AUSTELA

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ASTRI
Australian Solar Thermal Research Institute

AUSTELA and ASTRI response to the NSW Government Review of Long-Duration Storage.

(Part 6 of the Electricity Infrastructure Investment Act 2020)

AUSTELA and ASTRI, June 2024

Executive Summary

The Australian Solar Thermal Energy Association (AUSTELA) and the Australian Solar Thermal Research Institute (ASTRI) welcome the opportunity to respond to the NSW Government's consultation on long-duration storage (LDS). The key focus of our response is on the need to ensure that the definition of long-duration storage remains at 8+ hours. Specifically, we believe that a change in the definition of long-duration storage to include 4-hour storage would have a detrimental impact on the cost and timing of NSW's achievement of its emission reduction targets.

AUSTELA and ASTRI believe that the impending demand in the NSW grid is for long-duration storage – 8-hours and above – which will be needed to replace the retired coal assets, of which three out of four are being withdrawn in the next decade. As variable renewable energy further penetrates the state grid, more storage of longer duration will be required, and while 4-hour batteries will play a role in this emerging system, there will be a requirement for 8, 12, 15, 24 and 48-hour storage which will not be ameliorated by changing the definition of LDS.

If the NSW Government was to change the definition of LDS to 4-hour, there is a strong risk that this will incentivise the short-duration technologies that don't need support, while investors will steer away from what is really needed: long-duration storage. LDS technologies, such as pumped-hydro and solar thermal, have long lead times and high capital costs, and they need government support and stable policy to attract investors. These solutions will be critical in Australia's future energy mix, and by not supporting them today the technologies will continue to be expensive and in short supply when they're needed most. **We therefore recommend that the definition of long-duration storage remains 8-hours +.**

Further, we recommend:

- **The legislation should not be changed to allow the minister to change the duration by regulation as this will have a negative effect on investor certainty for long duration systems.**
- **The objectives and details of future LDS tenders should be improved to:**
  - **provide clear signals of the value of a given duration vs a shorter one;**
  - **ensure that technologies such as Concentrating Solar Thermal, that combine generation and storage, are explicitly facilitated; and**
  - **make allowances for the longer construction times of the most cost-effective LDS solution.**
- **That an EOI, funded by ASTRI, and prepared in collaboration with AEMO Services, be conducted to demonstrate industry's capability to deliver a cost effective, utility scale Concentrated Solar Thermal solution into the NSW LDS market, within the next 5-years.**

Responses

The Department seeks feedback on four questions raised in its Review Consultation Paper.

Question 1: ***What is the appropriate minimum duration for long duration storage infrastructure in NSW for 2030? Please outline why.***

AUSTELA and ASTRI believe it is critical that the long-duration storage (LDS) definition remains at 8-hours+, with greater incentives to deploy 12- and 15-hour storage in the electricity system included in future tenders. We reflect on the fact that the CSIRO's 2022 *Renewable Energy Storage Roadmap*, defines 4–12-hour storage as 'medium' and 12–24-hour storage as 'long intraday'. In its Levelised Cost of Storage (LCOS) tables, CSIRO also refers to 8-hour storage as 'medium'.

The need for 8-hours+ storage in the NSW grid of 2030 is stipulated in the EII Act, the Roadmap and the AEMO Services report. This is due to 8-hour+ storage being the technology that is lacking as NSW anticipates three of its four coal-fired power stations being retired in the next decade, removing as much as 70% of the state's power generation. In the National Energy Market (of which NSW is a significant part) AEMO has identified storage of four to 12 hours' duration as "the most pressing utility-scale need in the next decade"[1].

The Check Up Report rightly concludes that it is unlikely pumped-hydro will cover all the shortfall occurring when coal-fired plants such as Eraring close. However, the report's solution – that the 8-hour+ definition be changed – does not resolve the problem: 8-hour+ storage is what will be lacking in 2030. The need for 8-hour+ storage becomes more relevant with the closure of Eraring, rather than less. It certainly doesn't enliven the need for 4-hour storage.

