Tesla Motors Australia Pty Ltd
650 Church St
Cremorne, Victoria, 3121

Ms Taryn Moroney
Australian Energy Market Operator
530 Collins St
Melbourne Victoria 3000

4 December 2018

Re: Emerging Generation and Energy Storage in the NEM

Dear Taryn,

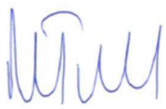
Tesla Motors Australia, Pty Ltd (Tesla) welcomes the opportunity to provide the Australian Energy Market Operator (AEMO) with feedback on its Emerging Generation and Energy Storage stakeholder paper (Consultation Paper). AEMO has taken significant initiative throughout this process and Tesla appreciates the work conducted to date, capturing industry-wide concerns and identifying opportunities to work together in removing risk and uncertainty for energy storage projects going forward. In particular, Tesla looks forward to continuing its work with the AEMO to achieve the following outcomes:

- The creation of a new defined term specific to energy storage in the National Electricity Rules;
- Appropriate registration categories and market participation classifications to recognise that energy storage is a unique technology within the scope of the National Electricity Market;
- Flexible participation arrangements that allows energy storage to co-locate with other renewable energy assets and loads, and optimises the operational benefits across multiple assets, providing clear incentives for renewable assets to do so (e.g. improved causer pays factors);
- Providing a clear and transparent regulatory position on network usage arrangements – including clarifying that energy storage assets should be exempt from paying transmission use of system (TOUS) charges, and treatment in respect of connection costs; and
- Providing a clear approach to site metering – including consideration to avoid negatively impacting on other market fees or incentives for hybrid systems (e.g. renewable energy certificates).

Tesla supports AEMO's proposed work plan and intention to submit a rule change to facilitate stand-alone energy storage participation as a matter of priority and will consult closely with AEMO to ensure the subsequent design of hybrid models can optimise the benefits of aggregated resources.

For further information on any of the points raised in this submission please contact Emma Fagan at efagan@tesla.com or Dev Tayal at atayal@tesla.com with any questions.

Kind regards



Mark Twidell

APAC Director – Energy Products

1. Context

As outlined in AEMO's consultation paper, the current national rules framework contains several distortions for emerging technologies. For battery energy storage, the NEM does not yet fully recognise its unique capabilities and performance in providing a range of grid benefits, nor does it allow efficient integration with existing assets within existing frameworks.

Battery energy storage does not fit well within any of the categories for traditional types of participants in the energy market. As AEMO has recognised, while storage assets most closely resemble a generator in the services they provide to the market, they do not generate electrons – so are not, technically, a generator. The controllable nature of the load side of a storage asset, as well as the services that it can provide whilst charging, including both frequency and voltage support – also means that it's more than a traditional market load.

As an interim measure, grid-scale battery assets register as both a generator and a market customer, which has allowed some participation of storage into the market (e.g. Hornsdale Power Reserve). However, this approach is creating ambiguity for registration and participation, adding complexity to dispatch, restricting battery storage operation and optimisation with renewable energy assets, and raising additional risks and costs with respect to network and system integration.

In parallel, from a wider system planning perspective, there is an established consensus of the need to promote the uptake of storage in the NEM to ensure continued safe, secure and reliable operation over the coming decades, as well as promote efficient investment in infrastructure in the interests of consumers.

A new storage category, whilst evidently not essential, would remove several operational and administrative inefficiencies associated with the current interim arrangements and accelerate the deployment of storage in the NEM. Tesla welcomes AEMO's strategic approach to improving the integration of grid-scale energy storage and enabling regulatory flexibility to incorporate new and emerging business models.

2. Defining energy storage in the NEM

General Comments

To facilitate the integration of storage, Tesla's preferred approach is to establish a new definition that encompasses bi-directional assets such as battery systems. This will align with the complimentary category and classification changes that are being proposed to manage the current inefficiencies in operation and dispatch outlined in the consultation paper.

