Plan B review - Jacobs' report - Volume 1

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DEECA

Mountain-Bartlett Report – Review
8 March 2024

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Executive summary

Jacobs has undertaken an independent assessment on behalf of DEECA of the feasibility and merits of the proposal: 'No Longer Lost in Transmission' (Aug 2023) prepared by professors Bartlett and Mountain and Darren Edwards. The proposal is referred to as the Plan B report. The physical network changes proposed (as an alternative to VNI West) are referred to as Plan B.

Jacobs has been asked to review[1]:

- Plan B report's assessment of VNI West (VNIW) transmission project (Scope Area A)
- The Plan B Electricity Transmission Network Plan as detailed in the Plan B report (Scope Area B), and
- Any consequential recommendations arising from the review (Scope Area C).

VNIW is a proposed upgrade to the Victoria to NSW electricity interconnector to allow more electricity to flow each-way between these two regions of the National Electricity Market (NEM). Plan B has been suggested as an alternative to VNIW and is a proposed upgrade to elements of the electricity network within Victoria (with some changes to the connection with NSW).

The objectives of VNIW and Plan B are different and the differences are important in this review. The objectives are summarised in Table 1 below. As Plan B advocates for an amendment of the VRET calculation, and bases its assessment of VNIW and Plan B against this changed measure, this change has been included in the table as an objective of Plan B.

Table 1. Objectives of the two plans

VNIW objectives as described in the PADR[2]	Plan B objectives
The "identified need' for the VNI West project is to increase transfer capacity between New South Wales and Victoria to realise net market benefits by:[3] ▪ Efficiently maintaining supply reliability in Victoria following the closure of further coal-fired generation and the decline in ageing generator reliability – including mitigation of the risk that existing plant closes earlier than expected ▪ Facilitating efficient development and dispatch of generation in areas with high quality renewable resources in Victoria and Southern New South Wales through improved network capacity and access to demand centres ▪ Enabling more efficient sharing of resources between NEM regions	Plan B is designed to deliver sufficient transmission infrastructure to deliver Victoria's Renewable Energy Target (VRET) of 65% (of Victorian electricity generation) to be supplied by renewable sources in Victoria by 2030, and 95% by 2035. In addition, Plan B is designed to meet three subsidiary objectives (and two further objectives): ▪ less than 13% curtailment, and marginal loss factors exceeding 0.93 in the Murray River and Western Victoria REZs (i.e. even lower curtailment and smaller marginal losses in the other REZs); ▪ no Single Points of Failure (SPoF) on new transmission lines that are likely to be defined as Systems of National Significance under the Security Legislation Amendment (Critical Infrastructure Protection) Act 2022 (SLACIP Act); and ▪ minimising the amount of new land required for transmission by making use of existing transmission networks and easements wherever possible

[1] Jacobs' full terms of reference and approach are included in the body of this report and the Appendix A

[2] Project Assessment Draft Report, AEMO and Transgrid, published July 2022

[3] This is footnoted to the 2020 ISP page 87. This was the table of Actionable Projects in that ISP. The need is expressed the same.

VNIW objectives as described in the PADR[2]	Plan B objectives
	▪ Minimising public opposition (which has been a material source of delay for transmission projects). ▪ Diversifying large scale supply around the State.
▪ VNIW assumes the current definition of the VRET remains where the legislation will[4] specify that (in 2035) 95% of electricity generated in Victoria is to be by renewable generation.	▪ Plan B advocates and assumes that the VRET definition be amended to require that (in 2035) renewable generation in Victoria must be at least 95% of Victoria's load

The first part of establishing the merits of VNIW and Plan B is to consider the extent to which they meet the objectives. The summary of Jacobs' assessment is given in **Table 2**:

Table 2. Evaluation against objectives of the two plans

VNIW objectives	Plan B objectives	VNIW	Plan B
Increase interconnection transfer capacity		Yes	No. Plan B reduces interconnection transfer capacity
Maintain supply reliability in Victoria when brown coal retires		Yes	Yes, but requires large storage additions
Facilitate efficient development and dispatch of renewable generation in Victoria and Southern NSW		Yes	Yes in Victoria, no in Southern NSW
Enabling more efficient sharing of resources between NEM regions		Yes	No
Meet VRET as presently legislated		Yes	Yes
	Meet VRET based on Plan B proposed amended form	No[5]	Yes, provided the additional storage likely to be required is included. Otherwise, more gas fuelled generation in Victoria would be needed

[4] The 2035 target is not yet enacted but has been announced as the intended legislated targets

[5] In the VNIW RIT-T modelling (Step Change) Victoria is a net importer of electricity over the relevant period. Under the Plan B formulation net imports + fossil fuel generation cannot be more than 5% of Victoria's load

VNIW objectives	Plan B objectives	VNIW	Plan B
	Curtailment and MLF improved in V2 and V3 REZ in Victoria	For plants to east of VNIW alignment but not those to the west. There would likely be improvement in some MLF in the west but not in curtailment	Yes, but needs more storage to avoid market curtailment
	No single points of failure	Yes[6]	Yes
	Minimise land use and use existing wherever possible	Poorer	Better
	Minimising public opposition	Local opposition is noted	Stakeholder consultation has not been undertaken so no gauge of opposition is available
	Diversifying large scale supply around the state	VNIW is an enabler for offshore wind in Gippsland and Portland and enables onshore development along its alignment. Other onshore development in Victoria will depend on other transmission projects	Plan B describes adding additional hosting capacity of 11,488MW over five REZs

In addition to the above comparison, the Plan B report suggests that the interconnection benefits have no value and do not provide diversification of variable renewable generation, and for this reason interconnection is excluded as an objective of Plan B. Jacobs' review has found that there is value in increased interconnection. Jacobs have identified using our own calculations that there is value in the diversity of output and parameters of geographically distributed generation. The Integrated System Plan (ISP) cost-benefit-analysis (CBA) and the CBA done for the Regulatory Investment Test – Transmission (RIT-T) both show positive benefit from increased interconnection. In the ISP the benefit is as a part of a portfolio of network upgrades and in the RIT-T on a with-versus-without basis on VNIW specifically.

The with VNIW versus without VNIW case presented in the RIT-T shows a material benefit overall and impacts in every NEM region, not just in Victoria and NSW. Jacobs notes that the Plan B report disagrees with inputs and assumptions made within the RIT-T and its CBA, however Jacobs' view is that the inputs and assumptions used in the RIT-T (and the ISP processes) are valid for the purposes used.

[6] The Plan B report concludes that VNIW design as double circuits on common towers represents single points of failure necessarily leading to widespread blackouts. Jacobs review findings are that there are no single points of failure in VNIW as discussed below

Interconnectors, including VNI West, can also provide benefits that are difficult to quantify in monetary terms and these types of benefits are not (or not fully) reflected in the CBA economic analysis. These include:

- Sharing of reserves and increase in reliability of the system[7]
- Sharing of ancillary services.
- Sharing of energy storage and renewable energy generation sources between NEM regions
- Supporting decarbonisation measures
- Enabling the benefits to be accessed of other major industry projects (such as Snowy 2.0 and all other pumped hydro storages, Project Energy Connect, HumeLink, Marinus and offshore wind).

Jacobs does not agree with the argument advanced in the Plan B report that equivalent generation projects can be built in Victoria with equivalent cost and benefits compared with project options beyond the northern end of the proposed VNIW.

There are many differences between potential generation projects in Victoria when compared with projects north of Victoria such as: capital cost, technical performance, siting factors (land availability, existing usage and land cost), population density/neighbours, environmental constraints, grid access and strength, congestion, output profile diversity for specific times of the day/year and others. Indicative capital cost per MW and annual capacity factor are not the only parameters that dictate the optimum generation build location. Sometimes the best option will be in Victoria and sometimes inter-state. Market modelling is appropriate to evaluate the likely least-cost development path to meet the NEM loads. Not all of the factors above are included in a typical market model analysis however capital cost, capacity factors, grid availability and losses, and diversity of output profiles are typically included. Some of the other factors are considered (qualitatively or quantitively) by AEMO in its assessment of the hosting capacity of REZs and this also influences market modelling outcomes. Thus, the proposition in Plan B that equivalent generation projects can always be built in Victoria and that, as a result, the interconnection benefits are minor, is not supported by Jacobs.

