MONASH
ENERGY MATERIALS
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# Integrated System Plan

## Modelling Approach


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# Assumptions and Approach to Modelling

The Integrated System Plan Consultation Report dated 22 December 2017 seeks input on the modelling approach by 2nd February 2018. This comment is provided by Dr Ross Gawler of Monash University with a view to recommending a different approach to the modelling. This comment refers specifically to Sections 1.3.1 and 1.4 of the Consultation report. A further submission may yet be made on the other issues raised.

The concepts of scenarios and sensitivities are useful when making investment decisions in the presence of uncertainty about the factors which influence investment in generation and transmission. However, this ISP is not intended to result in commitment to any particular investment, but rather provide a broad strategic map to indicate to investors where they should seek to develop new generation and transmission with a focus on renewable energy zones (REZ). To that end, it is uncertain whether the proposed approach will provide the richness of information needed by the many stakeholders across a region as broad as the NEM. It may meet the timing requirement for reporting but that will not be useful unless the resulting information can be used in decision making and further analysis.

A modelling approach with a base scenario and two bookends is the proposed methodology, plus some specific sensitivities for Snowy 2.0, the second Basslink crossing (here referred to as RELink[1]) as well as enhanced distributed energy resources which may be made up of demand side response, solar PV generation and distributed storage devices. There are some significant challenges with this approach:

1. The three scenarios combine too many diverse factors whose influences need to be understood independently, leading to a limited understanding from the scenario cases on which factors strongly influence the value of specific REZ, transmission routes and transmission projects. Indeed it is arguable that the strong and weak influences of some factors could readily be reversed between the slow change and fast change bookend scenarios.
2. The rate of change in itself will influence the timing of specific projects but it is less likely to influence the sequencing of projects and their inter-relationships. Therefore the scenarios may not reveal the key underlying value drivers for specific locations and classes of investment.
3. The treatment of Snowy 2.0, RELink and DER as sensitivities to the three recommended scenarios does not bring out the fact that these factors are key value drivers for transmission and generation development throughout the NEM and particularly south and west of Sydney. The sensitivities may well inform what additional or lesser transmission would be needed if these projects proceed, but they may not inform the market generally whether Snowy 2.0 and RELink are part of an optimal plan. Therefore, these proposed scenarios plus sensitivities may not well inform the stakeholders pursuing these particular investments. The method proposed below addresses this challenge.

[1] "A second Bass Strait crossing has also been referred to as Basslink 2 but this terms suffers from the commercial name for the existing Basslink, as originally proposed by the author in 1991 when at the State Electricity Commission of Victoria. The author proses the term RELink because it is a link to support renewable energy and it is another linking across Bass Strait.

4. The renewable energy trajectory, whether achieved by direct action, carbon pricing or an enhanced LRET and State based RET schemes is critical to the nature of the power system in 2050 when proposed transmission investment will be in their mid-life period. This is an important factor which would drive the optimal timing of specific investment classes and especially the larger REZ where there would be economies of scale in generation and to an even greater extent in transmission.

We therefore propose an alternative approach which analyses a large number of annual dispatch and investment cases using annualised project economic costs instead of three long-term scenarios. These annual scenarios would perhaps number at least 20 to 50 and may have randomly chosen but consistent sets of inputs. There would be a set of exogenous inputs which would be set for each annual case as shown in Table 1. Table 1 broadly follows the format of Table 1 in the Consultation Paper. Essentially, it is proposed that detailed electricity/gas market modelling be performed and as necessary, a transmission system dynamic analysis to find an optimal investment state for each set of randomised inputs.

