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1414 Degrees (14D) Response to the Energy Security Board's (ESB) Post 2025 Market Design Issues Paper

14D appreciates the opportunity to respond to the COAG Energy Council's (The Council) Issues Paper on the Post 2025 Market Design. 14D is pleased The Council has directed The ESB to consult widely on the Design and that this process has commenced well ahead of time.

14D will focus its responses in line with The National Electricity Objective (NEO) as stated in the National Electricity Law (NEL). The NEO is "to promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity with respect to:

- price, quality, safety and reliability and security of supply of electricity, and
- the reliability, safety and security of the national electricity system."

At this point in 2019, the ESB is commencing with its consultation and design work on a new market framework for the National Electricity Market (The NEM). Other Australian electricity markets may or may not be informed by this work but many of their challenges would be similar.

It is 14D's view that in order to deliver the NEO to customers, the energy supply systems of the future will need a more flexible regulatory framework that enables energy to be regulated and managed so that customers have the flexibility to optimise their energy needs and move to cleaner energy at lowest cost.

The stored energy in thermal energy storage (TES) systems can be used both directly as heat and also to drive a turbine like those used in fossil fuel power generation to provide base load supply. 14D has developed and patented its silicon based Thermal Energy Storage System (TESS), a versatile technology to firm renewable energy sources at industrial and grid scale, supplying heat and electricity with spinning inertia.

Multi-purpose technologies like TESS can be used:

- to supply heat;
- to supply dispatchable electricity;
- in centralised energy systems to deliver storage and the full range of ancillary services; and
- as Distributed Energy Resources (DER) across the distribution networks.

TES systems will therefore have huge impact on future electricity markets as they displace fossil fuels, effectively electrifying heat supply.

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Background

The Federal Government's major policy instrument over the past two decades for transitioning the Australian Electricity Market to a lower emissions Market has been the Renewable Energy Target (The RET). Introduced in 2001 by the then Howard Coalition Government, The RET has been reviewed, re-configured and increased by successive Governments. The rationale behind The RET has been an admirable one, to bring into the market, the next lowest cost, no emissions generation technology. It is a matter of history now that in 2019, most of the energy technology projects supported by The RET have been from intermittent or variable resources because they were lowest cost generation technologies at the time of development. This outcome contributed to other challenges in Australia's Electricity Markets because the focus of The RET was on the cost of energy rather than on value to the system. The RET has been the primary driver of investment in Australian electricity generation capacity over this time.

Many of the current challenges for the Australian electricity market are to solve the impacts of variability to ensure reliability of output and security of the system.
This variability has:

- reduced the reliability of supply;
- weakened system robustness and strength;
- Driven a shift in the economics and trading patterns where the daytime peak has effectively been removed by rooftop solar generation; and
- Resulted in an increase in the frequency of oversupply (and therefore negative pricing) across some periods and states.

These significant developments require many and varied solutions.

14D notes that at this stage of the NEM's development a number of early projects across the NEM (and broader Australian markets) are being considered, developed or trialled to resolve the physical matters of variability and security, including:

- Storage technologies including TES, batteries and pumped hydro energy storage (PHES);
- Non variable generation technologies being concentrated solar thermal (CST), newer generation bioenergy and potentially hydrogen;
- Distributed Energy Resources (DER);
- Virtual Power Plants;
- Demand Response to reduce usage at times of high demand;
- A range of energy efficiency applications which also reduce demand when it is high; and
- A range of technologies to provide other system benefits not provided by variable renewable generation technologies such as ancillary services.