With respect to security of the system, the Plan B report claims that VNIW introduces 1,000 single points of failure (referring to 1,000 double circuit towers) and that a double circuit outage on VNIW would cause a cascading power system collapse in Victoria. To evaluate this proposition, Jacobs has carried out a load flow study and indicative stability analysis for the failure of both circuits under maximum normal flow to Victoria conditions. The study determined that the expected system response is within industry norms and without apparent catastrophic failure,[8] and hence Jacobs does not agree that VNIW (or its elements) represent a single catastrophic point of failure in the manner described in the Plan B report.

Feasibility

The summary of our assessment of VNIW and Plan B against a set of high-level feasibility criteria is shown in **Table 3**.

[7] Such as the matters surrounding risks consequent on the retirement and ageing of the brown coal generation fleet in Victoria, as described in section 7 of the NEVA order gazetted 27 May 2023

[8] This is a study for the purpose of this review. Jacobs expects that system planners and designers will undertake many detailed evaluations in the design and implementation of this project, and will apply appropriate protection systems in the implementation as are employed elsewhere in Victoria and the NEM

Table 3. Feasibility assessment summary

Feasibility criteria	VNIW	Plan B
Does it meet its objectives?	Refer **Table 2**. It is feasible in its current stage of development	Refer **Table 2**, and as detailed below it may be feasible subject to further analysis to determine that it is conceptually viable
Is it likely to be deliverable?	Yes, assuming appropriate downstream engineering, and approvals are obtained	Yes, assuming appropriate downstream engineering and approvals are obtained
Is it likely to be what is described?	Yes, although the progress of the project from its current corridor concept to a specific route and easement will likely lead to localised adjustments to the as-built length and hence some cost adjustments may ensue	Generally yes, although localised departures are considered likely to meet brownfield project constraints unlikely to be known at the concept design stage. Jacobs expects solutions can be found to deal with such constraints, although cost impacts may arise
Is it likely to be economically feasible?	Yes, Jacobs has no reason to reject the assessment within the RIT-T prepared	Plan B report describes indicative capital cost but there is no overall economic assessment. The outcome against other alternatives would depend on whether the Plan B objectives were accepted as worthwhile changes to the rules

In the Plan B report an Extended VNIW plan was put forward for Plan B to be compared against (as opposed to comparing against VNIW). Extended VNIW includes VNIW, Western Renewables Link (WRL) and five additional transmission augmentation projects that together comprise of 1,233 km of transmission line in addition to the 236 km of VNIW and 190 km of Western Renewables Link (WRL). These additional transmission augmentation projects added to VNIW in the Plan B report are included in order for VNIW to be evaluated against some of the Plan B objectives, including to meet VRET based on the Plan B report's proposed amended form, and objectives for curtailment and MLF to be improved in V2 and V3 REZ in Victoria (refer to **Table 2**). The Plan B report also says the upgrades are required to achieve VNIW's claimed hosting capacity additions, but this is based on different expectations of how those future generation additions would be sited (VNIW proponents expect new generation can connect along VNIW itself – Jacobs agrees that it could but suggests further evaluation of enabling more westward developments via possible upgrades to the network to the west of VNIW alignment[9]).

These Plan B objectives (for a modified VRET) are not part of the National Electricity Market objectives nor the Victorian VRET legislation. If decision makers accept some or all of Plan B's proposed differing objectives and they become required objectives, then VNIW would need to be re-worked and optimised, or a different set of projects conceived for evaluation (one option for which might be Plan B or an extension of Plan B) to make it compatible with the changed objectives.

[9] This is not included in the review of VNIW as it is not a necessary part of VNIW or a part of the benefits claimed by VNIW in the RIT-T. It would be a separate project evaluation. These western sides of the state beyond Bulgana and Kerang are part of the focus area of Plan B

In the case of the proposed change to VRET, it would result in additional Victorian renewable energy generation (above that which is economic under the current rules) being built in Victoria whereas otherwise it would be more likely to be sited elsewhere.

The Plan B report has a proposed change to make specific constraint and MLF limits into additional criteria. This would be a change beyond the current process and may not be the optimum economic solution. The existing evaluation framework is intended to identify the highest net benefit to all those who produce, transport and consume electricity. As such, it is directed to finding the best balance of constraint and losses against costs. An optimum level of constraints and losses would be an outcome rather than a specific level of constraints and losses being an objective. There is no impact assessment contained in the Plan B report on the additional costs and other key measures such as emissions that might result to Victorians if those objectives were added, and it is recommended that effects should be assessed before changing the objectives.

Jacobs does not make the value judgements required to say whether the Plan B objectives are appropriate against their cost. This is not within Jacobs' scope for this review. The review has included descriptions of some of the impacts expected with the proposed objectives for consideration by decision makers.

Plan B has not undergone market modelling and simulation. The Plan B report shows annual GWh values. To understand how Plan B might meet Victoria's load across the year under the constraints Plan B has adopted, Jacobs has undertaken a simulation of the 2035 financial year on a single scenario (Step Change) and considering only the Victorian region. The analysis considered the time variability of the load, and the variability of solar and wind generation output relative to the load. The simulation results raise concerns that Plan B might not achieve its objectives over the year. The simulation suggests that one or more of the following would be necessary:

- Build much more storage in Victoria, potentially a multiple of the proposed capacity in the Victoria's energy storage targets[10].
- Build more intra-regional transmission, solar and wind generation and allow a significant amount of *market* curtailment[11]. Besides the additional cost, it may violate the subsidiary Plan B objective of reducing curtailment
- Build and operate more gas fired power generation in Victoria[12]. This would increase Victoria's gas usage and greenhouse gas emissions from the sector however it may still "fit" within the VRET target under the Plan B proposed redefinition[13]
- Upgrade one or more of the interconnectors to significantly higher capacity (to NSW, Tasmania and/or SA)

The difficulty appears to arise as the following may be incompatible:

- The Plan B proposed change in VRET making more variable renewable energy generation locate in Victoria.

[10] Proposed to be legislated as at least 2.6 GW of energy storage capacity by 2030 and at least 6.3 GW by 2035 - https://www.energy.vic.gov.au/renewable-energy/victorian-renewable-energy-and-storage-targets

[11] Plan B has a target to reduce curtailment in north-west Victoria by intra-regional network upgrades. Curtailment that is reduced in this way is network curtailment. There is another type of curtailment with the same impact called market curtailment – where the Victorian load is not high enough at a particular time to absorb the available renewable energy generation and there is insufficient storage or interconnector export capacity to use it

[12] In the period to 2035 gas fuelled peaking generation is the only practical alternative

[13] Under the existing definition in VRET gas fired generation cannot exceed 5% of generation and since under VNIW Victoria is expected to import more electricity and hence generate less itself, the allowable gas fired generation should reduce. Under Plan B's proposed changes once an amount of renewable generation is achieved (95% of the annual load) gas fuelled generation can make up any portion of further generation. Since under Plan B Victoria is likely to be a net exporter (due to the overbuild of variable generation needed to meet the load at difficult times of the year), there will be more potential for gas fired generation under VRET.

- The finite REZ hosting transmission capacity upgrades adopted.
- The lack of upgrades to the interconnections, and
- The curtailment target.

This cannot be established with confidence without appropriate market modelling and detailed multi-year simulation, however Jacobs' modelling done for this review suggests the concern is warranted. Plan B may need modification to meet its objectives, or the stated Plan B objectives may need to change.

Jacobs concludes that VNIW is feasible in its current stage of development, and that Plan B may be feasible subject to further analysis to determine that it is conceptually viable against its objectives. However there are concerns that Plan B may not factor in the storage requirements that might be needed to make it work, and which may not be feasible.

Merit

Jacobs' assessments of the merits of the proposals are given in **Table 4**: This does not repeat the objectives-based merits discussed above.

