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Submission AEMO Draft ISP 2022

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Executive Summary

- Australia is almost unique amongst large industrial economies in attempting to undertake its zero carbon transition by relying on solar and wind as the primary energy source without the possibility of back up from an alternative large scale grid of the type available in say California or Germany.

- Australia is **betting the economy and our future prosperity** that we can get this right where others have failed. Our view is that this path is likely to be viable only if we accept that the risks be properly integrated into the assessment of the *long term back up and security services* needed.

- Certainly, the Draft Integrated System Plan raises questions about the uncertainties surrounding the predicted trajectories, the risks associated with depending heavily on a narrow range of technologies and the assumptions adopted in the areas of long range technological development and consumer behaviour. But the forecasted potential capacity and contribution of solar and wind technologies may significantly exceed actual capability. This level of risk imposes large scale potential costs.

- Our modelling suggests that the impacts of the economic costs of uncertainty should place much greater weight on medium and long term storage than the figures contained in the ISP.

- Existing low or zero emissions technologies are available to replace coal and utilize the existing thermal infrastructure in a flexible manner. These can significantly mitigate the overall network risks and long term storage requirements associated with our current Optimal Development Path trajectory.

- We suggest the ISP include comprehensive analysis of thermal energy storage and generation in its projections. This includes: (i) estimating the benefits to the grid of large scale dispatchable generation; (ii) the savings in costs avoided to replace transmission and generation infrastructure; and (iii) the options benefits provided through hedging against uncertainties and risks associated with the current Optimal Development Path.

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1. Introduction

This submission is made in response to AEMO's invitation for submissions contained in the *Draft 2022 Integrated Systems Plan* (ISP) (see p.16) and includes comments in respect of the Optimal Development Path (OPD) and the Addendum to the 2021 *Inputs, Assumptions and Scenarios Report*.

The basis of our comments is a detailed independent report on medium and long duration storage Macroeconomics Advisory has prepared for Quantum Graphite Limited and The Sunlands Company Pty Ltd (collectively the "Client"). They are proposing a medium and long duration thermal energy storage solution that has specific application for the retrofitting of coal fired power stations. Our study of the Draft ISP raised questions about uncertainties around the predicted trajectories and the risks associated with depending heavily on a narrow range of technologies and on assumptions about long range technological development and consumer behaviour. In our view the ISP requires a response which:

a. maximizes optionality for the AEMO throughout the entire energy transformation trajectory;

b. provides AEMO with the most flexibility through time to effectively balance competing stakeholder interests; and

c. minimizes unintended consequences and detrimental impacts of implementation actions.

AEMO has the unenviable task of predicting trends whilst trying to optimize on the basis of these forecasts. Matthew Warren's recent contribution in the Australian Financial Review (8 February, Manage Coal Exit to Avoid Energy Crash) has described this difficulty as akin to *"...rebuilding a conventional car into an electric vehicle while still driving it."* We acknowledge that the range of options AEMO can consider at particular times may be severely limited, but this should not prevent the implementation of an ODP that is based on an optimizing principle.

2. Summary of Main Points

The main points we make can be summarized as follows.

Optimal Development Path

Our comments address the reasoning in the ODP and specifically the treatment of risks. They are:

- The reasoning behind the projections is often unclear beyond being a summary of opinions.
- Our calculations suggest that the ODP does not sufficiently consider the degree of uncertainty in the system and the risks generated for future developments. This creates distortions in the assessment of expected values.

Thermal coal plant assumptions

The estimate of the flexibility of coal fired power stations may need revision. Low or zero emissions technologies such as our clients' technology are available to replace coal and utilize the existing thermal infrastructure in a flexible manner. These technologies can significantly mitigate the overall network risks and long term storage requirements covered in the first part of the submission.