It is 14D's view that:

- a new fit for purpose market framework governing the complexities of technologies and services of a post 2025 NEM will need to incentivise innovative projects and new ways of using energy that ensure a reliable and secure supply of electricity in accordance with the value they deliver into that market for customers; and

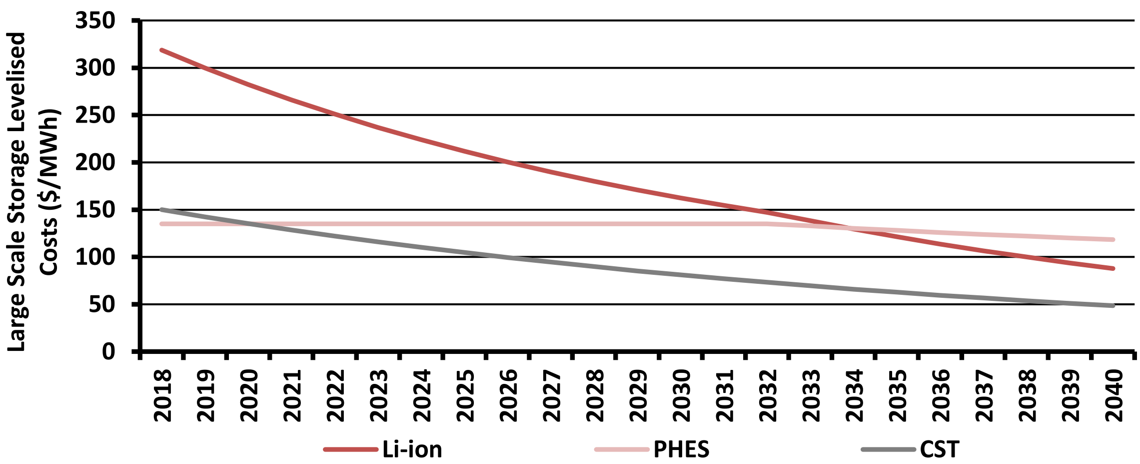
- smarter systems which increase productivity across the economy rather than simply compensate energy users for not using energy at times of high use when variable generation technologies cannot meet demand should be the focus of the ESB's deliberations.

The Role of Storage in Ensuring Reliability/Firming

The supply of electricity to customers requires that energy is available to them when they need it. With the increased level of variable supply, supply becomes less certain at periods of high demand and the system requires technologies that can store energy and release it to produce electricity as customers need it. As mentioned above TES, batteries and PHES are the technologies currently in the national focus likely to provide these storage capabilities and they can be customised to deliver these services from utility to bespoke scale across the transmission and distribution networks of the NEM.

It is 14D's view that action needs to be taken sooner rather than later to bring more storage projects into the market to meet reliability requirements that do not compromise the future optimisation of the operation of the market. For example, while the cost of grid scale batteries is coming down at this time, they are not predicted to be lower cost than thermal storage technologies or PHES into the period that the ESB is currently considering. In fact, from around this time (2019/20), some studies have predicted that PHES is already cheaper than batteries for large scale storage and further, that heat storage technologies are likely to overtake PHES by the middle of the coming decade.

– Large Scale Levelised Storage Cost per kWh installed



Source: Energeia Analysis

The figure above was produced by Sydney/San Francisco based energy modelling firm, Energeia for an ARENA funded *Australian Concentrating Solar Thermal Industry Roadmap*.

The figure shows the comparative cost of storage for batteries, PHES and Concentrating Solar Thermal Energy (CST) per kWh installed. The CST storage comparison is useful to this submission as a proxy for all TES, because CST uses a range of heat storage technologies so that it can be released later to produce electricity. At the present time, various heat storage technologies are being trialled around the world for efficiency and cost in order to improve the value that CST systems provide into electricity systems. It is, of course, very difficult to assess heat storage technologies in comparison with electricity only solutions, because the heat is used not just to regenerate electricity but to displace other heat energy sources such as gas or diesel. 14Ds TESS system has the advantage of storing the heat at a very high temperature enabling higher electricity generating efficiencies and a broad range of thermal applications.

As mentioned above, the storage technologies currently used in CST systems are continually being developed and improved through R&D and deployment activities across a number of countries including the USA, Spain, China Morocco and parts of South America. Even at the current improvement rate however, it is reasonable for 14D to assert that the widespread deployment of its TESS technology into CST systems will produce a step change in the thermal storage component of these systems. Moreover, whether deployed as a standalone storage technology within an electricity grid or as the storage component in a CST system, it will continue to improve in cost competitiveness. It is therefore not unreasonable to assert that it will be a significantly lower cost technology by the time of the post 2025 Market currently being considered by the ESB.