AEMO will need to ensure that any definition is future proofed for technological change, captures necessary distinctions between what constitutes a load versus a storage asset, and conforms with existing power system definitions – i.e. whether the definition of storage needs to explicitly refer to electricity conversion, or if it can be a broader reference to 'energy source' and rely on existing NER definitions.

There is a wealth of international experience that can be drawn upon to support the introduction of an appropriate storage definition, as outlined in Tesla's previous submissions to the AEMC consultation on the Coordination of Generation and Transmission Investment.[1]

[1] Tesla COGATI submission: https://www.aemc.gov.au/sites/default/files/2018-10/Tesla.pdf

Response to Consultation Questions

Question	Tesla Comments
Question 1: Referring to Section 2.3, are there any other issues with the current arrangements for ESS?	AEMO captures the broad range of issues and challenges currently being faced by large-scale storage projects. Additional (related) issues include: • De-risking of ESS development generally, as a single definition should provide more clarity and less interpretation for project developers; • Uncertainty on metering and connection requirements and costs – particularly with regards to how AEMO's processes interact with individual Network Service Providers; • How large-scale storage fits within FCAS registration processes (e.g. droop settings and system limitations), recognising the separate work AEMO is undertaking to clarify and improve these processes for emerging technologies as part of the Market Ancillary Services Specification (MASS) review; • Causer pays impacts and how storage contribution factors are calculated currently under separate generation and load categories; and how they may be calculated for proposed hybrid models; and • Treatment of LGCs and how renewables co-located with storage will claim loss adjusted LGCs.
Question 2: Do you have any views on whether a definition of ESS should be included in the NER?	Support inclusion of a specific definition for energy storage. This will facilitate integration in both energy and FCAS markets by more appropriately describing the unique capabilities of storage assets across generation and load for operation; and should address the existing uncertainty on network and participant fees and charges (e.g. TUOS).
Question 3: Do you have any views on whether a definition of ESS should be generic and encompass technologies other than batteries, for example, pumped hydro?	This will depend on the registration category/classification created and interactions with a definition appropriate for battery energy storage. If the NER can still recognise the uniqueness and benefits of battery storage to capitalise on its fast acting, accurate response - e.g. for FCAS participation – a more generic definition could be functional across multiple storage technologies.
Question 4: Do you have any views on AEMO's suggested definition of ESS?	Support alignment with international precedents as referenced in the consultation paper. It would be useful to get further clarity on AEMO's intention for including a reference to storage located 'at the same site' as customers – i.e. on what the definition of 'site' includes and whether this would allow for adjacent sites, or going forward, whether this could include 'virtual' arrangements where different assets are optimised together but not necessarily co-located.

3. Participation and operation

General Comments

A stand-alone battery category that enables battery storage to register under a single category is a sensible first-order priority for AEMO to progress under Stream 1, as it is relatively less complicated than combining different resources under a hybrid model. Tesla is supportive of introducing a bi-directional asset category that simplifies bidding and treatment by AEMO – including combined offers that reflect the overall capacity to move from load to generation and vice versa. We assume this would also allow battery storage to charge from any co-located renewable assets (unlike existing interim arrangements), as well as from the grid.

However, even within a storage-only model, stakeholders would benefit from more worked examples that outline how participation would work in practice (particularly from a bidding perspective), in order to avoid negative commercial impacts or burdensome compliance requirements. In particular it would be valuable to have a worked example that demonstrates how a bi-directional asset may bid using ten price bands, rather than the existing twenty (ten as a scheduled generator and ten as a scheduled load). Various scenarios could

be simulated (compared against status quo) to provide comfort that a merged optimisation and bidding process does not introduce new risks that are currently managed through separating dispatch for load and generation – e.g. forcing the load side out of a peak pricing period. Some input fields may also warrant being duplicated even under a merged dispatch model – e.g. with having maximum availability for both charge and discharge.