Table 4. Merit assessment summary

Merit criteria	VNIW	Plan B
Benefit to consumers[14]	Yes (has benefits over RIT-T Base Case)[15]	No. Costs will be higher than the RIT-T Base Case as Plan B is more constrained in siting of new generators than the Base Case and may need extra storage or gas generation or other modifications to the plan
Transmission costs[16]	Higher costs due to cost of project, but similar to Plan B case	Higher costs due to cost of project, but similar to WRL+VNIW case
Capex[17]	VNIW: $3.499B (June 2021 real incl WRL extension) WRL[18] $737M in $2021[19]	$4.952B, $2022
Hosting capacity of renewable generation	Adds capacity to Victoria, localised to the VNIW alignment and to its east. Does not need as much new generation to be based in Victoria V2: +1,580MW V3: +1,600MW N5 (NSW): +900MW +4,140MW	Adds more capacity in Victoria: V2: +2,471MW V3: +1,914MW V4: +3,000MW V5: +3,000MW V6: +1,100MW +11,485 MW
V2 and V3 existing generator congestion impacts	Improves for generation on and to the east of VNIW alignment but not to the west	Improves, including in the west
Easements	Needs new easements	Uses existing alignments but with changes (10 to 20m expected) to existing easements. May need new easements around localised constraints. Spare easement suggested does not exist

[14] In the case of VNIW this is a general statement with respect to consumers over the NEM. The benefits and the cost allocation/sharing specifically to Victoria have not yet been developed

[15] The CBA is based around benefits accruing as "Market benefits are the present value of the estimated economic benefits from the [projects] to those who consume, produce and transport electricity in the market". It assumes that competition and regulation (for networks) deliver the benefits to consumers in the long run

Merit criteria	VNIW	Plan B
Specific elements contained in the respective Multi-Criteria Analysis (MCA)	Should not be considered against each other until objectives agreed	Should not be considered against each other until objectives agreed

Primary factors

Jacobs considers that the following are the key factors that decision makers should consider in evaluating whether Plan B is a potential or feasible alternative to VNIW:

- The re-statement of the 2035 VRET target proposed in the Plan B report to be based on meeting 95% of Victoria's load by Victorian renewable generation (as opposed to the legislated model where 95% of Victoria's generation must be renewable) is fundamentally different and would have impacts beyond either VNIW or Plan B. Unless decision makers adopt the changed VRET formulation (and also accept the Plan B report's assessment of rooftop PV growth) it is unnecessary to evaluate VNIW as Extended VNIW in the way described in the Plan B report and so some key conclusions of the Plan B report are not supported by Jacobs. Under the Plan B proposed amended formulation of VRET not more than 5% of Victoria's load (in 2035) can be met by the sum of net imports plus fossil fuel generation. Unless the interconnectors are mainly for export (which requires overbuild of RE in Victoria), any significant amount of interconnector capacity (for import) to Victoria becomes largely unusable under the Plan B plan
- The Plan B report dismisses any value in interconnection. There is strong evidence that interconnectors are valuable and are necessary for the energy transition to "work" at optimum cost. Jacobs does not support the dismissal of the value of interconnection in the Plan B report.
- Jacobs expects that for Plan B to work, a large amount of additional storage and (possibly) gas fired power generation will be required to supply each and every time interval across the year rather than just considering the annual energy requirement. The Plan B report primarily describes capital cost as the parameter for making economic comparisons with and differences in storage costs, support generation (e.g. from gas) and renewable energy over-build needed to match the load profile are not included. Accordingly Jacobs view is that the total cost is understated in the Plan B report.
- The Plan B report puts forward a comparison based on capital costs of the network works. If VNIW is evaluated as VNIW instead of Extended VNIW (considering the first point above), the capital costs are of similar magnitude and no strong argument on capital costs alone for either VNIW or Plan B exists.
- Aside from capital costs (and OPEX), an evaluation of whether there are net market benefits delivered from Plan B and hence whether the cost of Plan B is in the interests of consumers is not provided in the Plan B report. However, it can be inferred from the VNIW cost benefit analysis (CBA) that Plan B would be relatively unattractive as follows[20]. The Base Case of the VNIW CBA is a market without VNIW and with the market served by the least-cost arrangement of renewable energy, storage and transmission across the NEM. Plan B is the same market but with some generation that would have been more optimally located elsewhere forced to locate in Victoria due to the re-stated VRET target method proposed, plus a likely larger amount of storage needed in Victoria than is otherwise optimal. Logically, this results in a

[16] Since the capex is similar it is expected that overall transmission cost increases would be similar. Some of the VNIW costs would be shared across other regions whereas all the Plan B costs would be borne by Victorian customers.

[17] "Overnight" basis (ie excluding IDC) where cost by state is $1.744b for NSW and $1.755b for VIC

[18] Note Plan B bundle VNIW and WRL

[19] https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/victorian_transmission/2022/aemo--clause-5164z3-analysis--wrl-project--november-2022.pdf?la=en&hash=6C69FC7AAEB1C36FE0A3F65AC99BB614. This is the TCD estimate without IDC and without deducting sunk costs

[20] This point assumes that VNIW is evaluated as VNIW and not as Extended VNIW

poorer economic outcome than the Base Case. Since the VNIW net benefits are better than the Base Case and the Base Case is better than Plan B it follows that VNIW is better than Plan B from an economic perspective (if the benefits that decision makers attach to the alternative VRET method proposed in the Plan B report are considered to be worth the cost impact then this may change the overall desirability of Plan B but are not likely to change Jacobs' economic assessment).

- Jacobs does recognise that VNIW has yet to achieve a "social licence" within the community and that there are elements of the Plan B concept that affected communities would be expected to consider as having lower impact, such as being close to existing alignments for the portion within the V2 and V3 REZs. If Plan B were to proceed further, stakeholder consultation would be very desirable to understand the community's views on the overall impacts including the differences in number, size and locations of associated renewable energy generation/storage and the necessary connection assets to the grid, in addition to consideration of the backbone transmission infrastructure.

Secondary factors

The following factors are important matters raised in the Plan B report about VNIW or Plan B but which don't weigh strongly in whether Plan B should or should not be substituted by VNIW, or whether Plan B has merit separately:

- Jacobs does not agree that VNIW as a double circuit 500kV project is an unacceptable risk of cascading failures leading to widespread blackouts in Victoria. Our analysis suggests the risks are within industry norms.
- Other than the issue of finalising the route of VNIW and securing the easements and land access required, Jacobs does not see significant differences between VNIW and Plan B buildability and project delivery risk. The two projects have differences (greenfield versus brownfield, new land impacted rather than adjacent/near land impacted etc) however none of the matters explored are considered likely to be unsolvable within the detailed implementation phases.

Conclusions

Plan B report's assessment of VNI West (VNIW) transmission project (Scope Area A):

Jacobs does not support the Plan B report's assessment of VNIW (being replaced by the Plan B configuration) for the following reasons:

- The VNIW objective to strengthen the interconnection capacity with NSW is considered important – Plan B does not meet this objective
- Without adopting the Plan B report's proposed changes to VRET, VNIW can be compared directly with Plan B and on this basis Plan B is not superior to VNIW in economic terms, nor in achieving NEM objectives. The comparison of Extended VNIW against Plan B is not necessary. If the government decides that there is merit in the alternative formulation then there are likely to be lower cost ways of achieving the target with the alternative formulation than to undertake the Extended VNIW works that Plan B propose.
- Jacobs' review finds that VNIW will not lead to cascading blackouts in Victoria in the manner described in the Plan B report.
- Jacobs' review finds that VNIW is consistent with Victoria meeting the 2035 VRET target as it is specified.

The Plan B Electricity Transmission Network Plan as detailed in the Plan B report (Scope Area B)

Plan B's objective to host a specific amount of renewable generation based on load MWh in Victoria to meet VRET or otherwise is not a recognised objective of the NER or Victorian law/policy. If such a change to VRET is not adopted, then there is reduced merit in Plan B.