Further, batteries have an end of life disposal cost that is not currently the focus of a market seeking to improve reliability and this problem will become increasingly problematic over the next few years as early projects come to the end of life. However, while batteries are not optimal for large scale grid storage, 14D believes that batteries have an important role to play in meeting system security needs by providing Fast Frequency Response (FFR) services due to the impact of variable projects on the stability of the system.

Any omission of a reliability mechanism that will incentivise the development of storage projects into the NEM will thus run the risk of producing sub-optimal outcomes that threaten the attainment of a secure and reliable, low emission energy supply system at lowest cost.

14D's Storage Technology

14D's vision is to provide affordable energy for all, at all times. Our unique, scalable large-scale TESS technology is designed for networks and industries to address renewable intermittency, grid stability and emissions reduction. The combined heat and power (CHP) solutions of TESS also fill a critical gap in energy storage.

14D's technology will make energy more reliable, affordable and environmentally friendly by harnessing silicon to provide very high temperature storage and regeneration.

Silicon's high energy density means it can hold much more energy as latent heat than other phase change materials. It therefore delivers maximum energy efficiency, is abundant and environmentally benign.

The TESS stores energy generated from electricity or gas and supplies both heat and electricity in the proportions required by consumers. It is therefore unique in its combination of flexibility of location, scalability, and sustainability.

The energy from the latent heat is recovered as very hot air that powers a turbine to produce heat and electricity when required. It transforms intermittent renewable electricity by providing reliability and stability identical to that of a coal or gas fired power station.

The TESS technology is designed to be worked hard and frequently without losing efficiency and capacity. The result is low cost and clean storage of energy providing a stable supply of heat for industry and electricity to the grid.

Industry accounts for about 40 per cent of all energy used in Australia and the majority of these significant energy users use more heat than electricity. 14D's technology can supply large amounts of heat at very high temperatures. While not the subject of the review of the NEM framework, 14D believes that the ESB should consider the holistic energy requirements of the market when considering solutions to Australia's energy challenges and future market design. Failure to include the effect of electrifying the much larger heat energy market will cause substantial future market disruption. It is notable that the UK has recently proposed that fossil fuel heating (mainly gas) be discontinued, while high gas prices in Australia are creating instability for industry and jobs.

Currently, non-electricity solutions like gas or coal are still cheaper than electricity solutions, so the considerations of the future operation of the NEM should make provision to compensate technologies like TES that provide longer term dispatchability ("base load power") during periods of high usage rather than simply turning off supply to some customers. Innovative low or no carbon solutions offer huge potential to take pressure off the NEM, and other electricity markets. Therefore, incentives for innovation, early demonstrations and ongoing deployment should be considered by The Council.

The Need for Incentives

It is 14D's view that a well-designed market framework with only the minimal incentives necessary to guarantee a secure supply of reliable power will ensure the lowest cost way forward for meeting the NEO and therefore customer energy needs at lowest cost.

In 2016, *The Independent Review into the Future Security of the National Electricity Market* was commissioned by The Council to develop a blueprint for coordinated national reform of the NEM. The Review, chaired by Professor Alan Finkel, focused on this issue in large part due to the increasing levels of variable supply generation coming into some geographical locations across the NEM, particularly in South Australia. The Review made recommendations to address the impact of variability on system security and the reliability of supply. The fundamental thrust of the Finkel Review was accepted by The Council and all but one of its recommendations were adopted. The high-profile recommendation not adopted by The Council was the Clean Energy Target.

It is 14D's view that while Australia does not currently face a shortfall in electricity supply, it does face a shortfall in the reliability of supply at this time. This shortfall will continue through to the post 2025 period, and greatly increase as heat energy is electrified, without a coordinated market framework that enables and incentivises the range of characteristics required by a secure and reliable market.

This current shortfall in the reliability of supply has been consistently raised by the Australian Energy Market Operator (AEMO) in its forecasts over recent years, particularly over the Australian summer period. A further shortfall of supply will occur as fossil fuelled assets retire from the market over the next two decades due to their age and their inability to contribute to future climate change targets. This will have further consequences for the reliability and security.

