehensive hub for battery research and development, with the ability to assemble, prototype, test and validate various battery types, including but not limited to,

[1] BloombergNEF (15 November, 2021). *Global Energy Storage Market Set to Hit One Terawatt-Hour by 2030*. https://about.bnef.com/blog/global-energy-storage-market-set-to-hit-one-terawatt-hour-by-2030/

lithium-ion batteries (LIBs). The facility also provides services for third-party battery materials testing and validation, aiding materials producers in entering the battery supply chain.

Further, the facility actively contributes to Australian standards development for lithium-ion safety and participates in multiple working groups under Australian Standards EL-005: Secondary Batteries. As the only public, industry-accessible facility of its kind in Australia, the ABF specialises in pilot-scale fabrication of standard format LIB cells, including commercial-grade cylindrical formats. It facilitates validation of battery-grade materials, accelerates research transition to industrial pilot-scale, and supports large volume manufacturing.

Key capabilities include the following:

- manufacturing prototype and standardised cell formats;
- operating a battery materials and components testing laboratory;
- offering training for LIB cell assembly and manufacture; and
- maintaining a curated test results database for battery materials and components performance.

Overall, the ABF plays a crucial role in advancing battery technology, fostering industry participation and training professionals for the energy storage sector in Australia.

- **Queensland Energy Storage Technology (QUEST) Hub**

  QUEST Hub is a $50 million facility that is also situated at the Banyo Pilot Plant Precinct. The Queensland Government is a key partner in the facility, which aims to foster a national battery value and supply chain for energy storage, including EVs, through targeted research, development, testing and deployment of advanced energy storage technologies. These technologies include iron and vanadium redox flow batteries (RFBs), sodium sulphur (NaS) batteries, and LIBs, all of which incorporate advanced safety features.

  Through industry collaboration across various stages of the battery value chain, QUEST Hub focuses on value-added energy storage materials, separator membranes, advanced LIB cells for specialised applications, large-scale battery energy storage systems (BESS), and power conversion systems for grid connection. By expanding existing QUT capabilities, as well as establishing accredited certification services, the facility also supports the production of battery components and systems while providing prototyping and demonstration facilities for industry partners.

  Further, QUEST Hub provides industry incubator spaces and leverages Queensland owned energy assets, enabling the facility to both develop and deploy world-leading energy storage technologies, which supports both domestic and international battery supply chains and markets.

- **Advanced Robotics for Manufacturing (ARM) Hub**

  Australia lacks efficient mechanisms for transitioning research into commercial products, especially in areas such as battery and EV innovation. To address this issue, it is necessary to consider the establishment of industry-focused innovation hubs with strong manufacturing potential. We recommend that the Committee consider ARM Hub as an exemplary model for bridging the gap between research and industry through the fostering of local manufacturing expertise and competitiveness.

  Founded in 2020 by QUT and urban art manufacturers UAP, ARM Hub has received major funding from the Queensland Government to serve as a blueprint for research, industry and government interactions that drive innovation and foster economic development. By connecting university research with manufacturing, ARM Hub supports skill development and technology adoption, aspects that are crucial for advancing the battery manufacturing sector

in Australia. Since its inception, ARM Hub has supported numerous businesses and secured significant funding for digital transformation projects, highlighting its effectiveness in driving innovation and industry growth. At the end of its first three years, ARM Hub had: assisted industry secure $54m in funding; worked with 68 companies on projects; assisted ARM Hub members deliver four new products; and engaged 5,500 people in both in-person and online events. In 2023, the Queensland Government refunded ARM Hub for another 4-year term.

Further Opportunities

For Australia to elevate its global reputation in the battery supply chain, the Committee should consider several opportunities as identified below.

- **Raw mineral mining**

  Battery technologies rely on various critical elements and minerals such as lithium, vanadium, iron, nickel, manganese, cobalt and rare earths. To effectively harness the critical mineral reserves in Australia, further research and development support is essential, particularly for equipment that will enable vertical integration and the production of high-quality battery precursors. As has been indicated in this submission, the ABF and QUEST Hub are already developing standardised testing and qualification to assist industry players in entering the battery supply chain.