There is no objective for a specific level of curtailment in the NER separate from providing lowest costs to customers as an eventual outturn.

Plan B without interconnection upgrade would require significantly more storage and/or curtailment in Victoria. The cost of the additional storage required is likely to be significant. This capex is not included within the Plan B capex. Plan B would not meet its objectives without the additional storage

Consequential recommendations arising from the review (Scope Area C)

Jacobs does see merit in VicGrid having an additional look at the grid west of Bulgana/Kerang to see if an upgrade (in conjunction with VNIW) could benefit customers and have benefit by attracting new generation away (further west) from the Bulgana/Kerang alignment (and hence potentially reducing stakeholder impacts). It has been a number of years since it was last evaluated, and an update of its cost-benefits may be warranted. This considers:

- Existing generation has located in V2 and V3 above the existing 220kV transmission capacity. There are network constraints on the output. If in relieving the constraints there is a market benefit of a type that is allowed in a RIT-T evaluation – deferring other new generation for example – then this may provide a lower cost option to access the additional MWh than other options
- The presence of VNIW divides the two relevant REZs (V2 and V3). It is expected to have the effect of relieving constraints and MLFs for existing and new renewables generation along its length and to the east, but will have no effect to the west of its alignment. The portions of Plan B that would be of interest would thus be Redcliffs-Murra Warra-HOTS-Bulgana (approximately 300km) on the south and west sides of the rhombus and Redcliffs-Wemen-Kerang (approximately 230km) on the north side.
- The presence of VNIW will also draw renewable energy developments to its alignment because of its transmission capacity relative to the 220kV network. Each renewable energy development will have its own impact in footprint, noise (wind) and aesthetics (wind), and will generally have connection assets. Given that population density (refer Section 3.10) and competing land uses increase as you move eastwards across the rhombus this may have a higher impact on stakeholders than if renewable energy developments were further westward and the energy was brought across to the VNIW alignment via upgraded intra-regional transmission

Other matters

VNIW fits into an overall "jigsaw" puzzle including Marinus, Project Energy Connect, HumeLink, Snowy 2.0 and offshore wind. These other infrastructure pieces will have materially less value without VNIW. The identified need for interconnection that is met by VNIW is not met by Plan B. The Australian Energy Regulator (AER) has indicated[21] that when AEMO establishes the identified need for a project it must consider "maintaining the integrity of the optimal development path, reflecting that AEMO has identified each actionable ISP project to make a particular contribution towards achieving a system-wide optimised solution". VNIW and WRL are part of this integrated plan.

[21] AER "Cost benefit analysis guidelines - Guidelines to make the Integrated System Plan actionable", October 2023, at page 53

Offshore wind in Victoria in particular, at the scales identified in the Victorian Offshore Wind Policy Directions Paper[22], needs significantly enhanced interconnections and storage to manage the large, highly correlated, generation levels that would ensue.

The VNIW RIT-T cost-benefit analysis evaluation does not include some of the additional benefits of VNIW that are not costed or detailed in the AEMO documentation. This includes increased reliability and security (by increased meshing), and sharing of ancillary services between regions.

Plan B primarily addresses the period to 2035, and the Plan B report states that attempting to plan beyond 2035 invites grave mistakes given the enormous uncertainty about Victoria's future electricity demand and the prodigious rate of technology change. However, the energy transition will continue well beyond 2035 and requires transmission planning to be aligned efficiently with the needs of longer-term ambitions[23] such as net zero goals and the expectation that load will continue to grow due to (for example) electrification of loads presently served by natural gas, electric vehicles, and potentially green hydrogen production.

The NEM costs and benefits are to be evaluated over the whole NEM, not just over Victoria (sharing of the costs between regions on the basis of the share of benefits to be received is a later stage of the regulatory process). The Plan B report does not adequately consider these whole-of-NEM matters but focusses only on the Victorian context.

Further consequential suggestions arising from the review

- Improving the MCA process for transmission projects would appear to have merit based on this review. Governance arrangements for setting the criteria and weights should be made transparent. The governance body should set the criteria and weightings and should sign off on the scoring (with the scoring typically done by the working team for a proposal). Criteria should include all objectives of the relevant policy and legislation (NER, planning and environment, GHG policies, industry development policies etc). Criteria should cover those areas where a hard-to-quantify cost or benefit has not been included in the CBA but is material to decision making (reliability, security, strategic fit, resilience, stakeholder impact, planning and environment, do-ability/risk). Based on this review it appears that the criteria used in the PACR appear too narrow (albeit they are only used in the PACR to compare two similar options).
- VicGrid should review whether the current framework produces incrementalism. For example, if in 2050+ would it be preferable to have 500kV circuits to an area instead of three times as many 220kV circuits? What is the balance between under-build regret and over-build regret under the specific issue of the energy transition?
- Critical infrastructure should be identified and formal risk/hazard assessments (likelihood, consequence, mitigation, conclusion) should be brought forward in the planning cycle to recognise this in decision making.
- Where an element in an MCA assessment (such as visual impact) could be adjusted or mitigated using things like alternative tower designs, then this should be considered in the concept (and any consequential cost impacts in the CBA) and the MCA should be adjusted before the MCA process is finalised and decisions made.
- Jacobs notes that increasing community engagement and enabling it earlier in the planning process is an area being considered (noting rule change process underway). Jacobs suggest reviewing the arrangements to see if they are adequate. Engaging with stakeholders in the broader community in earlier processes (such as ISP), for example may improve the planning process.

[22] https://engage.vic.gov.au/victorias-offshore-wind-policy-directions-paper-developing-the-offshore-wind-sector

[23] IEA (2023), Electricity Grids and Secure Energy Transitions, IEA, Paris https://www.iea.org/reports/electricity-grids-and-secure-energy-transitions, License: CC BY 4.0

Jacobs' response to the Plan B authors' comments on the draft report

The Plan B authors made a submission to VicGrid on Jacobs' draft of this report. The draft had been provided to the Plan B authors (and to AEMO). The submission is appended to Volume 2 (in Appendix C18) of this report.

The matters raised in that submission are responded to by Jacobs as a separate section of this report (Section 5 below).

Besides the inclusion of some additional supporting materials in the Volume 2 (Information document), and the Section 5 below, there are no changes to Jacobs' substantive evaluation and conclusion arising from that submission.

ⓘ Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to provide an independent assessment on behalf of DEECA of the feasibility and merits of the proposal: 'No Longer Lost in Transmission' (Aug 2023), in accordance with the scope of services set out in the contract between Jacobs and VicGrid (a division of the Department of Energy, Environment and Climate Action – DEECA, Jacobs' Client'). This report does not include an assessment of the appropriateness of Plan B objectives against their cost, or a review of the accuracy of completeness of AEMO responses to Plan B proponents submissions, nor does it include a peer review of the whole of the AEMO/Transgrid work.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by DEECA and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate, or incomplete then it is possible that our observations and conclusions as expressed in this report may change. The information provided in this report is sufficient to assess the technical feasibility and merits of Plan B. Studies, calculations, detailed design, consultation and environmental/planning consent activities will need to be undertaken to determine the actual requirements and design for any of the projects discussed in this report.