It would also be useful to understand AEMO's limitations with price bands, and whether energy storage could have more than ten to assist with optimisation (e.g. retain 20 to remain at parity with the existing dual registration model) provided this is still practical to administer and does not introduce additional/prohibitive system costs. Unlike traditional generators, energy storage is inherently based on opportunity costs, so the greater number of price bands the greater flexibility for optimising bidding spreads, particularly at extreme price levels.

In general, Tesla views AEMO's proposed information requirements (outlined in table 7 in the consultation paper) as practical inclusions to improve AEMO's visibility on system operations. However, we assume this information will not be published or made available to parties other than AEMO – as many of the input fields are commercially sensitive and have potential to distort bidding behaviour across the market.

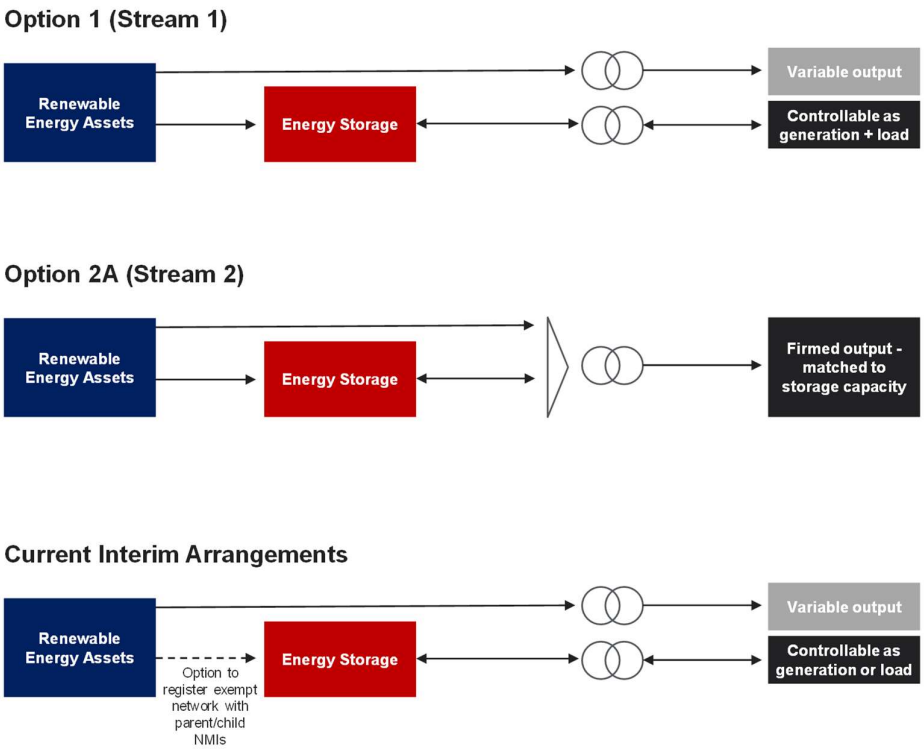
Longer term, Tesla supports AEMO's commitment to continue to refine the proposed hybrid model categories and classifications through Stream 2 of the consultation process. Each model addresses particular aspects of the existing integration issues, but there is no single model that appears to resolve all complexities and can simultaneously maximise benefits for co-located BESS and renewable energy assets (i.e. simplifies registration, reduces causer pays factors, minimises curtailment, optimises load/generation dispatch, provides firmed output, and retains a semi-scheduled classification for the renewable energy assets). As such, Tesla considers these models should not be treated as mutually exclusive.

It may be worth AEMO considering the introduction of two categories and/or preserving the stand-alone energy storage category beyond the initial stream of work. For example, providing developers the opportunity to select either a hybrid bi-directional participant category for a BESS and renewable asset to be co-located and dispatched under a single instruction (e.g. under Option 2A – depicted as the second diagram in Figure 1 below); or to register the BESS separately under a stand-alone category, together with a stand-alone generation category for the renewable asset (e.g. under Option 1 – depicted first in Figure 1).