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3. International Adjustment Task

Nations across the world are selecting a mix of technologies that will produce electricity with low emissions under conditions of considerable uncertainties surrounding technology and capital costs. Australia is almost unique amongst large industrial economies in attempting to do this by relying on solar and wind as the primary energy source without the possibility of back up from an alternative large scale grid of the type available in California or Germany.

Australia is making a bold wager that we can get this right where others have failed. It is true that we have the land resource, location and geography that delivers superior natural resources in terms of solar and wind. However, these advantages do not eliminate the risk and create a number of challenges. Our view is that this path is likely to be viable only if we accept that the risks be properly integrated into the assessment of the long term back up and security services needed.

The AEMO has recognized that there is a problem associated with risk and uncertainty and has taken this into account in Section 7 of the ISP.

We do not disagree with the substance of Section 7 however the assessment of risk and uncertainty in the ISP report is too restrictive. In our opinion it does not fully cover the characteristics and magnitude of these risks and we recommend that this section of the report be further developed.

4. The ODP

The dual task of predicting the actions of investors and government and trying to establish an optimal path is difficult and we acknowledge that these two demands are a tough exercise for the AEMO to reconcile. The result is that the underlying rationale for some elements of the ISP is unclear. For example on p.22 of the Draft ISP 2022, the fact that solar and wind have grown in excess of expectations, and very much in excess of 2020 predictions, we are told that '*Modelling for the Draft ISP confirms that this rate of transformation will continue to accelerate* (see Part C).'(p.22). In Part C, however the aim is to conduct 'a rigorous analysis of the network investments needed (p.55) without providing the promised model of the rate of transformation.

Our comments similarly apply to the retirement of coal.

Further our comments should not be construed as questioning the assumptions but rather that the underlying rationale is unclear. Greater clarity at this level would deliver benefits at many levels and provide invaluable signals to the market.

Optimality Principle

The AEMO's prescribed purpose is '***t****o establish a whole-of-system plan for the efficient development of the power system* (p.18)'. The AEMO appears to direct its response to the question 'what can be done to accommodate our guesses about the development of intermittent energy sources?' This is a reasonable question. But it is not necessarily directed at achieving optimality across the system.

It might be helpful if the AEMO formed its ODP in a framework guided by principles of optimality.

It is consistent with the AEMO's purpose to understand what the optimal path is and use it to obtain a solid and transparent frame of reference for the predictions in terms of cost and sustainability for the entire system. Of course there are complications. Decisions may deviate, or stretch to accommodate market design. But aspiring for optimality reframes the problem in a way that rejects false or imprecise goals.

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Incorporating uncertainty

As an extension of our point on optimality, we believe that projections in the ISP and the ODP and the response to these projections, should take into account the uncertainty in the assessments of the capacity of solar and wind and enabling technologies. In particular, the forecasted potential capacity and contribution of these technologies **may significantly exceed actual capability**. This level of risk imposes large scale potential costs on the economy.

We suggest that it might be appropriate to consider the real economic costs involved more fully in terms of the standard economic tools of expected values, opportunity costs and options values of different pathways and technologies.

This extended analysis is likely to impact three sections of the 2022 ISP report:

a. the analysis of medium and long term storage;

b. the value placed on dispatchable energy;

c. the analysis of and projections based on energy markets.

Medium and long term storage

Our modelling suggests that the impacts of the economic costs of uncertainty would place much greater weight on medium and long term storage than the figures contained in the ISP. One reason is that the risks associated with developments in Distributed Energy Resources (for example, solar panels on roofs) and their ability to contribute to large scale storage capacity produce lower expected values than implicitly assumed. In this case **a detailed assessment of the investment required in firming and backing up solar and wind resources and the feasibility of providing this investment is likely to shape the recommendations in the ODP.**

Dispatchable energy

Uncertainties in battery developments, the availability of pumped hydro and other forms of medium to long term storage should also be treated in terms of economic costs and alternatives. Both the Government's long term emissions reduction plan and the ISP have not adopted this treatment. We concede it is difficult for AEMO to reconcile projections, Government targets and the instruments it can control. **One hedge against failure of non-existent or partially developed technologies to emerge would be to properly value thermal dispatchable technologies.**

Market based projections

It has been noted by the Energy Security Board that much of the back up and other security services provided to the grid are not captured in current markets and this creates obvious problems of underinvestment. In conjunction with the previous two points we suggest that it would be a useful addition to the ISP to consider the effect of a secondary market for services on the development of medium to long term back up and security services.