  Rare earth elements (REE) and other critical minerals, like high purity alumina, present another opportunity, especially in developing sustainable electrochemical processing technologies to meet the demand for EVs. However, the diverse nature of REE-containing minerals and lower quality ores for critical minerals requires tailored research for mid-stream processing, which can address both energy costs and environmental concerns.

  Lithium, which is crucial for LIBs, is another raw mineral that presents an opportunity for expanding battery manufacturing in Australia. Lithium primarily exists in spodumene deposits, necessitating advancements in extraction technologies to reduce energy inputs and improve extraction efficiency. Current extraction methods, such as rotary kiln processing, are energy-intensive and leave a substantial portion of lithium in the ore. Despite strong demand, projects in this sector remain in preliminary stages of development. However, refining, processing and sustainable practices surrounding lithium are crucial for the critical minerals industry in Australia to thrive in the evolving battery market.

- **Cell manufacturing and battery assembly**

  Australia requires a reliable supply of high-quality LIBs to meet the rising demand. With proven high technical readiness level (TRL), and enhanced safety, the LIB format is crucial for various domestic applications, including EVs. Supporting existing domestic manufacturers to expand and enhance manufacturing capacity is vital for fostering the battery supply chain in Australia.

  However, a pressing issue is the lack of domestic certification services available to verify cells according to Australian standards. Again, as indicated elsewhere in this submission, the ABF is currently the only facility in Australia that can validate battery-grade materials, through its battery materials and components testing laboratory, while also offering training for LIB cell assembly and manufacture.

  Additionally, advancing research and development, particularly in Industry 4.0 manufacturing, is another opportunity that is essential to elevating cell manufacturing capacity in Australia. QUEST Hub is an example of the kind of support initiative required for this transition, to bridge the gap between lab research and commercial production.

  The growing demand for LIB energy storage also impacts battery assembly. Currently, local manufacturers rely on imported LIBs to assemble systems. However, with the potential

growth of domestic LIB cell manufacturing, there is an opportunity to supply local pack manufacturers with mature products. While this represents an opportunity for further development of a sovereign battery supply chain, one major obstacle is the lack of domestic certification services for LIB modules and packs. This necessitates costly and time-consuming exports for certification. As noted above, this will require the expansion of services that can expedite product certification and enable quicker market entry for local manufacturers, as is currently provided by the ABF.

- **Integration, service and maintenance**

  There is an urgent need to update the Australian standards and best practices for the safe and efficient implementation of BESS. The current standards lag consumer adoption rates, particularly regarding LIBs and other emerging battery technologies. More testing facilities, like those provided by the ABF, are needed to gather data for an informed development of Australian standards.

  As a registered, nominating organisation with Standards Australia, QUT seeks representation on the EL-005 committee to bolster expertise in BESS. We use this submission to emphasise the importance of supporting the further development of safety standards and best practice for BESS as this will be crucial to meeting demand and accelerating battery manufacturing in this country.

- **Recycling and reuse**

  A national plan for battery recycling will be required as part of any acceleration to the adoption of EVs, and associated industries, throughout Australia. Initiatives including a recycling guarantee for batteries that are manufactured in Australia for domestic use should be considered. This approach would promote responsible manufacturing practices, while also fostering a circular economy where materials are reused and repurposed, reducing the demand for raw materials and minimising waste and associated environmental impact.

  Investment in the research and development of innovative recycling technologies will enhance the efficiency of battery recycling processes. Existing technologies and processes for the extraction of valuable materials like lithium, cobalt and nickel from spent batteries should be explored further to enable the reintegration of recovered materials into the manufacturing process. Such a process would reduce the reliance on raw mineral mining, lowering the environmental footprint of battery production.

  It is also suggested that the Committee consider the exploration of battery reuse and repurposing. This is particularly relevant for high performance mobile mining applications. High volumes of cells are required to electrify mobile mining fleets, with the potential to reuse the cells/modules/packs for static storage applications at the same mine site. It should be noted that reuse of LIBs poses potential safety hazards, and appropriate testing and prove out of such a platform, should be carried out first to ensure safe implementation of reuse cells. Due to the safety risks associated with repurposing of LIBs at end of life, it is not recommended that this practice be implemented for other applications such as EVs unless the process is highly regulated with significant testing completed to ensure safety. A more appropriate and lower risk destination for these cells is complete recycling and refining to battery grade chemical precursors for reinsertion into the supply chain.