Each option presents different benefits and restrictions. In Option 2A, a combined facility will likely require a single grid connection point sized to match the peak discharge power level of the BESS, with the renewable generation sized optimally relative to storage capacity to minimise the average cost of electricity sent out. Depending on configuration, this may still mean small amounts of curtailment occur, but is likely to benefit operators through fully firmed output that can effectively manage causer pays factors.

Alternatively, whilst separate registration under Option 1 will not solve for curtailment issues and only partially firms output (potentially leading to higher causer pays factors), other benefits can be maintained for developers. This includes still being able to optimise the BESS load/generation dispatch (relative to existing interim arrangements represented last in Figure 1), allowing the renewable asset to be oversized relative to storage capacity, and maintaining its status as a semi-scheduled generator under a well understood registration process. This model also recognises that not all output from renewable energy assets needs to be 'firmed' or dispatchable to provide value, with exact proportions depending on the contractual and commercial arrangements in place.

Figure 1: Schematic Interpretation of AEMO options proposed for energy storage co-location



Multiple options will preserve flexibility to explore across various use-cases and commercial models that different developers may be seeking, including for operations across not just energy market participation, but all FCAS markets as well as any future primary frequency markets that may be introduced. As increasing numbers of renewable assets are paired with storage, there is only likely to be an expansion in the number of innovative business models being pursued.

Response to Consultation Questions

Question	Tesla Comments
Question 1: What are your views on the appropriate participation model for integrating ESS into the NEM?	As above, no single model resolves all complexities for co-located BESS and renewable energy assets. Ideal model would simplify registration, reduce causer pays factors, minimise curtailment, optimise load/generation dispatch, provide firmed output, and retain a semi-scheduled classification for the renewable energy assets / not limit size of renewables by storage capacity. To preserve flexibility, Option 1 and Option 2A should not be treated as mutually exclusive and both warrant further exploration. Option 2B does not appear to simplify the registration process or allow a generating unit and a load to be aggregated together – this means it is unlikely to unlock the full benefits that AEMO is seeking to achieve with a new participant category.
Question 2: Would the proposed participation model (2a) meet your future needs, both in terms of participating in the NEM with an	Option 2A unlocks many of the benefits available from hybrid units: • fully firmed output; • associated firmed contracts and financial products (streamlined);

individual ESS or where multiple resources (e.g. ESS and generating units) are to be aggregated? ***AEMO is particularly interested to understand the additional benefit that you would derive from aggregating hybrid systems and offering them to the market as a single resource that is not available by separately offering the components to the market***	• ability to reduce causer pays factors across portfolio; • allows BESS charging from both the co-located renewables and the grid; • aligns with wider Government/market policies requiring 'dispatchable' supply; To achieve these aims, however, there are several considerations that AEMO and industry will need to work through, including: • the total capacity (MW) that will be required to be registered for a site – whether it's based on total cumulative capacity of all assets, or a reduced peak export (MW); • If cumulative capacity is registered – will the entire site be treated as scheduled? If so, industry will need to consider the implications of sizing ESS assets correctly to meet this requirement; • Risks and costs associated with treating traditional semi-scheduled assets as scheduled within a hybrid model (see 'Other Issues' section below). Tesla encourages AEMO to explore flexible ways that a new hybrid category could allow renewable energy curtailment to be managed (under a combined/single unit dispatch model) whilst also allowing individual resources to operate when required. Ideally, this could allow a renewable asset to charge the BESS with any energy being generated over a curtailment cap (via an embedded network) whilst still being able export (and be paid for) energy below the cap; and/or allow relevant participation in FCAS markets. Curtailment and mitigating causer pays impacts are of particular importance to existing generators assessing the commercial value of retro-fitting storage assets to form a hybrid portfolio.
Question 3: Refer to Table 8, are there other potential challenges and risks associated with option 1?	As per general comments above, AEMO needs to develop more worked examples regarding market participation – for example to demonstrate how the 10 price bands (or more) would operate under a single BESS asset classification. Duplication of input fields may also provide comfort that optimisation risks can be managed. For MLF challenges, we recognise MLF is already not-reflective as it is set at the beginning of year. If MLFs are averaged or merged for a hybrid unit, sites will lose even more granularity dependent on operations. Support parallel work as part of AEMO's wider MLF consultation exploring dynamic calculations. As a first principle, anything that adds fidelity to market price signals would provide more transparency and remove existing distortions for energy storage. One model could be to have a unique MLF calculation for energy storage that is dynamic enough to reflect that storage typically charges during periods of high congestion, and can discharge during periods of low local network usage. Even under a single registration, storage will need to bid prices to charge and prices to discharge, so there will always be a dual resource/bidding approach. However, the reduction in complexity for double sets of FCAS products would be welcome.
Question 4: Refer to Table 9, are there other potential challenges and risks associated with options 2a and b?	It is a sub-optimal approach for AEMO to take the lowest FCAS availability of intermittent generators and apply it across entire hybrid sites. This would lead to significant value being lost for ESS providing FCAS and further distort the market. More consideration is warranted on how additional granularity of co-located units' FCAS capability can be better represented. Support AEMO proposal for hybrid market participants to provide AEMO with additional information to signal what type of unit is providing what service for each offer (i.e. whether they are intermittent or storage). Energy management systems already provide aggregation and coordination services and more sophisticated bidding and dispatch requirements is unlikely to pose a major risk. Clarity is needed on how AEMO models would interact with NSP requirements for connection and how network constraints would be managed, as well as any differences across transmission or distribution networks.