The arguments to maintain the LDS definition at 8 hours + storage (2GW/16GWh +) can be summarised as follows;

- as coal generation is reduced and retired from the system, the required duration of LDS will *increase* to 12 – 15 hours storage, or enough to cover the overnight electricity market, which is the market currently served by coal;
- increasing extreme days create peaks in demand that will require dispatchable power for conceivably longer than 4 hours;
- deployment of 2 and 4-hour battery storage is already sufficiently scaled, and this shallow storage end of the market does not need government support;
- LDS technologies – such as pumped-hydro energy storage (PHES) and concentrated solar thermal (CST) – have high capital costs but deliver critical value for NSW's long-term energy reliability and affordability, and they need support measures to induce private investment;
- maintaining an 8-hour+ benchmark in the Roadmap/EII Act makes it more likely that the LDS contracted is PHES or CST which not only gives 12-hours+ of storage, but generates power with a synchronous generator, delivering much-needed system strength into a grid dominated by volatility-inducing inverter-based resources (IBR).
- LDS of 15hrs+ will be a critical component of Australia's long-term energy mix and critical to phasing out fossil fuel supply, according to the CSIRO Renewable Energy Storage Roadmap for 2050 (they estimate 150GWh is needed).
- CSIRO's Renewable Energy Storage Roadmap refers to 4–12-hour storage as 'medium' and 12-24 hour as 'long intraday'. Given this definition, it is difficult to see how the EII Act can be changed to refer to 4-hour storage as 'long-duration';

[1] AEMO 2022, 'Integrated System Plan 2022'.

- the Check Up and the AEMO Services report both focus on the financial benefits of 4-hour versus 8-hour storage. The CSIRO Renewable Energy Storage Roadmap shows that the lowest cost technology for eight-hour storage in 2050 is thermal energy using concentrated solar thermal power, with a Levelised Cost of Storage (which combines power capital cost, energy capital cost, charging cost and OPEX) at slightly over A$100/MWh, compared with lithium-ion battery at A$140/MWh and pumped-hydro at around A$155/MWh.

As part of our response to Question 1, we also address several challenges in the AEMO Services Report analysis. In particular, the conclusion that 4-hour duration storage is sufficient to meet system requirements in the 2030 NSW grid relies on that storage being 100% charged prior to the event, which relies on perfect market signals and predictability. Longer-duration storage will be more likely to have sufficient energy to cover critical events, particularly as USE events become more frequent and longer. Further detail of our response to AEMO Services Report is outlined in Appendix 1.

Finally, reference should also be made to NSW's LTESA system which is designed to provide offtake certainty for developers and investors, and establish a market value for technologies that will be critical in the future but are not yet viable on their own, allowing long-term infrastructure to be built that might be avoided by private capital if not for the service agreement. The LTESA guarantee should prioritise renewable technologies that are unlikely to be viable on purely commercial terms and the target market for this is 8-hour + technologies, not 4-hour batteries which are already sufficiently scaled.

As concluding comments to Question 1:

- We believe the NSW government should maintain its definition of LDS being at least 8-hours+ of storage.
- We submit that the Department should be very careful that it doesn't change a definition so a policy can be fitted to a favored technology (i.e. Lithium ion). Globally, Lithium-ion storage is being optimally deployed for 2-4 hours. Lithium-ion storage is excellent for short to medium time periods, for time-shifting solar PV, and for fast-response FCAS tasks. However, it is not economically competitive above 4 hours, especially at MW scale, as suggested by CSIRO's Roadmap cost modelling.
- We believe that the focus of the government should be on the commercially marginal, not the uneconomic. To this end, long duration storage technologies such as PHES and CST are commercially marginal in terms of capital costs, but are valuable in high-value segments such as overnight and reliability events. In contrast, 8-hour battery storage is uncompetitive at a MW scale and will remain so into the future (it underperforms both CST and PHES in the CSIRO Roadmap). It is also important to note that the UK government is now excluding battery from its long-duration LDES program. It is therefore important that policies remain and are strengthened to establish a pipeline of projects and growing supply chains for the other technologies.

Question 2: ***Should the Minister have regulation making powers to change the minimum duration of long duration storage infrastructure over time? Please outline why or why not.***

No. We believe there is a critical need for long-term regulatory and policy certainty for investors and project developers. The ability for a Minister to alter these settings would have significant negative effects on capital inflows to NSW's renewables infrastructure program. There would likely be the perception that a high-cost project developed at considerable expense under one set of rules could be undercut by more mature, shorter duration technology, before it has been awarded a contract.

