1. **What is an appropriate minimum duration for long duration infrastructure in NSW for 2030? Please outline why.**

We strongly recommend that the minimum duration for long duration infrastructure in NSW be 8 hours. As mentioned in the consultation documents, there is no standard global definition on what discharge duration is considered long. The UK specifies 6 hours, most American RFIs and tenders for long duration storage (LDS) have specified 8 hours. Early RFIs for LDS pilots by NTPC (a state-owned utility in India) specify 8 hours. METI in Japan is standardizing the definition of LDS as discharge durations exceeding 6 hours. The LDES Council, an industry body representing a wide range of technologies from Li-ion batteries to compressed air storage and so on recommends that LDS technologies be defined as those which can offer discharge durations exceeding 8 hours. As such, the international trend is such that most countries appear to be accepting 8 hours as the benchmark to define LDS technologies.

In addition, the reasoning behind the move to reduce the discharge duration of LDS technologies from 8 to 4 hours does not represent the full picture of the NEM and the NSW grid. AEMO's draft ISP for 2024 suggests that 20% of renewable energy generation is forecast to be spilled or curtailed by 2050 with select nodes in the system possibly experiencing much higher levels of curtailment. High levels of renewable energy curtailment can lead to negative or low market clearing prices, especially during the solar peak hours. This has the potential to depress investments in capacity by investors. As such, generation and demand need to be balanced at all times and bulk energy shifting will become increasingly important going forward necessitating LDS deployment. Since many LDS technologies have long lead times, even for applications beyond 2030, project proponents need to be incentivized starting now to ensure that the grid is operated in a reliable and economic fashion. Furthermore, the load demand associated with setting up data centres, training large language models for generative AI, electrification of transport and industry will grow at faster than expected rates necessitating additional renewable capacity deployment and bulk energy storage. The proliferation of e-fuels, SAF and hydrogen derivatives will also significantly add to the load demand in the system. In this context, using 2030 as a cutoff year for long lead time projects may not be the best path forward. A longer-term perspective is needed to avoid expensive mistakes by policymakers and prevent reliability issues from plaguing the system into the next decade.

AEMO's draft ISP also suggests that 12.7GW of utility scale storage is required by 2030 including 2.4GW of deep storage (>12 hours) and 3.6GW of medium storage (4-12 hours). The ISP is essentially a capacity expansion or generation planning model which solves either a linear or a mixed integer linear program to identify the least cost pathway for the system based on various inputs. Among the inputs are renewable generation profiles, demand profiles and most importantly cost data for various technologies. The ISP only considers pumped hydro and Li-ion batteries as energy storage options in the optimization model whereas numerous LDS solutions exist commercially in the market. Many companies have raised large funds and commercialized innovative LDS technologies in recent years. A number of these technologies have demonstrated their competitiveness at longer durations when compared with conventional storage technologies such as pumped hydro and Li-ion batteries. The ISP also lacks nuance in terms of informing policymakers about exactly how much of the medium storage capacity is in the 8 hour and above category. However, the merits of the ISP cannot be analysed in this consultation. Even with such limitations, the ISP provides a good indicator of how much LDS is needed over the short term till 2030. As such, using only the unserved energy as a barometer to determine the discharge duration may not offer the most cost-effective transition pathway for the NSW grid. The supporting documents prepared by AEMO for this consultation also indicate that energy storage mixes involving Li-ion batteries and pumped hydro (at various discharge durations) were evaluated to determine the lowest cost combinations. Many of the emerging LDS technologies have demonstrated their cost competitiveness versus the technologies evaluated by AEMO, especially when considering longer discharge durations and technical and economic lifetimes. In this context, using a limited set of mature, conventional technologies to evaluate the optimal storage mix may not deliver the lowest costs for NSW consumers.

Finally, optimal power flow studies need to be done to identify specific nodes in the system likely to experience congestion or face stability issues. The need for LDS solutions which can provide bespoke services to improve grid reliability might be greater at these locations.

SFW believes that considering global trends, the complexities in operating a reliable power system and the needs of the NSW grid as identified by AEMO in the 2024 ISP, and other factors mentioned above, it may be in the best interests of consumers to specify 8 hours as the discharge duration for LDS systems.

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?**

Any major policy changes need to be carried out after thorough, scientific power systems studies carried out by independent third-party experts. The contours of the study need to be made available for comments from various stakeholders and any suggestions or comments need to be discarded only with proper justification. Scientific studies conducted by independent bodies need to guide policymaking and there needs to be transparent communication with the industry at all stages. As such, we believe that the minister should not be able to arbitrarily change policy without solid evidence to support decision making. Without due process, any decisions can be called into question and such decisions can be detrimental to achieving NSW's sustainability and net-zero goals.