Question 5: Do you have any views on AEMO's proposed approach to implement a single participation model to integrate ESS?	As per general comments above, there is merit in preserving a category for a stand-alone ESS alongside a hybrid model, as each will have different advantages and disadvantages depending on the wider business model being pursued. It does not appear that one single participation model is able to address all issues being raised across registration, participation and operation, however it may be preferable to developers as a less complex option than the hybrid model.
Question 6: Do you have any views on the proposed key requirements AEMO has identified for an ESS participation model?	Support information requirements and role it will play for system operations. However, AEMO needs to ensure each requirement is justified and critical for dispatch and operational purposes. This information, in particular fields such as state of charge, should not be published or made available to parties other than AEMO – as many of the input fields are commercially sensitive and have potential to distort bidding behaviour across the market. This would also be overly and unfairly burdensome for energy storage relative to other asset types and existing plant. More detail would also be helpful on what the implications are for storage specifications changing over the life of the asset – e.g. if more MWh is added over time – and whether this would affect the GPS. The preference would be for maximising optionality and minimising the need to re-open connection documents.
Question 7: Do you have any views on whether existing ESS should be transitioned to the proposed participation model?	Transitioning existing storage assets should be considered on a case-by-case basis and under opt-in grandfathering arrangements. AEMO should not add unnecessary cost or resource requirements for existing systems or penalise first-movers deploying storage in the NEM.

4. NER recovery mechanisms

General Comments

Ongoing payments for use of transmission networks by utility scale storage is a key operational consideration for project developers looking to build new hybrid facilities, retrofit storage onto an established wind or solar facility, or for transmission connected storage assets to be viable in providing market and network support services.

Tesla welcomes the AEMO position on transmission use of system (TUOS) charges that reinforces the appropriateness of exempting storage assets. Tesla agrees with the principles outlined and the need for technological neutrality. Any asset capable of receiving electrical energy from the grid or another asset and storing it to be provided later for energy or frequency purposes, should be considered within its own classification.

As the AEMC notes: "ideally, consistent decisions on this would be undertaken across the NEM". It is hoped the AEMC now actions a decision to exempt all large-scale storage projects from TUOS charges following the consensus of feedback received as part of the COGATI review and aligning with AEMO's position.

General participant fees and charges should align with the principles outlined under AEMC's wider reviews.