The assumptions behind this approach are:

- The cost of well-established transmission and thermal generation technologies are the cost reference for the study as there is much less uncertainty about these than for renewable energy and storage technologies. Cost variation in other technologies would be considered relative to the well-established technologies in principle.
- Gas price and gas for power generation is derived in the modelling and is not exogenous.
- Retail power pricing including network and energy costs will influence the deployment of distributed resources. As much as possible, decisions about wholesale developments and deployment of distributed resources should be based on price effects and relative costs, rather than exogenous assumptions.
- It is desirable to test the viability of Snowy 2.0 and RELink for a range of projected costs so that the study will reveal the optimal associated transmission costs. It may not be feasible for the proponents to assess the viability of their projects at the same level of detail which AEMO could accomplish under the Integrated System Plan. By this means the ISP will provide an independent assessment of the conditions under which Snowy 2.0 and RELink are favourable.
- It is not necessary to model a carbon price as AEMO has recognized. This is because a carbon price is essentially an economic transfer seeking to represent the external effects of carbon pollution in the atmosphere. A carbon price would influence the level of demand through the retail price effect but it would not be a significant determinant of optimal transmission capacity for a specific level of wholesale demand for electricity. However, a carbon pricing policy may change the risk perception of investors and the effective cost of generation technologies versus transmission but it would not be sensible to try to assess this factor in the Integrated System Plan.
- The market simulations and transmission performance assessment will require different software frameworks and iteration to find optimal solutions.

Table 2 includes dependencies for associated modelling of gas price and retail electricity price that could link the distributed energy variables to the wholesale market decisions. As much as possible the market effects for small and large scale developments should compete through analysis of retail prices so that assumptions about supply and demand based decisions are internally consistent.

# Method

The current proposals are developed prior to a complete study of the ISP Consultation Report. This may be updated in future submissions.

It is expected that each annual scenario would be examined using the existing network to determine what thermal power plants would retire based on their avoidable costs or likely schedules, and then a market solution would be assessed assuming no significant network development apart from that necessary to connect REZ radially to the existing 330/500 kV backbone using indicative costs. RELink and Snowy 2.0 would be included as options, as well as distributed resources based on prices to prosumers. Based on the LRMC of the chosen resources and the constrained parts of the network, options for network reinforcement would then be added to the solution method. If necessary, the lowest cost generation resources added in the first phase would be retained. The next stage would be to identify where higher cost generation resources may have been added in association with network constraints or larger amounts of distributed storage. This would identify where network projects may be cost-effective to make lower cost generation and storage projects viable, such as Snowy 2.0 and off-river hydro pumped storage. The studies would be revised, keeping the low-cost generation resources (for convenience to reduce problem size) and allowing the choice between the higher cost generation and storage options and transmission augmentation. With that solution, the gas market and retail electricity market prices would be revised if necessary and the distributed resources revised before a final assessment is confirmed for each annual scenario. The result would be an optimsied investment state for each annual scenario. This would be optimal if demand did not change from this state. In view of the demand outlook presented by AEMO, this is expected to be a meaningfull result for a steady state market. The next stage would be to use this information to understand the value drivers for each major investment.

From the annual scenarios, for each major project (transmission, Snowy 2.0, RELink, off-river pumped hydro), the underlying economic and cost conditions that make them viable would be mapped in tabular and graphic form. This information would then support the analysis of the longer-term time-based scenarios as proposed by the ISP Consultation Report. Most importantly, this method would reveal the conditions under which each project and class of projects serve to reduce total electricity costs. It would also reveal the stranding conditions for each class of investment where they may be viable during the transition to low emissions but not when the abatement level gets to 70% to 90% reduction with low costs for distributed resources and energy storage. This is a particular risk for large scale transmission due to its fixed long-term cost and long technical life.

**Table 1 Framework for Scenario Modelling for the Integrated System Plan**

| Inputs (R= Randomised) | Relevant Derived Inputs and variations | Distributed Resources Estimated | Discrete Renewable Energy Generation Projects Tested | Discrete Thermal generation Projects Tested | Discrete Transmission Projects Tested |
|---|---|---|---|---|---|
| Economic Factors (Gross National Product) (R)<br>State Growth (Gross State Product) (R) | Regional native peak demand, energy and load profile excluding electric vehicles. Demand levels should be considered to cover a period up to about 2060 to allow at least 40 years of transmission life to be tested. | | | | |
| Cost of solar PV for small and large scale use (R) | | Distributed solar PV based on customer decisions | Large scale solar PV arrays considered in suitable REZ | | |
| Cost of solar thermal power (R) | | | Large scale solar thermal power considered in suitable REZ | | |
| Cost of battery technology for small and large scale (R) | | Distributed battery storage quantities based on customer decisions and aggregation models | Large scale battery storage considered at distribution and transmission level | | |
| Penetration of electric vehicles (R) | Demand component added to reflect electric vehicle charging: controlled and uncontrolled components made be represented (and varied in the annual scenarios) | | | | |
| Emissions reduction level (R) | Specify a proportional reduction of carbon emissions relative to 2005 from say 15% up to 90% | | | | |