14D believes that a framework which provides more flexibility for customers to meet their energy needs will assist in alleviating the impact of the retirement of these large energy providers. It notes that thermal storage technologies have the multiple capability to provide power and the full range of ancillary services, like retiring coal assets and they also have the capability to provide customised storage and heat solutions.

Market Framework

Following on from the recommendation in the Finkel Review, and other recent review processes undertaken by government bodies and industry, 14D has given consideration to the following approach, in line with the current NEM structure. A future NEM framework will need to enable and incentivise the development of projects that meet all the requirements of a reliable, secure supply of electricity. It should be able to offer the different services that the NEM system needs as a whole within the one framework. In 14D's view, this should include the use of TES where heat is the lowest cost solution at times when it supports or enables dispatchability.

14D proposes that the following functions would meet the requirements of a market-based trading system for electricity and would produce a lowest cost outcome for consumers with the added benefits of providing clear and adequate markets for reliability and system security benefits:

1. ***A wholesale supply market for electricity;***
2. ***A day ahead reliability market to effectively incentivise the development of storage/dispatchability technology projects (whether integrated into generation projects or standalone) with reference to the requirements of geographical locations, particularly as fossil fuelled assets retire;***
3. ***Increase the value provided by the ancillary services market so that it adequately rewards the value provided by those services;***
4. ***A short-term market (typically 5 minutes for shortfalls);***
5. ***Rewarding the use of heat for thermal applications where this reduces demand on the electricity system; and***
6. ***Stronger direction and a more stringent regulatory regime for network providers to support storage projects and projects that provide ancillary services to the system along the main spines and in the outer regions of the grid. This would avoid over investment in poles and wires throughout a period when large fossil fuelled assets are coming out of the***

system and it would foster innovation where this innovation is needed most and would ultimately deliver lower prices to customers.

Invited Comments

Stakeholders are invited to make submissions on the issues raised in this consultation paper. In particular, the ESB invites stakeholders to provide comments on:

1. What scenarios and shocks should be used? How should these be used to test market design?
2. How can market and economic modelling best be used to evaluate individual components of market design or the end-to-end market design?
3. Is the assessment framework appropriate to evaluate the effectiveness of future market designs? What else should be considered for inclusion in the assessment framework?
4. Have we identified all of the potential challenges and risks to the current market? If not, what would you add?
5. Which of these challenges and risks will be most material when considering future market designs and why?
6. Which (if any) overseas electricity markets offer useful examples of how to, or how not to, respond to the challenges outlined in this paper?

What scenarios and shocks should be used? How should these be used to test market design?

Of the five 2019-20 AEMO ISP Scenarios, Slow Change, Central Scenario, High DER, Fast Change and Step Change, 14D believes that the Slow Change and Central Scenarios are least likely given the already rapid changes seen in the world's rapidly changing electricity markets. This reality of the transition is acknowledged by The Council on page 14 of its Paper. These changes driving the other three scenarios are unlikely to go away or slow down. Many of these drivers such as the increasingly dire predictions of the climate impacts and of 'old fuel' usage, the rapid advances in technology and system operations and the increased desire for energy autonomy by consumers are here to stay and will affect all energy markets of the future.

14D sees the following shocks as requiring investigation and risk evaluation:

- Ongoing and rapid technology advances resulting in the development of rapidly out of date technologies and systems.
- Climate Change impacts.
- A more rapid exit of coal assets due to the cost of maintaining and refurbishing old assets and the potential impact from future climate change policies.
- Electrifying heat energy -the major impact of supplanting the heat energy currently supplied by gas, coal or diesel fuels
- Terror attacks, with potential mitigation from decentralised asset devolvement.
- The increasing desire for autonomy by customers.
- Unplanned outages from transmission/distribution failure due to ageing assets and the increasing ferocity of weather events.

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14D believes that in the process of testing the impact of market design on the framework scenarios consideration should be given to ensure that the cost impact is spread evenly across all parts of the NEM and that Australia's future commitments to climate change goals should be considered such that our exports are not penalised by future global climate change agreements to which Australia has not equally committed.