Response to Consultation Questions

Question	Tesla Comments
Question 1: What are your views on how to integrate ESS into the NEM's recovery mechanisms?	Agree with AEMO's proposed approach (no TUOS charges) and underlying principles to cost recovery for energy storage, pending additional details on required exceptions.

5. Application of performance standards

General Comments

The uncertainty and fear of onerous requirements being added to existing renewables if an energy storage asset is retro-fitted is presently driving layouts that are economically inefficient and sub-optimal from a power system security perspective. Consideration of where connection and metering points are required for renewable projects should take into account these storage integration issues and ensure an ability to integrate new storage assets with existing generators seamlessly.

It would also be useful for AEMO to clarify its approach and consideration for creating performance requirements for the load side of the asset – expanding the requirements of GPS that currently only applies to generators and not for scheduled loads.

Response to Consultation Questions

Question	Tesla Comments
Question 1: Are there other options to address the issue identified for connecting plant in an exempt network?	We note that generator performance standards will be progressed in separate rule change proposal by end-2018. We support AEMO aligning with the AEMC review and recommendations.
Question 2: Are there other costs, risks and benefits associated with the options presented? If so, please indicate what these are.	Some existing solar or wind sites that have a common coupling on the HV side of substations must also have their NMI on the high-voltage connection side, but then may look to connect an ESS on the medium voltage side. This creates secondary issues for projects that are retro-fitting storage, including potentially having to re-negotiate generator performance standards for the entire existing site. It would be useful for AEMO to clarify how the application of performance standards would be treated under a hybrid model that includes retro-fitting storage. One solution would be to relax the requirement for NMIs to be on the HV side of renewable asset's substations to begin with. Alternatively, AEMO could introduce a simplified and transparent process for shifting connection points from HV to MV to mitigate risk for developers.
Question 3: Which option to address the issue is your preferred option? Why?	Support AEMO clarifying this issue and resolving as a matter of priority.

Other Issues and Considerations

Separating operational and financial responsibility

Tesla welcomes the additional project flexibility that would be introduced from separating out operational and financial responsibility as developers look to increase the commerciality of projects and protect against risks.

More broadly, as the number of battery storage projects grows in both volume and type, it will be important for AEMO to consider the commercial implications of registration models and market participation. The desired outcome would be to preserve flexibility for developers to work with project partners, equipment providers, financiers, governments, and market customers across a range of financial and operational structures. This will be of particular advantage as the size of projects increase and necessitates multiple owners and off-takers.

For example, future 'financial firming' arrangements and the growing market for corporate PPAs should unlock the potential for battery storage to compliment renewable energy assets beyond just spot market energy. This

might call for more accurately valuing time of use or load following products or incorporating hedging products such as revenue swaps that recognise the ability for storage to shift generation. Currently these emergent structures largely exclude battery storage participation, in part due to restrictive regulatory frameworks, which is limiting commercial benefits. If flexibility for these types of innovative business models can be considered, without causing commensurate administrative burden or risk for market and system operators, it will be in the best interests of end-customers to capture this value.

Logical Metering

Tesla notes AEMO's consideration of logical metering arrangements and supports a principle-based decision. Logical metering arrangements should be progressed if they can maintain accuracy and transparency across distinct asset connection points, and if the benefits outweigh the administrative cost of AEMO to enable the arrangements – relative to the cost of installing physical meters. AEMO should recognise that any mechanisms to permit logical metering arrangements must also consider flow-on impacts to LGCs (see below).