We believe:

- the minimum duration should be set out with long-term energy mix requirements in mind. If we know the mix of LDS required in the NSW grid post-2030, this should be signalled today to enable investment in that pathway;

- some of the LDS technologies – such as PHES and CST – take several years to design and construct, and the project owners and investors must be able to rely on the government's benchmarks;
- the current legislated target gives the industry certainty however it would be more subject to election cycles if the minister could make changes unilaterally.

Question 3: ***how can the infrastructure objectives and LDS tenders be improved to support a range of long duration storage projects? Are new measures required such as:***

- ***Requiring the Consumer Trustee to explicitly consider the benefits of duration in calculating financial value to customers.***
    - **AUSTELA/ASTRI response**: The inclusion of 'value' of LDS as opposed to the 'cost' of short-duration storage could be an effective tool for the Consumer Trustee in assessing the need for storage. This is potentially valuable, but the proposal must be sufficiently transparent to provide certainty to investors or project developers.
- ***Requiring the Consumer Trustee to discount the capacity of projects with duration less than 8 hours (if allowed) as though the duration is 8 hours when calculating financial value to consumers.***
    - **AUSTELA/ASTRI response:** Applying discounts to projects that are not LDS could be an effective tool in establishing financial value to customers. It might also be argued that the 8-hour+ projects – and rising to 12, 15 and 24-hour – need their own LDS program, while sub-8-hour perhaps require less incentives? The program design should ensure the right storage is built for the needs of the grid and its customers, rather than trying to shoe-horn short-duration storage into an LDS system. The NSW LDS system of the 2030s will be replacing coal, it will not be competing with 4-hour battery. The 12hr+ technology serves a different purpose in the grid as opposed to a 4-hour battery. The comparison is not always captured by discounting, and perhaps thought could be given to two separate programs?
- ***Establishing a minimum LDS objective for 2035 to provide more certainty for proponents with long lead time projects.***
    - **AUSTELA/ASTRI response:** Yes, we agree. The NSW government does not need to put all projects and technologies into one program. It can assign special status to LDS infrastructure and set an LDS objective for 2035, giving investors certainty for long lead times. When considering Generation + LDS projects, it is also essential to ensure they are not at a disadvantage compared to projects focused solely on generation or on storage only.

Moreover, we agree with points made in the AEMO Services analysis on the need to complement this work with reforms that encourage investment in longer duration projects. The Department is highly aware of the retirement of coal assets in the NSW electricity system, and any LDS program should incentivise projects that cover the retirement of those power plants.

To this end, we would also propose that an EOI, funded by ASTRI, and prepared in collaboration with AEMO Services, be conducted to demonstrate industry's interest and capability to deliver a cost effective, utility scale Concentrated Solar Thermal solution, into the NSW LDS Market, within the next 5 years.

Question 4: ***Should the NSW Government introduce amendments to the LDS definition to clarify it can include aggregated LDS infrastructure across multiple sites*****?**

No. This idea will only benefit small battery systems which are not the most cost-effective way of meeting the target, and which are not specifically designed and built to meet the objectives of a long-duration storage program. It is more likely that projects not suited to LDS are drawn into the Roadmap simply by aggregating.

Appendix 1: AEMO Service Report

As part of our response to the Consultation, we would like to reference the analysis presented in the AEMO Services Report commissioned by the government.

