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25 November 2022

Senate Standing Committees on Economics
PO Box 6100
Parliament House
Canberra ACT 2600

Dear Sir/Madam

Engineers Australia is the peak body for the engineering profession in Australia. We are a professional association with over 115,000 individual members, constituted by Royal Charter to advance the science and practice of engineering for the benefit of the community. Our members represent every discipline of engineering and work across all sectors of the economy impacting the lives of Australians every day.

We are pleased to have the opportunity to make a submission on the National Energy Transition Authority Bill. The energy transition is critical for the prosperity and well-being of all Australians. Engineers Australia supports the creation of a National Energy Transition Authority (NETA). The Bill identifies a policy gap in planning and coordination to help drive the energy transition. However, it needs a broader and stronger remit to ensure we can get the focus and guidance to complete the transition to clean, reliable and affordable energy in a timely fashion.

Whereas California and Germany were once the jurisdictions to watch, the world is now – quite literally – closely watching Australia's rapidly transforming energy sector. In this context, this paper addresses the following:

- Recommended Terms of Reference
- Australia's unparalleled scale and pace of change
- The need for consumer needs and aspirations to be central
- Navigating the massive complexity of energy system transition
- New national capacity for developing whole-system solutions
- The critical role of independent technical advice
- Reliability and security
- Engineering skills supply and demand
- Final Thoughts

An inadequate NETA remit may contribute to a slower and more problematic transition, unrealised creation of new, highly skilled jobs and export opportunities, and the squandering of many hundreds of $-billions of economic value.[1] However, an effective NETA will be a key enabler for Australia in pursuing the significant opportunities associated with the energy transition.

[1] A growing number of credible Australian and international sources are quantifying the massive scale of economic value at risk where systems-based or 'whole-system' approaches to the integration of renewable

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Recommendations

Engineers Australia recommends that the National Energy Transition Authority Terms of Reference (TOR) and scope should include the following:

- drive 'whole-system' approaches to both the envisioned final energy system, and to the various stages along the way
- create the context for multi-stakeholder participation in envisioning and planning the energy systems that 21st-century Australia needs
- assess the merits of technologies on their evidence base and focus on clean, reliable, secure and affordable energy
- identify the key elements of the post transition systems and assess their benefits, costs, and risks
- monitor and advise on energy and electric power security, reliability, and stability against Australian and International benchmarks
- require an account of system efficiency, circular resource usage, total environmental impact and whole of life 'net energy' contribution (all including resource recovery or disposal), supply chains and sovereign capability
- perform workforce modelling and planning, including assisting communities transitioning towards low-carbon industries
- monitor, advise and report on consumer protections and community benefits
- work closely with other national energy bodies.

Australia's unparalleled scale and pace of change

Australia is undergoing a once-in-a-century energy transformation. For example, given the key role of electrification in meeting Australia's Net Zero ambitions, it is noteworthy that AEMO's 2022 Integrated Systems Plan recognises the 'Step Change' scenario of 2050 as highly plausible. This anticipates an unprecedented scale of change to the NEM between 2022 and 2050, including:

- **9x utility-scale VRE:** A nine-fold increase in utility-scale variable renewable energy (VRE) capacity
- **5x rooftop solar PV:** A near five-fold increase in Australia's already world-leading levels of distributed solar photovoltaics (DPV)
- **3x dispatchable firming capacity:** Treble the firming capacity, including utility-scale batteries, hydro storage, gas-fired generation, and smart behind-the-meter "virtual power plants" (VPPs)
- **99% vehicle electrification:** Massive levels of transition of electric vehicles (EVs)

energy are not applied. Several examples are provided below: https://www.iea-isgan.org/wp-content/uploads/2020/05/ISGAN_DiscussionPaper_Annex6_microVsMEGA_2020.pdf (pages 73-74)
https://smarten.eu/wp-content/uploads/2022/09/SmartEN-DSF-benefits-2030-Report_DIGITAL.pdf
https://arena.gov.au/knowledge-bank/valuing-load-flexibility-in-the-nem/
https://www.datocms-assets.com/32572/1629948077-baringaesbpublishable-reportconsolidatedfinal-reportv5-0.pdf

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- **2x electricity delivery:** Almost double the electricity delivered to approximately 320 terawatt hours (TWh) per year
- **zero coal-fired Generation:** Coal-fired generation is already being withdrawn faster than announced, with 60 - 70% by 2030 and the entire fleet retired by 2043.
- **additional 10,000km of Transmission:** More than 10,000 km of new transmission to connect geographically and technologically diverse, low-cost generation and firming
- **significant investment in the human and social capital** to manage the complex and growing supply chain risks inherent for investments of this scale that face prior competing claims on plant, skills and resources.