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| Inputs (R= Randomised) | Relevant Derived Inputs and variations | Distributed Resources Estimated | Discrete Renewable Energy Generation Projects Tested | Discrete Thermal generation Projects Tested | Discrete Transmission Projects Tested |
|---|---|---|---|---|---|
| Large Generation Renewable Energy targets – LRET (R) | Assume 33 TWh remains to 2030 as well as higher levels up to say 200 TWh or 90% of wholesale energy supplied as appropriate to the annual scenario | | | | |
| State based RET (VRET and QRET) derived according to LRET | These State based schemes may not be politically robust and could be replaced in the future if LRET is increased. Therefore it might be best to define an LRET and then allocate a State target if LRET is not greater than say 40 TWh. | May influence distributed solar PV and storage depending on impact on retail tariffs for small customers. | | | |
| Energy efficiency of appliances and buildings (R) | Add an efficiency factor to the native demand based on variation below the based forecast derived based on economic activity. | | | | |
| Cost of aggregation of distributed resources | A low cost of aggregation technology would facilitate greater quantities of demand side response. | Influences the penetration of demand side response by small customers in relation to retail tariffs | | | |
| Wind Power costs and performance – utility scale (R) | A range of cost reduction considered, perhaps with some correlation to cost reduction for related technologies such as solar thermal | | Wind projects in suitable REZ | | |
| Gas demand LNG (R) | Variation from current projections. Influences the price of gas for local power generation | | | Influences gas price and availability for new power projects, especially peaking | Gas transmission projects may be influenced by LNG demand |

| Inputs (R= Randomised) | Relevant Derived Inputs and variations | Distributed Resources Estimated | Discrete Renewable Energy Generation Projects Tested | Discrete Thermal generation Projects Tested | Discrete Transmission Projects Tested |
|---|---|---|---|---|---|
| Gas demand for local needs (R) | Variation from current base projections. Influences the price of gas for power generation. | | | and intermediate duty. Determines gas required for power generation and gas price. | Gas transmission projects may be influenced by local demand |
| Gas resources (R) | The proven and probable gas reserves should be varied at each point in time to estimate how much spare capacity is available and hence the prevailing wholesale gas price. | | | | |
| Snowy 2.0 capital cost and performance (R) | | Will reduce the viability of distributed storage by flattening the wholesale price volatility. | Influences the viability of Snowy 2.0 and new REZ, particularly in Western Victoria and southern NSW | | Influences the optimal development of the NSW-Vic-SA interconnections and state networks. Snowy 2.0 tested for optimality in each case |
| RELink cost and capacity options (R) | Connection of RELink between western Tasmania and western Victoria as various options. | | | | The location of RELink connections may need to be considered if 500 kV developments are anticipated in Victoria. RELink tested for optimality in each case. |
| Off-river pumped storage technology | A cost of off-river pumped hydro for some favourable sites should be included if only to show how this technology would interact with grid development. | | Off-river hydro storage projects tested in favourable locations relative to Snowy 2.0 and RELink | | |

**Table 2 Linked variables and supporting modelling for scenario modelling**

| Key Intermediate variable and modelling | Factors which influence it | Factors it influences |
|---|---|---|
| Gas price for power generation (wholesale gas market) | Deployment of new gas transmission and overall demand for gas relative to gas supply and resources | Optimal deployment of new gas powered generation as substitution for storage capacity |
| Retail price of electricity for small residential and commercial consumers (addition of wholesale energy and network service costs + retail components) | The wholesale electricity price as influenced by the optimal investment state in each year. | The deployment of distributed resources, particularly solar PV and distributed storage. |

**Figure 1 Outline of Method of Analysis**