3. **How can the infrastructure objectives and LDS tenders be improved to support diverse 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 consumers.**
- **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.**
- **Establishing a minimum LDS objective for 2035 to provide more certainty for proponents with long lead time projects.**

In addition to bulk energy shifting, LDS technologies are capable of providing numerous services which can enhance the reliability of the power system. For example, mechanical LDS technologies with synchronous generators on the discharge side can contribute inertia and short circuit capacity to the power system. They can also potentially be operated as synchronous condensers to contribute reactive power. Furthermore, in some mechanical storage technologies, additional inertia can be provided by adding a flywheel and clutch. In addition to assessing the need for bulk energy shifting in various parts of the network, thorough modelling studies need to be performed in order to understand what grid services will be required from energy storage systems in 2030, 2035, 2045 and 2050. An RFI recently released by the Salt River Project (SRP) utility in Arizona, USA is an excellent example of how precisely future energy storage tenders/RFIs should be designed. In the aforementioned RFI, SRP identified the needs of the system in the coming years and specifically requested information about non-inverter-based storage technologies which have a discharge duration between 8-12 hours (ideally 10 hours) and which are capable of providing rotational inertia. SRP identified a need for not only bulk energy shifting in the system but also inertia which they felt could be best served by niche LDS technologies. A tender based on the RFI is expected this year and mechanisms have been identified to make projects commercially viable.

Furthermore, LDS technology developers are involved in developing markets across the world in collaboration with policymakers and stakeholders. Some LDS technologies also have long project lead times. In this context, solution providers and investors will not hesitate to reduce their focus on the NEM in general and NSW in particular if the right signals do not emanate from policymakers. Diluting the discharge duration requirements for LDS solutions, not having clear capacity targets for storage systems with discharge durations >=8 hours, not identifying the technical needs of the system in terms of grid services which can be provided by LDS solutions are all signals which can cause technology providers to shift focus to other markets which can be potentially detrimental for NSW in terms of innovation, grid reliability and investment.

Extensive system modelling needs to be performed to clearly identify the storage requirements at each node. These efforts can include building capacity expansion models (integrated system plans) including a wider range of storage technology options (than being considered currently) at various durations, power flow modelling to identify congested nodes and dispatch models to ensure that any planning solution is compatible with market models. This will allow NSW to clearly demarcate storage requirements into various buckets based on actual system requirements and cost considerations. The buckets here can be 0-2 hours, 2-4 hours, 4-6 hours, 6-8 hours, 8-10 hours and so on. Based on the results of the modelling exercise, tenders can be designed specifically to procure capacities in the longer duration buckets. Tenders should offer offtake agreements for 30 years considering the long lifetime and negligible degradation experienced by many LDS solutions to incentivize developers and stakeholders in the absence of favourable market mechanisms. It has often been observed that market mechanisms and policies are always in catch-up mode and long-term offtake agreements and capacity procurement combined with some viability gap funding might be required in the initial stages to allow LDS technologies to reach commercial viability.

The financial benefits from LDS technologies can be calculated more holistically. For example, if certain LDS technologies provide rotational inertia support to the grid (during both charge and discharge processes), the quantity of fast frequency reserves which need to be procured by the market operator reduces. Two recent examples from the Nordic countries are shown below in Fig. 1. In these graphs, it can be clearly seen that the quantum of fast frequency reserves (FFR) reduces with higher levels of grid inertia. This has clear financial benefits for consumers. Furthermore, bulk storage at certain locations could reduce the need to invest in additional transmission infrastructure which could also indirectly benefit consumers. In addition, the ability of LDS technologies to provide bulk shifting can better balance the generation and consumption of electricity in the grid at all times. AEMO's Draft 2024 ISP suggests that 20% of renewable energy produced is expected to be curtailed by 2050. At certain key nodes in the power system with high renewable energy potential, the percentage is likely to be higher. The generation and demand in power systems need to be balanced at all times. High renewable energy penetrations can lead to a situation in future where the market clearing prices on the NEM might be very low or even negative for an extended period of time which can disincentivize developers from investing in renewable capacity. Having bulk storage and energy shifting capabilities starts to become critical under this scenario to ensure that economic and technical renewable energy curtailment is reduced. These benefits provided by LDS technologies need to be accounted for when evaluating the financial benefits to consumers.