As this critical societal system experiences deep decarbonisation through the withdrawal of dispatchable coal-fired generation, entirely new sources of system flexibility will be required to maintain an instantaneous balance of supply and demand every microsecond of the year. This will require an entirely new level of sector coupling with other parts of Australia's energy system.

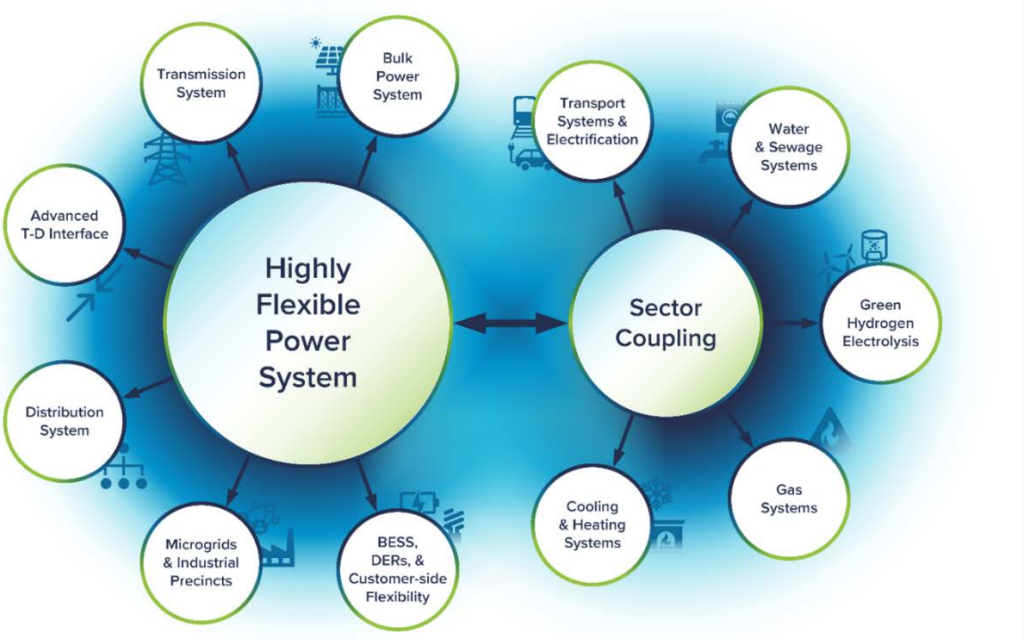

Figure 1: Decarbonised power systems requires new sources of flexibility and deep sector-coupling[2]

We know the government understands these numbers, but we repeat them here to emphasise the enormity of the task at hand, and the governance required at the Federal level to achieve the collaboration between industry, regulators, governments and communities at the pace needed.

[2] Image: International Renewable Energy Agency (IRENA) and Strategen Consulting

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The need for consumer needs and aspirations to be central

To remain viable, the energy system must primarily exist for the well-being of Australians and to support our lifestyles and businesses. Access to affordable, reliable, sustainable and modern energy is a human right. In the last century, energy consumers were largely treated as passive recipients of a limited range of utility offerings. This century, consumers in every sector are empowered with an expanding range of traditional and disruptive options and the energy sector is increasingly impacted by these very same disruptive trends. In the context of the current energy crisis, driven by geopolitical events and high coal and gas prices, it is increasingly difficult for many residential and business customers to see the system as working for their benefit. If Australia's energy systems are to rapidly decarbonise while remaining economically viable and enhancing equity, it is critical that 21st-century models for ensuring the needs and aspirations of diverse customers are placed at the very centre of decision-making processes.

The Authority could play a critical role in strengthening the participation of diverse customer representatives and other stakeholders in envisioning and planning Australia's future energy systems. This should include the far more active inclusion of low-carbon 'demand-side' technologies and digital platforms that empower customers to help enhance energy system outcomes and share in the value created.

The energy transition is an opportunity to correct some imbalances and create accountability. The Authority should be able to monitor and make recommendations on the laws and regulations to manage the access, cost and supply of energy for the benefit of the community. The Authority should also have the power to review and advise on whether network investments are effective and value for money, as well as limiting the ability of businesses to operate 'natural' monopolies. Measures should be monitored and reviewed at every stage of the energy transition to ensure it is delivering clean, reliable and affordable energy. The Authority should provide regular reporting on whether the system is providing value for money for consumers. The Authority should include consumer representation.