Jacobs derived the data in this report from information sourced from the Plan B materials, AEMO and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full, and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of DEECA and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and DEECA. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

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Acronyms and abbreviations

Acronym/abbreviation	Interpretation
AC	Alternating Current
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APD	Alcoa Portland (smelter)
AVP	AEMO Victorian Planning
BESS	Battery Energy Storage System
Capex	Capital expenditure
CBA	Cost Benefit Analysis
CCGT	Combined Cycle Gas Turbine
CDP	Candidate Development Path
CHMP	Cultural Heritage Management Plan
DC	Direct Current
D/C	Dual circuit
DEECA	Victorian Department of Environment, Energy and Climate Action
EES	Environmental Effects Statement
EPBC	Environment Protection and Biodiversity Conservation (Act, Commonwealth)
EY	Ernst and Young
FY	Financial Year
GHG	Greenhouse gas(es)
GW	Gigawatt
GWh	Gigawatt-Hour
HVAC	High Voltage Alternating Current
IASR	Inputs, Assumptions and Scenarios Report – part of the ISP process
IDC	Interest During Construction
IDP	Integrated Development Plan
ISP	Integrated System Plan, published on a two-yearly cycle by AEMO
kV	kilovolt
MCA	Multi-Criteria Analysis
MLF	Marginal Loss Factor
MW	MegaWatt
NCIPAP	Network Capability Incentive Parameter Action Plan
NEM	National Electricity Market (covering Victoria, New South Wales, Queensland, South Australia, Tasmania and the ACT
NER	National Electricity Rules

Acronym/abbreviation	Interpretation
NPV	Net Present Value
NSP	Network Service Provider (ie transmission and distribution businesses)
OCGT	Open Cycle Gas Turbine (a colloquialism for a Simple Cycle Gas Turbine, SCGT)
ODP	Optimum Development Path
Opex	Operations (and maintenance) expenditure
PACR	Project Assessment Conclusions Report ((part of the RIT-T process in the NEM))
PADR	Project Assessment Draft Report (part of the RIT-T process in the NEM)
PHES	Pumped Hydro Energy Storage
PSCR	Project Specification Consultation Report (part of the RIT-T process in the NEM)
PV	Photovoltaic (in this context: solar power generation)
RAB	Regulatory Asset Base
RE	Renewable Energy or Renewable Electricity
REZ	Renewable Energy Zone
RIT-T	Regulatory Investment Test – Transmission
S/C	Single Circuit
SLACIP Act	Security Legislation Amendment (Critical Infrastructure Protection) Act
SLD	Single Line Diagram
SPoF	Single Point of Failure
SSR	Sub-synchronous Resonance
SSCI	Sub-synchronous Control Instability
SVC	Static Var Compensator
TCD	Transmission Cost Database
TNSP	Transmission Network Service Provider
TOOT	Take Out One at a Time
VCR	Value of Customer Reliability
VicGrid	A body within DEECA
VNIW	Victoria-NSW Interconnector – West
VPP	Virtual Power Plant
VRET	Victorian Renewable Energy Target
WACC	Weighted Average Cost of Capital
WRL	Western Renewables Link

1. Introduction

1.1 General

Jacobs Group (Australia) Pty Ltd ("Jacobs") has been engaged by the Victorian Department of Environment, Energy and Climate Action (DEECA)[24] to undertake an independent technical assessment of the feasibility and merits of the proposal by professors Bartlett and Mountain and Darren Edwards entitled 'No Longer Lost in Transmission' (Aug 2023)[25]. The proposal is referred to as the Plan B report. The physical network changes proposed (as an alternative to VNI West) are referred to as Plan B.

The Australian Energy Market Operator (AEMO), in conjunction with the NSW electricity transmission system entity, Transgrid, propose the development of a high-capacity interconnector upgrade between Victoria and NSW called VNI-West (VNIW).

Plan B is described in the Plan B report as an alternative project/plan to VNIW.

Jacobs' scope is to assess and provide recommendations on:

- Plan B report's assessment of VNI West (VNIW) transmission project
- The Plan B Electricity Transmission Network Plan as detailed in the Plan B report, and
- Consequential actions/considerations for VicGrid when undertaking further planning of the Victorian transmission network, including the development of the Victorian Transmission Plan

Jacobs' brief is provided in Appendix A.

The Plan B report includes references to other submissions and reports made by the Plan B proponents, and the Plan B proponents have provided additional materials and correspondence on the specific matters raised in the Plan B report and on other matters.

Jacobs' review is directed at the Plan B report proposals. The additional materials are considered to the extent considered appropriate to inform the review.

DEECA has advised Jacobs that Jacobs' scope is to undertake a technical assessment of the Plan B proposal under the relevant Victorian laws, regulations and published government policies. Jacobs is not undertaking a peer review of the whole of the AEMO/Transgrid work – Jacobs notes the Plan B proponents' criticisms of the VNIW arrangements and assumptions and Jacobs has assessed the VNIW materials where these materials need to be evaluated in order to undertake the scope of the review.

1.2 Method/approach

VNIW is a particular transmission project development that has evolved from AEMO's ISP processes and then to the NER RIT-T process. It is fundamentally an interconnector project between Victoria and Southern NSW ("transfer capacity") with purported benefits and objectives around reliability, economic efficiency and renewable energy transition.

[24] The division within DEECA representing the department is called "VicGrid"

[25] Full citation: Mountain, B.R., Bartlett, S., Edwards, D. (2023). "No longer lost in transmission: Expanding transmission need not be at the expense of land-holders, renewables investors, communities, consumers and the environment". Victoria Energy Policy Centre, Victoria University, Melbourne. DOI: 10.26196/gf0x-ww20

As stated in the PADR:

> *The "identified need' for the VNI West project is to increase transfer capacity between New South Wales and Victoria to realise net market benefits by:*[8]
>
> - *Efficiently maintaining supply reliability in Victoria following the closure of further coal-fired generation and the decline in ageing generator reliability – including mitigation of the risk that existing plant closes earlier than expected*
> - *Facilitating efficient development and dispatch of generation in areas with high quality renewable resources in Victoria and Southern New South Wales through improved network capacity and access to demand centres*
> - *Enabling more efficient sharing of resources between NEM regions*

Plan B is fundamentally an intra-regional transmission augmentation project. It reduces interconnection to NSW[26]. The stated objectives of Plan B are:[9]

> *Plan B is designed to deliver sufficient transmission infrastructure to deliver Victoria's Renewable Energy Target (VRET) of 65% (of Victorian electricity generation) to be supplied by renewable sources in Victoria by 2030, and 95% by 2035. In addition, Plan B is designed to meet three subsidiary objectives:*
>
> *• less than 13% curtailment, and marginal loss factors exceeding 0.93 in the Murray River and Western Victoria REZs (i.e. even lower curtailment and smaller marginal losses in the other REZs);*
>
> *• no Single Points of Failure (SPoF) on new transmission lines that are likely to be defined as Systems of National Significance under the Security Legislation Amendment (Critical Infrastructure Protection) Act 2022 (SLACIP Act); and*
>
> *• minimising the amount of new land required for transmission by making use of existing transmission networks and easements wherever possible.*

Plan B has been suggested as an alternative to VNI West[27].

The objectives are also assessed over differing timeframes – the modelling for VNIW included in the PACR of the RIT-T extends to 2050 whereas the primary focus of the Plan B is to 2035.

Accordingly, in order to address whether Plan B is an alternative to VNIW Jacobs has:

- Made an assessment of whether the interconnection objective of VNIW is important (Section 2.3)
- Assessed the specific propositions made about VNIW by Plan B proponents (Section 2 overall)
- Assessed the specific propositions made about Plan B by its proponents (Section 3)
- Assessed if the "Extended VNI West" project described by the Plan B proponents as necessary for comparison with the Plan B concept are necessary for VNIW to achieve either its objectives or the Plan B objectives (Section 2.7)

Since the two objectives (VNIW and Plan B) are not necessarily mutually exclusive, Jacobs has also considered whether there are elements of the Plan B concept that may warrant further evaluation by VicGrid.

[26] The connection between Redcliffs and Buronga is opened during the daytime to avoid overloading of the 220kV system

[27] At Page 11, : "*Considering the importance of an effective plan and our conclusion that AEMO's plan is not adequate, we have developed an alternative.*"

The most significant differences in the objectives are the value of interconnection and the different formulation of VRET proposed in Plan B. The different formulation of VRET proposed has consequential impacts on the overall assessment. Some of the impacts are described in this report. Whether the alternative formulation (and its impacts) is considered to be worthwhile is a question for government.

Jacobs is not undertaking a peer-review of all the VNIW materials. Our scope is to technically assess the three scope item areas that relate to Plan B's propositions about VNIW and the Plan B concept.