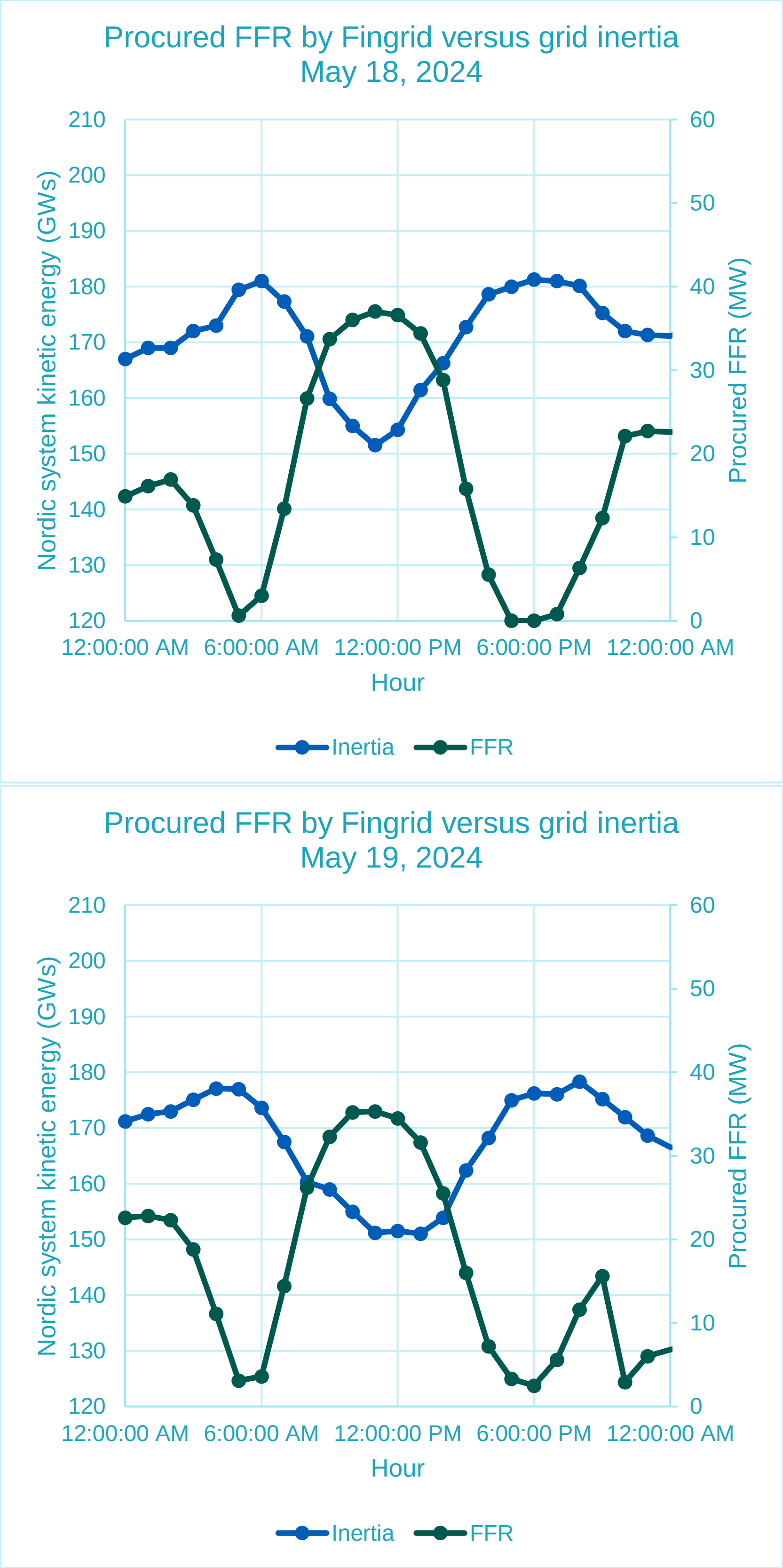

Fig. 1 Procurement of FFR by Fingrid based on levels of inertia in the power system

4. Should the NSW Government introduce amendments to the LDS definition to clarify it can include aggregated LDS infrastructure across multiple sites? Should aggregated LDS infrastructure need to register on AEMO's NEM Registration and Exemption List and participate in central dispatch? Please outline why or why not.

   SFW generally does not have any comments on this subject. Aggregating storage systems across multiple sites and including them in the central dispatch could theoretically deliver benefits to certain nodes in the power system. It is our view that all aggregated LDS systems need to register as scheduled facilities with AEMO and participate in the central dispatch for the NEM. This can provide AEMO with a better visibility of the power system and help in preventing any stability issues in the power system due to the operational patterns of multiple aggregated LDS systems.