Navigating the massive complexity of energy system transition

The continental-scale energy systems created in the 20th century were already some of the most complex systems ever created by humanity. Deep decarbonisation, with its dependence on an expanding range of highly variable renewable energy resources, is now driving the most profound expansion of energy system complexity ever seen.

Collaboratively navigating this complexity requires appropriate 'system of systems' level governance structures. Importantly, because 'cyber-physical-economic' systems are critical to a developed economy, they are irreducibly 'physics-based'. Governance models must therefore ensure that a balanced range of discipline perspectives are heard in the transformation of these systems. While market and economic perspectives are critical, it is imperative that these are balanced with the voice of the engineering profession, which deeply understands the cyber-physical realities of these highly complex systems.

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New national capacity for developing whole-system solutions

Critical national infrastructures such as our energy system may typically be thought of as a 'system of systems' – and energy systems certainly fall into this category. For example, not only do electricity systems require increasing couplings with other sectors (as above), internally, they are also a network of seven major structures, each of which impacts the operation of the others. As highlighted in Figure 2 below, the power system is a network of physical and digital infrastructures, regulatory structures, markets and operations – changing any one of these will positively or negatively influence the function of the others. A NETA should contribute to developing a deeper understanding of energy system interconnectedness to help manage cascading risk, especially of critical infrastructure.

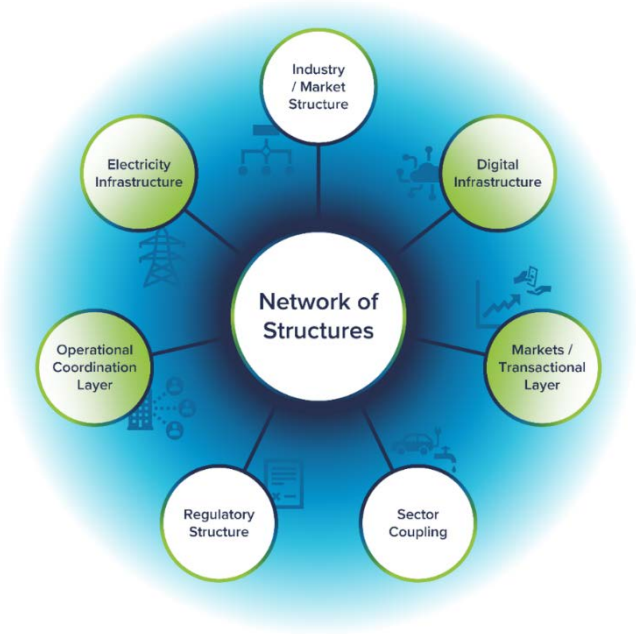

Figure 2: Modern power systems are an ultra-complex 'Network of Structures'[3]

With the growth of VRE and customer owned DPV, these ultra-complex systems must now evolve in ways not seen since the dawn of electrification. This evolution must, therefore, be holistically coordinated in a manner consistent with its status as an integrated engineered system. From the perspective of many engineers, however, the current governance and change mechanisms of these systems often have a vastly inadequate understanding of how complex systems work. This often results in an unduly 'reductionistic' focus on individual parts at the expense of more integrated 'whole-system' approaches critical to unlocking massive economic value (refer footnote 1).

The integration of electric vehicles (EVs) and the electricity system at national, state and local levels provides one of many examples. Subject to whether a holistic balance of well-targeted policies, regulations, economic incentives and technologies are in place, EVs will either further accelerate

[3] Image: Pacific Northwest National Laboratory (PNNL) and Strategen Consulting

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Australia's power system risks, costs and prices or, alternatively, help improve system resilience, stabilise costs and prices and enhance the deep integration of renewable generation. Achieving the latter positive outcome will not just happen. It will require new national capacity for developing far more sophisticated whole-system solutions than were required in the past.

This requires Australia to develop valuable new 21st-century skills that bring together multi-stakeholder collaboration, systems architecture tools and multi-disciplinary design.[4] Importantly, in an increasingly complex future, such capabilities and skills will have wide transferability across all societal sectors and industries and will be key to Australia's long-term economic performance.

In summary, it is easy to underappreciate the 'physics-based' complexity of energy systems and therefore apply an entirely inadequate theory of change that is simply incapable of enabling the level and pace of change required. The Authority can play a role in providing guidance and independent technical advice to inform the changes.

Finally, the call for an enhanced systems approach does not suggest that no planning is taking place. On the contrary, many actors in the energy sector are developing and executing detailed plans for their specific parts of the system. For example, AEMO's Engineering Framework and Integrated Systems Plan initiatives provide excellent examples of such work. However, what is missing at this time of profound change are the collaborative platforms needed to empower the comprehensive involvement of diverse customer and stakeholder representatives in envisioning and planning Australia's future energy systems from a whole-system perspective. Together with advocacy for building new national capacities and skills, creating such a collaborative platform is a key role the Authority should play.