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5. Storage and distributed energy resources

In Section 8 AEMO supports its claim that coal fired plants cannot operate flexibly. This may or may not be the so but this conclusion does not apply to the case where existing coal fired plants are operated with alternative energy inputs which retain their value (including the significant infrastructure transmission and distribution) to the system.

We recognize that it is necessary to reduce coal fired generation, or develop carbon capture and storage, and this adds a layer of complexity to the predictions. But, if large scale capture and storage fails then we need to be careful that the imperative to reduce coal generation does not lead us to underestimate the value of large scale dispatchable generation and the benefits of retaining existing infrastructure.

It is important to recognize that these benefits go well beyond stabilization and supply security to providing options and flexibility in developing an optimal path. It is not at all clear from, say, the German experiment, that a transition away from thermal generation will be straightforward, or even possible. Nor is it clear that the costs of removing thermal generation and the steps required to compensate are well understood.

In order to avoid these costs we suggest that the ISP should include an analysis of thermal energy storage in its projections. IRENA's Innovation Outlook, Thermal Energy Storage 2020 explicitly stated that "thermal energy storage has the potential to be an important enabler of increased renewables penetration in energy systems". This technology directly responds to market needs for medium to long term storage and the risk abatement highlighted above.

Importantly, this technology has more specific application as support for thermal generation plants. This application is not well understood.

In brief, large scale thermal storage units can be used to replace coal as the thermal input to existing steam turbines in a thermal plant. To the extent that this is possible it would allow:

- the benefits to the grid of large scale dispatchable generation to be retained in full;
- existing infrastructure to be retained with considerable costs avoided in replacing transmission and generation facilities; and
- a fairly straightforward hedge against the uncertainties and risks associated with our current development trajectory.

In relation to the first two points, Macroeconomics Advisory has made a preliminary estimate of the average value of thermal outputs retained of between **$6 - $10 billion** per GW in costs avoided based on a conservative methodology.

In relation to the third, by retaining a major component of an existing centralized distribution network the development of the grid and our future energy requirements is spread across two different classes of technology. This not only reduces the risks associated with intermittent production. It reduces whole of economy risks associated with unforeseen developments in technology and the possibility that we may need to switch trajectories at some future time.

In terms of our introduction, by retaining the thermal production capacity and infrastructure, we reduce the probability of our bet regarding primary reliance on solar and wind failing.

It is understood that for the AEMO to consider thermal storage of the capacity required to run existing large turbines it needs to be a feasible technology. Preferably its prospects would have to be no worse than other technologies discussed in the ISP report.

In our estimation thermal storage is more developed as a viable technology than either low cost long duration electrical batteries or hydrogen. We do not consider pumped hydro a large scale solution because of the costs of developing smaller units and the environmental damage entailed.

On current figures thermal storage is also considerably less expensive than either electrical batteries or hydrogen. Because of the nature of the technology we estimate that this cost advantage will continue under feasible conditions.

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6. Closing remarks

The points raised in our submission are directed at highlighting certain aspects which we consider will significantly improve the ISP. Our suggestions in relation to long duration storage, its role in maintaining inertia and enhancing dispatchability and the economic value attributed to existing thermal generation are not the whole analysis but they are critical elements which we believe should be further developed within the analysis undertaken by the AEMO.

We are happy to provide further information on the calculations of options values and expected costs associated with risk and uncertainty around energy technologies.

We are also happy to provide further information on developments in thermal storage units with the capacity to run the type of turbines in existing thermal power plants.

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