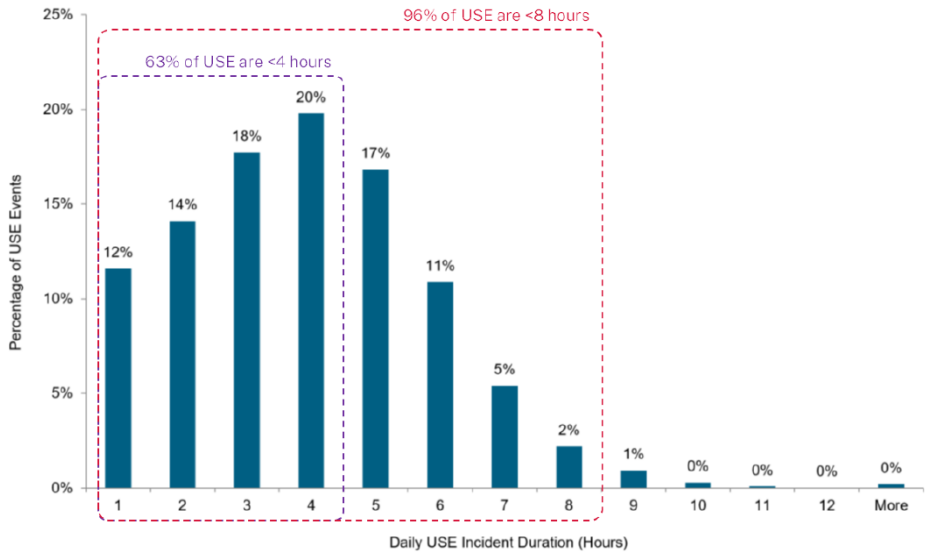

Figure 2: AEMO Services modelled duration of forecast unserved energy (USE) events in 2030

The above distribution analysis of USE event duration – included in the AEMO Services Report – appears to be a key driver leading to the suggestion that 4-hour duration will be sufficient in the 2030 NSW grid. However, it could be noted in response:

- systems with storage will not necessarily be charged prior to such an event. Their ability to cover a USE event will depend on the market signals they are responding to and the extent to which an event was predicted. For instance, 20% of USE events last four hours, according to AEMO Services' table, but a 4-hour battery that is not 100% charged, will not cover this event; therefore,
- to cover an incident of a certain duration it could be hypothesised that storages with a duration of some multiple of the incident duration are most likely to be of benefit. In other words, there will be a stronger probability that longer duration systems actively participating in the energy market, will have sufficient energy available for a critical event. Any storage with a duration longer than the incident could cover it, however the storage must be charged to that level;
- AEMO Services' paper notes that the greater the share of variable renewables in the system in later years the more frequent the longer duration incidents will be. Put another way, with greater renewables penetration USE events will get longer on average into the future;
- despite its USE tables, AEMO Services itself also correctly argues there is a need for deep-duration infrastructure to mitigate the risk of 'low probability, high impact events';
- the Department's Consultation Paper reflects the growing storage task of the 2030s, finding (on page 22) that the mean USE event extends to 7 hours as VRE penetration grows to 75% in the NEM. We need longer duration storage, not shorter.

Another key part of the AEMO Services analysis is the modelling of 10 specific BESS/PHES infrastructure scenarios to estimate quantity and cost to meet the IRM:

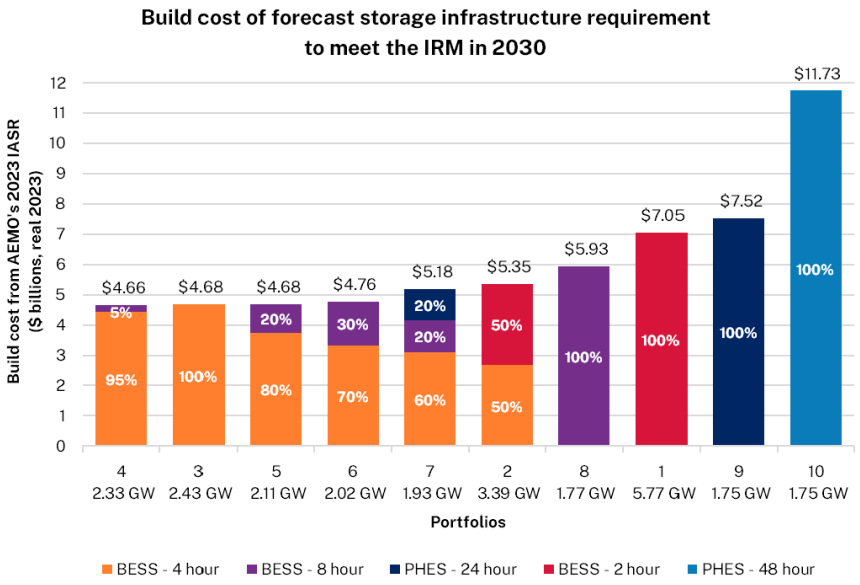

Figure 3: AEMO Services modelled absolute build cost of forecast storage infrastructure requirement to meet the IRM in 2030