  We also highlight that collaboration between government, industry stakeholders and research institutions will be essential for the successful implementation of recycling and reuse initiatives. By fostering partnerships, and incentivising investment in battery recycling and reuse infrastructure, Australia can position itself as a leader in sustainable battery management practices.

- **Australian Battery Industrialisation Centre**

  The University supports the creation of an Australian Battery Industrialisation Centre (ABIC) in Queensland to accelerate and scale domestic battery manufacturing. Led by the Queensland Government, in partnership with the Australian Government Department of Industry, Science and Resources (DISR), as well as a consortium of Queensland universities, ABIC will provide a national hub for manufacturing, innovation, collaboration, training and skills development, battery research and development, and commercialisation activities. The ABIC would support and enable battery industry growth with the local manufacturing of battery components, cells and systems. Bringing together training organisations, industry, government and research organisations, the ABIC will leverage and scale existing capabilities and investments across the battery value chain. Expanded and larger scale battery testing capabilities are urgently needed to enable Australia to access the economic value currently available through the global clean energy transition. ABIC is critical to ensuring Australia can capture this value through onshore manufacturing technologies that are critical to our national energy security and achieve our net zero targets.

- **Chassis Electrification Innovation Hub**

  We support the creation of a Chassis Electrification Innovation Hub that would be focused on chassis electrification for 4WDs, utilities, caravans, trucks and trailers. Ideally, the Hub would be supported by a vehicle testing facility that could rigorously test electric chassis vehicles such as towed vehicles, while also having recreational vehicle (RV) applications.

6. Impact of Australia's limited EV supply compared to peer countries, and any other relevant matters

The University recognises the pivotal role of higher education in shaping a skilled workforce for the future EV industry. We are actively engaged in aligning curriculum with the evolving needs of various renewable energy industries, which are increasingly reflected in our undergraduate, postgraduate and professional education curricula. As such, it is necessary for an increase in support for both vocational education and training (VET) and university education that is relevant to the EV and battery manufacturing industries.

We use this submission to highlight that the domestic battery manufacturing industries will not grow, nor become globally competitive, unless there is a substantial increase in the available workforce and research base. Such an increase is only achievable through the adoption of strategies that address the upskilling needs of both researchers and workers who are engaged in the battery industry. As this suggests, it will be necessary to provide additional investment and support for the university sector, as well as relevant apprenticeship and trainee programs. A stronger connection, including pathways to and from, the VET sector will also be critical. These initiatives will be essential to ensure a sustainable pipeline of skilled talent. We recommend that existing programs, such as government incentives that support graduates into industries for both innovation and employment opportunities, could be tailored to support the development of the battery industry.

AT QUT, the Faculty of Science is offering industry-relevant projects for undergraduate and postgraduate students leveraging the nation-leading capabilities and facilities present at the ABF. Further, the Faculty is undertaking a redesign of the Bachelor of Science, as well as developing microcredentials and graduate certificates, to ensure that course content provides students and graduates with links to industry and renewable energy practices.

We also offer a Bachelor of Engineering (Electrical and Renewable Power), which equips graduates with the skills and knowledge that will be crucial to national efforts in reaching net zero emissions and achieving seamless integration of future renewable power generation. As we move towards a renewable energy future, QUT recognises the indispensable role of education

and training in fostering the capabilities necessary for a transition to a sustainable energy landscape in Australia, including sovereign capabilities and skills within the battery industry.

Further engagement
Our response has been informed by input provided by the QUT Advanced Battery Facility, Faculty of Science, Faculty of Engineering and other senior leaders from across QUT. We welcome the opportunity to provide more detailed input into the feedback we have provided, or guidance surrounding the terms of reference, should that be of interest to the Committee. For additional information in relation to this response, please contact:

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