Accordingly, a series of propositions in the Plan B report are evaluated to assess what has been put forward. They are grouped according to whether they are primarily surrounding Plan B's critique of VNIW (Jacobs' Scope Area A), or whether they are primarily about Plan B's own concept (Jacobs' Scope Area B). However, there is overlap between these two sets of evaluations. Jacobs is not undertaking detailed system modelling in this review but has undertaken and applied some calculations as necessary to inform our decisions on the matters within our scope.

1.3 Description of tools and analysis methods

1.3.1 Market Modelling

Electricity market modelling has a long history of application in the NEM. Jacobs itself has been providing this service to industry stakeholders (including generation developers, network companies and planners, state and federal governments, battery and pumped hydro storage proponents, financial institutions, new technology proponents (such as hydrogen) etc) for over 20 years. There are a number of companies who have this capability besides Jacobs including AEMO (who uses such models for the Integrated System Plan development), Ernst and Young (EY) who undertook the modelling that supports the VNI-W RIT-T process, and a number of others.

The electricity market comprises existing and future loads spread across five states and the ACT, generation and storage plants such as coal and gas fuelled conventional plants, hydro, pumped storage, wind, solar, batteries, biomass/biogas etc) connected by the electricity network (the electricity grid). The loads and generation outputs change with time of day, according to weather and climate, seasons, fuel availability, droughts, plant and network outages, electricity losses and auxiliary loads and other factors. The market also needs to be continuously supplied with ancillary services to help balance the supply/demand, cope with contingencies, support the network flows and (if the overall system fails) to be able to re-start it. Timescales relevant to electricity market operations extend down to milliseconds though for market modelling purposes normally either 5 minute, 30 minute or 1 hour periods are normally considered.

Investments made or considered can last many decades. The parameters of the possible new sources of generation and other elements of the market may change over time (battery costs are expected to reduce over time due to learning and mass production for example). Modelling tends to be done over (typically) at least a 20 year horizon and often more[28]. There are also several scenarios to consider (there were four main scenarios in the ISP2022) and several sensitivities as well.

In order to identify the expected least cost set of new network and generation developments, or to provide insight into other factors, a large computerised optimisation and simulation process is undertaken. Runs of the simulations can take many hours each. Typically, the set of new generators, network augmentation and the associated locations, timings and technical parameters is established which gives the least overall cost (such as electricity prices), adequate returns to investors and satisfies the customers' loads in every time interval in the model to an acceptable standard.

[28] The ISP 2022 market results are shown to 2051 for example

This form of analysis is considered by Jacobs to be the "industry norm" for simulating or forecasting what might or might not be optimally developed over the modelling time horizon. Like any forecast of the future the actual outturn can be different from what was anticipated from the modelling however this system is the best known method of making investment decisions in the national electricity market (NEM).

Jacobs has not found it necessary to undertake additional bespoke market modelling for this review as adequate results can be extracted from the market modelling that is already in the public domain. Jacobs have considered the published analysis and their stated assumptions and published outcomes against our own recent models run for other (private) clients.

The PACR has been published with market modelling analysis. Consistent with the requirements of the RIT-T process the market modelling undertaken for the PACR includes a Base Case that is a market model (and CBA) without VNIW. Although the disposition of generation (and the cost of the different network upgrades) within Victoria will differ between the PACR Base Case and the Plan B case they should be similar. Given that the PACR Base Case is optimised it would be reasonable to expect the PACR Base Case to be a lower overall cost (higher net benefit) than the Plan B case except potentially for the effects noted by Plan B proponents regarding disagreeing with some of the ISP assumptions.

Electricity market modelling includes recognition of market constraints, where the generation is greater than the load in the region and the excess cannot flow elsewhere (e.g. via an interconnector) or be stored in a battery or PHES. The type of constraint described in the Plan B report (whereby generation capacity is curtailed) is caused by inadequate local network capability, or "network constraint", tends to be avoided during the optimisation process – the optimiser within market modelling will locate the generator elsewhere where the constraint is not as strong or it will allow for the cost of the REZ (intra-regional) transmission upgrade to reduce the effect of the constraint.

1.3.2 Simulations

In the context of the current work, a simulation includes setting up a spreadsheet model with the assumed hourly load profile (e.g. for Victoria as assumed in 2035 under the Step Change scenario) and adding a mix of generation capacity in various zones/locations around the state and simulating their outputs over the year using hourly output profiles for the relevant location and technology. Each of the assumed load profile and the assumed generation profiles are themselves derived from other analysis or historical periods considered representative etc. Sets of such data are available for use in simulations.

By adding the generation outputs and subtracting the load for each of the time steps in the simulation (e.g. each 30 minute step) insight can be gained into how much flow there might be on network elements, the amount of "market curtailment" (in contrast to network curtailment) that might arise, how storage might be sized or could reduce curtailment and over-build of generation and other metrics.

These simulations are simplified pieces of analysis, which are undertaken more comprehensively in the market modelling analysis. However, such simulations provide illustration and insight.

1.3.3 Load flow and stability assessments

In electricity network planning it is necessary to understand how electricity flows in the meshed transmission network between the multiple generation sources and the multiple load points. Load flow studies apply computer models of the generation and loads along with the technical parameters of the various network elements to model the flows, often based on a "snapshot" of a point in time when the flows are likely to be most critical to the issue being evaluated.

Where there are multiple parallel pathways across which electricity can flow (such as the Victoria to NSW interconnector which presently has flow paths between Buronga/Redcliffs in the west, Wodonga/Dederang in

the centre and Tumut/Murray in the Snowy Mountains[29]. VNIW would add another (double circuit) flow path to the interconnector) it is appropriate to understand how much load flows down each path making up the whole interconnector. This assists in evaluating whether one of the flow paths might be overloaded and allows assessment as to how much flow would be in one of the elements (such as VNIW) at the time of any event (such as an outage/failure).

Stability assessments are detailed computer simulations of how the network responds to disturbances and events at the millisecond level. They are used to assess, for example, if an event is likely to lead to a cascading adverse outcome or if the system is likely to return to a stable condition after an event.

Jacobs has undertaken load flow and stability studies in this review.

1.4 Information for the review

Materials gathered relevant to Jacobs' review, and details of technical assessments/calculations undertaken, are included in the Volume 2 of this report.

1.5 What is VNI West and Plan B?

Descriptions of VNI West and Plan B are provided within the Volume 2 of this report.

[29] Murray is located in NSW but is in the Victorian NEM region. Murray is connected to Dederang also and often the flows at Dederang (from Wodonga and Murray) are considered in combination rather than separately as there are three 330kV circuits into Dederang from the north and only two 330kV circuits from Dederang to South Morang to the south.

2. Scope Area A : Plan B's assessment of VNI-West

2.1 Introduction/summary

This Section reviews a series of propositions put forward in the Plan B report on the VNIW project. This informs our conclusions on Plan B as an alternative to VNIW. A summary of Jacobs' assessment of the Area A propositions is shown in **Table 5** with further discussion below.

Table 5 Area A summary

Item	Matter for review	Does Jacobs support this proposition?
Area A -1	Completeness of VNI West Plan B: "AEMO and Transgrid say that VNI-West and a much smaller augmentation of transmission in South Western REZ (by 2034) and an even smaller augmentation in Central Northern REZ (by 2046) is all that is needed to almost completely decarbonise electricity supply in Victoria."	No
Area A -2	Merits of interconnection Plan B:"In our Submission to the VNI-West Consultation Report, we pointed to AEMO's assumptions indicating that renewable generation costs were comparable across the NEM, and so questioned how such expensive interconnection could be justified. AEMO rejected such analysis which it derided as "simplistic" and insisted that its modelling (with its consultants EY) took account of all relevant factors and credibly forecast outcomes for every hour until 2050"	No
Area A -3	Merits of interconnection, assumptions Plan B: "We have identified many concerns about the assumptions and methodology which AEMO has used (set out in our Submission1), none of which AEMO has Plan B: adequately addressed."	Jacobs has reviewed the Plan B report, the earlier submission and the subsequent submissions to us. We have no material concerns with the PACR/ISP assumptions and method
Area A -4	Merits of interconnection Plan B: "To get a "first-principles" assessment of the value of increased interconnection between NSW and Victoria we compared the value that would arise if the cheapest wind or solar in NSW displaced the most expensive wind or solar in Victoria (and vice versa) using CSIRO's latest assumptions of costs (AEMO will use these in its forthcoming ISP) and AEMO's latest assessment of all other relevant parameters. We found that the value per MW is less than a quarter of the cost of VNI-West per MW"	No