Further, as previously raised in this submission, the ESB should consider where and how thermal energy can assist in meeting the NEO in order to mitigate risks.

How can market and economic modelling best be used to evaluate individual components of market design or the end-to-end market design?
Market modelling is rarely proven to be 100% correct over time but it does offer the best available tool to policy makers in circumstances such as that which the ESB is currently involved. In order to base any element of the design of the future framework of the NEM on the results, the ESB will need to satisfy itself through an exercise that incorporates a range of scenarios. One of the major problems with this approach is that it is especially difficult to model the impact of technology step changes or of new technology impacts and the energy space globally is a very dynamic one that is bring new discoveries and innovations into the marketplace constantly.

Is the assessment framework appropriate to evaluate the effectiveness of future market designs? What else should be considered for inclusion in the assessment framework?
The ESB has proposed the following potential principles to underpin the assessment framework:

A. Efficiency – productive, allocative and dynamic as well as capital efficiency in order to be able to demonstrate least-cost outcomes are delivered by the market design
B. Practicality of implementation
C. Effective entry and exit of generating capacity
D. Costs are allocated to those best placed to respond to them
E. Risks are allocated to those best placed to manage them
F. Transparency and simplicity
G. Consumer empowerment
H. Resilience to external shocks such as critical asset failure, climate and technology change
I. Robust to possible future government policy changes
J. Technology neutrality
K. Competitive neutrality
L. Supportive of innovation

14D supports the potential principles and makes the following the comments:

1. In regard to A (above) least cost outcomes for single projects may not always represent best value for the system when the project delivers a service that results in other impacts that need to be addressed with further investments. For example, an over build of variable generation projects within a region could require additional investments to provide for reliability and security services when other options that may have been more costly than the original generation investment would provide a lower cost outcome overall and could

deliver a more robust system. The market design needs to allow for these system impacts that go further than just the cost of single projects.

2. In regard to L (above), innovation in the NEM is largely supported by grants from government bodies for trials. 14D believes that the framework itself could enable and incentivise innovation in a similar way to the way in which margin loss factors are treated.

Further, as previously raised in this submission, The ESB should consider where and how the contribution that thermal energy can make to assist in meeting the NEO in order to mitigate risks can be included in the assessment framework.

Have we identified all of the potential challenges and risks to the current market? If not, what would you add?

14D's main concern about the challenges and risks is that the future framework needs to be flexible enough to enable technological and systems innovations to enter the NEM. This allowance needs to be made even if they don't produce the immediately lowest cost impact but if they can demonstrate that they will lead to greater value across the system and that they will lead to lower cost impacts over a reasonable timeframe. 14D sees a great risk of locking out innovations and the potential for step changes in innovations and therefore cost reductions for customers with the overbuild of sub optimal solutions.

Which of these challenges and risks will be most material when considering future market designs and why?

As above.

Which (if any) overseas electricity markets offer useful examples of how to, or how not to, respond to the challenges outlined in this paper?

14D does not have a comment on the usefulness of how other countries have responded to the challenges outlines in The Council's Issues Paper except to suggest that the UK's recent proposal to ban the use of fossil fuels for heating and subsequent initiatives should be examined by the ESB as part of its considerations of the post 2025 framework.

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Summary

Once again, 14D thanks The Council and the ESB for the opportunity to comment on this very important paper. As outlined in page six of this submission, 14D proposes that it is possible to develop a framework for the NEM that delivers all the services required by a secure and reliable electricity supply system at lowest cost and that this framework would also be relevant for other Australian non-NEM markets.

In 14D's view, this should include the use of TES where heat is the lowest cost solution at times when it supports or enables dispatchability.

14D acknowledges the significant transition of the technologies and services that now comprise the NEM and indeed, its own technology is an example and it acknowledges the complexity of the task ahead of The Council and the ESB.

If the ESB has any questions or requires any further information about 14D's technology and Projects I would be more than happy to assist.

Yours sincerely

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