Causer Pays Contribution Factors

In theory, owners and operators of multiple assets in the market can use energy storage assets as a financial (if not physical) hedge for any negative causer pays liabilities. However, in practice, increasing numbers of operators are registering assets as separate commercial entities (e.g. Hornsdale Power Reserve and Hornsdale Wind Farm). This prevents the use of storage to hedge because the liability is spread across two separate entities. This is compounded by the current arrangements that see positive causer pays factors net out to zero – so there is no upside. As hybrid models gain traction, and storage is integrated into the market more widely, options for AEMO to explore include:

- Hybrid arrangements (as outlined in this consultation paper) that ensure a physical reduction of causer pays liability can be achieved through storage complimenting intermittent output. This should also allow for reduction of causer pays liability in instances where there are separate owner/operators behind a single connection point.
- Progressing the proposed deviation payments for regulation FCAS. This would allow operators with two separate commercial entities to offset the positive causer pays against the negative liabilities.
- Rule changes to allow for possible aggregation of financial liabilities up to the controlling corporation level – rather than at the level of individual assets.

Renewable Energy Certificates

Whilst likely to be a time-limited issue, AEMO should not adversely impact incentives that are currently afforded to renewable energy assets, such as a claim to large-scale generation certificates (LGCs). If renewable energy assets co-locate with large-scale storage under some form of hybrid registration model, they should not lose their ability to claim for LGCs relative to operating as stand-alone assets.

The only electrons technically consumed by utility scale energy storage assets is the net variance in total MWh charged from the grid, and subsequently discharged into the grid, based on round-trip efficiency losses. This is the view that has been taken by the Clean Energy Regulator in allocating renewable energy target liability to utility scale storage assets, and with appropriate metering arrangements, could also apply to LGC allocation under any proposed hybrid model. However, consideration must also be given to how losses will impact the calculation of LGCs, and whether the type of metering and operational arrangements being considered will create additional complexity.

Scheduled vs Semi-scheduled

Tesla supports an approach that allows for the co-location of multiple assets behind a single point of connection in order to realise greater utilisation of existing network infrastructure. However, installing a storage asset downstream of an existing generating asset connection point should not necessarily require the entire combined asset to register as a scheduled generator. Project developers looking to combine their existing renewable assets with storage see this as a change to the risk profile and are still exploring ways to preserve the renewable generator's classification as semi-scheduled, whilst pursuing separate registration for the battery.

Even when operated by a single market participant, a co-located renewable asset should be able to combine with an energy storage system to effectively provide 'firmed' output, without being penalised for not responding to a precise forecast (e.g. in instances where the battery is full or empty). To achieve this, a new classification could be introduced to unlock the flexibility and fast response attributes of batteries when firming renewables to the benefit of market and technical outcomes.

AEMO should be careful not to introduce unintended outcomes that could distort new project developments and lead to storage capacity limiting the size of renewable generation assets, or inadvertently place obligations on battery size specifications and limit the application of batteries.

To use the Bi-directional Resource Provider example: an aggregated 10MW BESS, 20MW wind and 30MW solar farm system may see its renewable asset capacities re-scoped downwards by developers if they are required to register the collection of assets as a fully scheduled 60MW generator and would not be compensated, or could even penalised, for any 'un-scheduled' generation. Tesla recognises the intention of AEMO to encourage battery storage systems to be an asset that can be complimentary to existing or proposed renewable generation assets and be designed into developments in a way that creates value to the project and wider network. Further design details and worked examples of how these models are intended to operate in practice would be helpful to clarify these initial concerns.

Conclusion

Tesla supports all ongoing work undertaken by the AEMO (and AEMC) to facilitate the integration of large-scale battery energy storage into the NEM. Recognising the renewable transition that is currently underway, and with significant investment still to come to drive the integration of new generation and energy storage (as highlighted in AEMO's Integrated System Plan), Tesla welcomes changes to current market structures that will enable more battery storage projects to be deployed and participate in the market more efficiently.

Managing the issues covered in the consultation paper together with the close input from stakeholders will reduce uncertainties in ongoing market developments related to energy storage assets and ensure that the uptake of storage projects is commensurate with the need for critical system security and grid support identified.

Tesla welcomes the opportunity to progress the proposed work streams with AEMO and all relevant stakeholders, to ensure a fit for purpose market and regulatory framework that enables efficient investment and optimised integration of storage in the decades to come.