Item	Matter for review	Does Jacobs support this proposition?
Area A -5	Merits of interconnection Plan B: "With reference to data on the correlation of wind/solar resources in some REZs in NSW with others in VIC, AEMO also suggests that interconnection is valuable in being able to diversify variable renewable generation. The value of diversification of variable renewable resources is difficult to estimate and it is not yet well understood. But AEMO's data suggests no greater diversification of variable renewable generation between NSW and VIC than it finds within REZs in VIC, or within REZs in NSW"	No
Area A -6	VNI West doesnt address curtailment Plan B :"Leaving to one side our critique of the merits of interconnection, our analysis of the results of AEMO's modelling analysis of VNI-West finds that it is not successful in meaningfully addressing the pressing problem of renewables curtailment in Victoria. AEMO's results show a slight reduction in renewable curtailment in those REZs affected by VNI-West in the decade after VNI-West is commissioned. But this is followed by a return to the pre- VNI-West levels of curtailment a decade after commissioning"	No
Area A -7	VNI West and curtailment Plan B: "AEMO also defends its projected curtailment on the basis that it has determined the "efficient" outcome. This is not correct: AEMO has failed to account for generation curtailment (i.e. that curtailed generators will require higher prices than uncurtailed generators in order to compensate their curtailment) in its modelling of the relative economics of variable renewable generation and transmission."	No
Area A -8	Impact on prices (capex, WACC, IDC, opex) Plan B: "Moving onto the impact on prices as a result of its proposals, AEMO says that VNI-West will only raise transmission charges by 25% in Victoria. But AEMO uses 2021 prices, a cost of capital that does not reflect the re-pricing of risk that AEMO is adopting in its forthcoming ISP, ignores interest during construction and understates capital costs and greatly understates operating costs"	No

Item	Matter for review	Does Jacobs support this proposition?
Area A -9	Geographic diversity Plan B: "Furthermore, AEMO's work suggests that the temporal diversity of variable renewable generation is no bigger between neighbouring regions of the NEM than it is within regions, contrary to what has long been suggested to be the case. A failure to respond to this new information has resulted in transmission plans that have become superseded by events and new knowledge.."	No
Area A -10	VNI West needs to be evaluated as VNI West Extended Plan B: "To fairly compare Plan B to AEMO's plan, we could not limit the analysis to VNI-West and the 1,500 MW augmentation that AEMO anticipates in South Western Victoria. Rather we had to include two major projects to augment the 220 kV networks in the Western Victorian and Murray River REZs without which VNI-West will not be able to offer any increase in hosting capacity in Victoria. We also included a necessary augmentation in Gippsland and between Shepparton and Dederang without which AEMO's renewable hosting capacity increases are obviously impossible to achieve. Together this constitutes what we call AEMO's "Extended VNI-West" project, which can be compared with Plan B. "	No
Area A -11	Easements Discuss easement risks and processes. What is the risk profile of 500kV and 220kV regarding easements, and the risk issues of new easements versus extensions or shifts of existing easements	Yes

2.2 Completeness of VNI West

Area A -1	**Completeness of VNI West** Plan B: "AEMO and Transgrid say that VNI-West and a much smaller augmentation of transmission in South Western REZ (by 2034) and an even smaller augmentation in Central Northern REZ (by 2046) is all that is needed to almost completely decarbonise electricity supply in Victoria."

Jacobs note that AEMO have indicated that that this assertion was not made by AEMO/Transgrid in relation to VNIW.

The VNIW objectives do not include that it will, by itself or in conjunction with other specific small upgrades, almost completely decarbonise electricity supply in Victoria. Jacobs has noted (refer Section 3.2.1) that the VNIW modelling does show that VNIW is compatible with the VRET target in its legislated form being achieved.

The PACR and other materials describe that further work will be undertaken. Jacobs do not see an assertion in the RIT-T materials that VNIW will, by itself, have that outcome. This outcome is not a direct or stated objective of VNIW.

ISP and PACR modelling each indicate the VRET 2035 95% target is expected to be met (though the indicated location of renewables in Victoria may warrant further review in Jacobs' opinion – see Scope Area Part C). Driven in AEMOs modelling by assumed closure of Loy Yang A and B before 2035. If the brown coal generators are still operating in 2035 then neither VNIW nor Plan B will meet the 95% VRET criterion.

Jacobs suggests that the tests to apply to VNIW are the extent to which it meets its stated objectives and the extent to which the benefits claimed (that are in the CBA modelling) are properly attributable to VNIW. There are other developments around the NEM now and in the future to meet the market's needs and objectives. If other matters are not affected (in cost or benefit terms) by VNIW proceeding or not proceeding then those other costs and benefits need to be excluded from the assessment altogether or they need to appear in both the "with" case and the "without" case CBA. Either method has the same effect. Jacobs are not aware of any benefit being credited to VNIW in the analysis inappropriately.

Jacobs' review found that VNIW meets its stated objectives and there is no evidence of a claim that VNIW and smaller augmentations "is all that is needed to almost completely decarbonise electricity supply in Victoria."

2.3 Merits of interconnection

Area A -2	**Merits of interconnection** Plan B:"In our Submission to the VNI-West Consultation Report, we pointed to AEMO's assumptions indicating that renewable generation costs were comparable across the NEM, and so questioned how such expensive interconnection could be justified. AEMO rejected such analysis which it derided as "simplistic" and insisted that its modelling (with its consultants EY) took account of all relevant factors and credibly forecast outcomes for every hour until 2050"

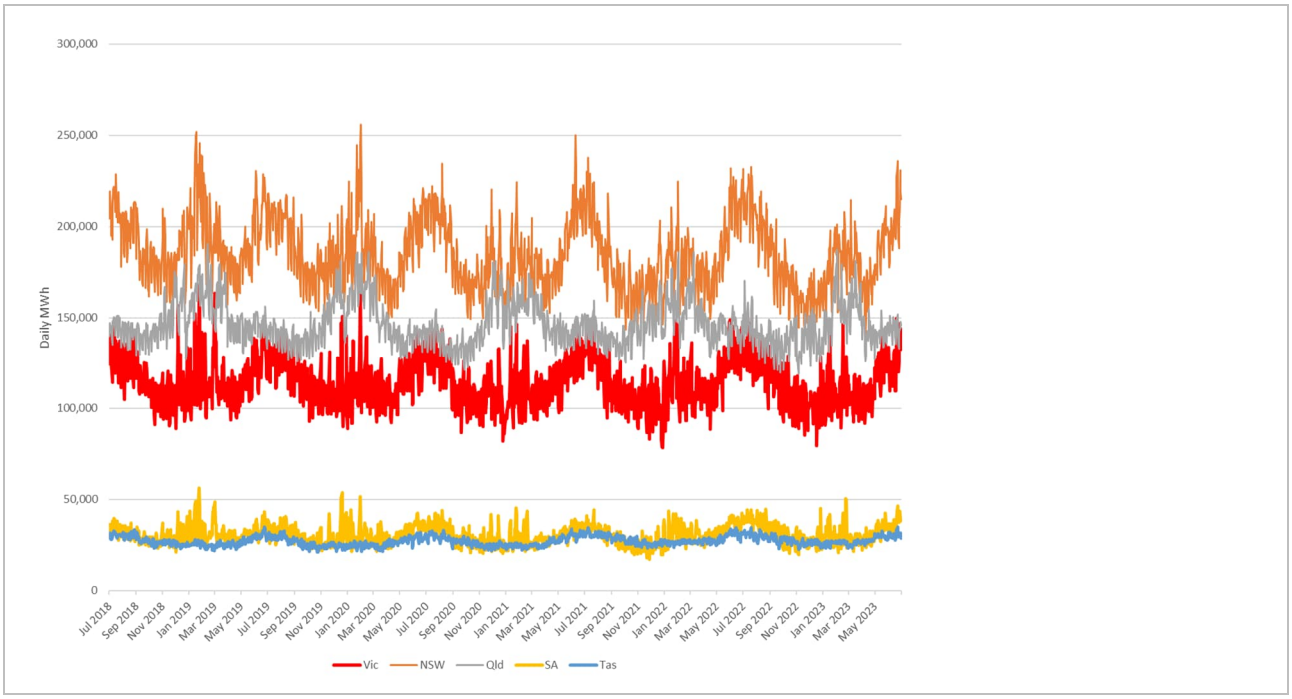
The Plan B approach is described in Section 5.1 of the Plan B report. It calculates an annual cost per MW of capacity for VNI CAPEX and OPEX which it calculates to be $0.17M/MW/y. It then considers whether this is lower than the savings from choosing the least cost wind plant in NSW (43% capacity factor) against the most expensive cost wind plant in Victoria (30% capacity factor). Plan B calculates a cost of $0.237M/MW/y for the NSW plant which they calculate is only $0.047M/MW/y (20%) better than the Victorian plant. The Plan B report notes that the same holds if NSW and Victoria are reversed and that the same holds for solar. Plan B concludes on this basis that the relative costs of wind and solar in NSW versus Victoria does not justify the expense of VNIW.