The construction of the scenarios seems to use similar assumptions to the USE table:

- there is no guarantee that shorter duration BESS systems will be fully charged when called-on;
- the BESS scenarios will likely require storage durations that are multiples of the incident duration;
- LDS can cover the USE incident anyway (if it's charged to that level);
- the analysis does not present an optimisation, nor does it include the range of viable LDS technologies such as CSP;
- the uncertainty of such modelling means that the first 6 scenarios by cost are likely equivalent;
- looking at the scenarios considered, it can be hypothesised that another scenario of, for example, 2-hour BESS, 4-hour BESS and 24-hour PHES could well be the most competitive (and in this PHES becomes a proxy for all LDS technologies, such as CSP);
- there will always be low probability, high impact events as acknowledged by AEMO. As we remove our fully dispatchable coal generation, we still need the ability to cover these high impact events, and 4-hour BESS storage is unlikely to provide the capacity required.

AUSTELA and ASTRI treat the pumped-hydro in the USE and IRM tables as broadly interchangeable with concentrated solar thermal in terms of cost, lead times, storage performance and turbine/synchronous generator-based generation.

Appendix 2: Background on AUSTELA, ASTRI and CSP

AUSTELA is an industry association, representing companies that are involved in solar thermal power generation. Its members include Australian companies and Australian subsidiaries of international companies.

Solar thermal technologies take their energy from the sun and – unlike solar PV – store the energy as heat rather than converting it to electrons immediately. Concentrating Solar thermal Power (CSP) generation systems operate with an array of mirrors that concentrate the sun's heat and store it in a medium (typically molten nitrate/potassium salts). The heat – to around 600˚Celsius – can be stored for many days and used to drive a steam turbine which produces electricity via a synchronous generator whenever needed, day or night. Typical systems have tanks with enough salt to run the power block in the absence of sun for 15 hours or more. CSP systems can also provide clean industrial process heat which typically displaces gas-powered heat in manufacturing.

While the renewable energy sector has been dominated by wind and PV, the imperative for reliable dispatchable renewable generation – to balance variable generation – makes CSP an ideal technology option to include in electricity grids. While relatively small in uptake to date, CSP has a 30-year track record and currently around 6.5GWe of installed capacity in more than 100 utility scale plants around the world. Spain is the past leader in utility-scale CSP and China is currently building 28 CSP projects. A recent key example is the Noor Energy project in Dubai, a 700MW CSP project hybridised with 250MW of solar PV.

AUSTELA regularly comments on the mix of future renewable energy technologies, energy system design and market rules and incentives. We brief ministers, senior departmental officeholders and regulators and continue to be available to discuss program-design for the energy transition.

ASTRI is a consortium of leading Australian research institutions working with Australian and international developers to facilitate commercial interest in and domestic uptake of solar thermal technologies. The intent being to ensure that solar thermal is considered as an option in support of Australia's transition to a low emission energy future. ASTRI is managed within CSIRO, in the Energy Business Group.

To achieve its objective, the ASTRI Program focuses on technology development and commercial facilitation. ASTRI's technology based activities are aimed at improving the cost competitiveness, efficiency, and reliability of solar thermal technologies. This includes the use of multi-hour thermal energy storage (TES) systems as a cost-effective option to address Australia's emerging energy storage need.

ASTRI's commercial facilitation activities promote the value proposition that solar thermal systems can deliver within key Australian energy markets. These activities involve close engagement with system developers on the technical challenges facing domestic deployment of solar thermal systems. It also involves engagement with major industry players on commercial uptake opportunities across a broad range of end-use applications including power generation, industrial process heat, off-grid mining, and renewable fuel production.

ENDS

Submission from AUSTELA and ASTRI directors:

AUSTELA:

- Keith Lovegrove (Managing Director ITP Thermal)
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- Craig Wood (CEO and Director Vast Energy)

ASTRI:

- Dominic Zaal (Director, ASTRI - CSIRO Energy)