The critical role of independent technical advice

The role of market economics is currently very apparent in the governance structures of Australia's energy systems. By contrast, however, a focus on holistic, independent technical advice is lacking in decision-making and forward planning. Given the expanding physics-based complexity of decarbonised energy systems, highly competent engineering is even more critical for system and market design, safe operation and technological innovation. The current governance arrangements are a separation of functionally differentiated roles that risks accentuating compartmentalised problem solving when far more holistic and multi-disciplinary solutions informed by independent engineering advice are required. The Authority will require access to the best independent technical advice and a greater emphasis on engineering advice in government policy.

Independence from political or ideological bias in all aspects of the Authority's TOR, scope and work is of fundamental importance. This role should include some level of assessment of the 'if not, then what

[4] For example, Australia's contribution to the Global Power System Transformation (G-PST) led by CSIRO and AEMO highlights the critical role of developing a holistic transformation roadmap with systems architecture disciplines as foundational to the nation's power system transformation: https://www.csiro.au/-/media/EF/Files/GPST-Roadmap/Executive-Report-for-CSIRO-GPST-Research-RoadmapCSIRO-TemplateV32-1.pdf (refer Section 3.2).

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else' scenarios, which presents the diversity of experience and understanding within the sector. Government at all levels would seek advice from the Authority before making decisions. Incorporating such a perspective into the decision-making process would ensure that decisions are based on thorough assessments of long-term needs and cost/benefit analysis.

Any model for an independent authority would need to have a governance and operating framework that recognises that minister(s) and Cabinet are accountable for policy decisions, setting financing parameters, and entering agreements with state governments.

The specific responsibilities of a technical authority could include the following:

- systematic engineering advice and insight at critical decision-making junctures
- advice on engineering capability development
- definition of technical and performance standards or deviation
- interpretation of good engineering practice
- review and audit
- risk assessments
- ensuring conformity with legislation and standards.

An independent technical authority could work with other organisations in the system to proactively investigate systems and technology to manage, operate and regulate future energy systems.

Reliability and security

In the 2022 Electricity Statement of Opportunities (ESOO) report, AEMO forecasts electricity reliability concerns that require an urgent response in most regions of the National Electricity Market (NEM) in the next ten years. The ESOO models the instances when electricity supply is insufficient to meet demand. Without further investments, coal and gas plant closures along with insufficient new generation, will reduce supply and challenge the achievement of reliability standards.

The Authority could advise on the actions needed to maintain the reliability of supply while still delivering net zero emissions at the lowest cost. The energy transition is a chance to create a clear line of responsibility for the reliability of energy supply vested in the states and territories, but with the Authority providing regulatory and technical advice and regular monitoring and reporting.

Engineering skills supply and demand

Engineers Australia supports the focus on workforce modelling and planning, and the support for communities and workers affected by fossil fuel closures.

In addition, Australia is currently experiencing a shortage of engineering skills, with an expectation these shortages will become acute and persistent. The dynamics of Australia's supply of engineers are complex. Driving demand is ongoing investment in public infrastructure, a resurgent demand for minerals, and the global transition to clean energy and adaption to climate change. Maintaining an adequate supply of engineers will require modelling, planning and a long-term commitment by

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industry, the tertiary sector and government. For further analysis and recommendations, see *Strengthening the engineering workforce in Australia* here.

Circular economy, built energy and embodied carbon

On the path to a circular economy, improving the understanding of embodied energy and carbon in the context of the energy transition, should be a critical element of the Authority's analysis and evaluation processes.

Final Thoughts

The Australian energy market governance structure was designed to deliver reliable, secure, and affordable energy from large synchronous generators. The system's ability to deliver reliable, secure and affordable energy, while at the same time moving to a Net Zero future with the transition to highly variable VRE and DPV generation, is a very different proposition. It requires a governance structure that focuses and coordinates efforts in technical, regulatory and investment policy, looking forward to how the sector will operate in 2050. Roles and responsibilities are evolving to fit this 'whole-of-system' perspective, but we need transformational, not incremental, change, which means we need to consider a national energy transition authority.

Given the complexity of the energy transition, it is likely to be somewhat unpredictable at times. Focussed governance and leadership that brings everyone together to achieve clean, reliable, secure and affordable energy with customer choice at its heart is essential.

Please do not hesitate to contact us if you would like clarification or to discuss anything further. You can contact us at [redacted].

Yours Sincerely

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