Jacobs' findings are:

- The "capacity" of an interconnector bears little comparison to the capacity of the renewable generation in the way described. The benefits of the capacity of the interconnector include, amongst other things:
  - an annual availability of the capacity well over 99% all year round.
  - the interconnector can transfer flows in each direction
  - the interconnector can cope with flow changes and the flows can be managed (indirectly by changing controllable generation or load outputs on either side relative to the loads)
  - The interconnector capacity can share reserves between the two adjoining regions thus requiring reduced reserves on the system (or equivalently providing a more secure system)
  - Neither the wind nor solar plants are considered "capacity" in the same sense. They are intermittent variable generation sources. The NSW wind farm and the Victorian wind farms are not themselves comparable to each other as they have evidently different capacity factors and their outputs at different hours/days/seasons would make their values quite different to just their capex and opex differences. If the same argument were presented with respect to batteries or PHES being of similar cost on either side it would be similarly differentiated by the limited "duration" of the storage capacity.

- The interconnector capacity is an enabler for sourcing generation from multiple interstate sources to service the variable load (at either end depending on the flow direction) in a more optimum fashion than if supply sources were only able to be chosen in the same region as the load.
- The interconnector is an enabler for transferring excess variable renewable generation in one region to a potential load in another region where the loads in the two regions are not fully correlated (which is the case). If none of the loads can be served then the interconnector can facilitate transfer of the excess to a storage plant that is not yet at capacity in the other region – in either case the interconnector is reducing spill/curtailment of the renewable energy generation. In the other direction a storage that is not empty in one region can supply electricity to a load shortfall in another region
- Interconnectors share load as well as generation. Figure 1 shows the daily loads over the NEM for the last five financial years. Whereas Victoria has a clear energy peak each winter (and weak but high (demand) peaks in summer), NSW and South Australia have two clear energy peaks per year, summer and winter, Queensland only has a summer peak and Tasmania only has a winter peak. The same day in each year can be quite different. As rooftop PV grows the summer energy demands on the transmission system will fall (but MW demand will not fall as much) and – particularly in Victoria – as electricity is substituted for gas heating and hot water service the winter energy load will increase. At a daily level distinct differences can be seen between the load shapes of the NEM regions as the weather varies between the major capital cities (refer to Volume 2 Sections 2.2 and 2.5 for further data).
- The interconnector is an enabler in the case where Victoria might decide to build a more significant amount of a particular generation technology in a relatively small area. Offshore wind in Gippsland for example. At times where the wind and sunshine are strong across Victoria relative to the Victorian load, the excess energy must either be sent interstate, stored, or spilt/curtailed. Storage is not practical in the foreseeable future at the large scales such as would fit the Victorian Offshore Wind Directions paper outlook.
- The interconnector allows the benefits of diversity between variable, intermittent plants in different locations to be effective. If, at a critical hour of the day or year a unit of load in Victoria could be served by a generator in NSW (or elsewhere) that at that particular time had an output of 50% of its rating whereas if the Victorian wind farm at that particular time had an output of only 10% then you would need five times more of the Victorian wind farm towers to be built than the NSW wind farm sizing for that load service. And similarly, there might be another hour of the day/year where the Victorian wind farm could better serve a particularly difficult load to serve in NSW.
- The interconnector is an important piece of an integrated system that includes all the other states/regions
- The interconnector is an important "piece of the jigsaw" that includes Project Energy Connect, HumeLink, Basslink/Marinus, and Snowy 2.0

Figure 1. Daily loads in NEM regions, five years to June 2023[30]



Market modelling is necessary and appropriate to find the optimum mix of generation and transmission to match the loads across the five NEM regions.

Market modelling as undertaken in ISP and in RIT-T processes is necessarily a simplification/model. This market modelling is more detailed, granular and considers more complete factors than the analysis adopted within Plan B, such as inclusion of resources in all REZs, fitting technology output traces specific to the REZs to the regional loads (albeit this is limited to a small sample size of meteorology), REZ limits and losses.

Different REZs have different capacity factors of resources and different "fits" to the load shapes. Refer to Area A-4 below.

There are different REZ limits and connection costs (and some differences in regional construction factors)

Jacobs is very familiar with the type of modelling undertaken by AEMO and EY and undertakes similar modelling. This form of modelling is the basis on which decisions are made in the industry.

There is no market modelling presented for the Plan B configuration in the Plan B materials. Inferences about the expected outcomes that might result from such modelling can be drawn however from the market modelling done for the Base Case in the RIT-T which specifically is a "without VNIW" analysis consistent with the "with VNIW case", and also with considering selected Candidate Development Path market modelling outputs in the ISP materials that do or do not include VNIW.

The assumptions used are imperfect and under continual refinement but are nevertheless the best available for decision making at the planning stage, and are considered reasonable to use for the ISP and RIT-T processes that they are used for here.

Noting the results of the RIT-T modelling, which Jacobs has no basis for rejecting, Jacobs concludes that without an upgrade to Vic to NSW interconnector there will be higher costs.

Jacobs' review has found that there is value in increased interconnection and therefore we do not support the Plan B report proposition. Jacobs have identified using our own calculations that there is value in the diversity

[30] Data is 5 minute TOTALDEMAND for each region aggregated to daily quantities, sourced from AEMO "Public Daily" files.

of output and parameters of geographically distributed generation. The Integrated System Plan (ISP) cost-benefit-analysis (CBA) and the CBA done for the Regulatory Investment Test – Transmission (RIT-T) both show positive benefit from increased interconnection. In the ISP the benefit is as a part of a portfolio of network upgrades and in the RIT-T on a with-versus-without basis on VNIW specifically.

Area A -3	**Merits of interconnection, assumptions** Plan B: "We have identified many concerns about the assumptions and methodology which AEMO has used (set out in our Submission), none of which AEMO has adequately addressed."

In the submission by Prof. Bartlett and Prof. Mountain to the VNIW Consultation Report Options Assessment (4 April 2023), the following matters of assumptions and methodology differences are noted:

- It suggests AEMO Victorian Planning (AVP) have greatly underestimated the costs of VNIW-WRL
- Build limits in Gippsland V5 REZ
- Gippsland V5 transmission expansion cost for generation above its 2000MW RE limit
- It suggests AVP have ignored the "*enormous level of spilled production from wind generation and even moreso solar generation along the WRL-VNI 500kV corridor*".
- It suggests the discount rates used as sensitivities and the offshore wind assumptions used as sensitivities should have been the base assumptions instead of sensitivities. It suggests that OSW is no less uncertain than the hydrogen superpower scenario nor Marinus
- It suggests system restart requirements have been overlooked in the Optimal Development Plan (ODP)
- It suggests that the extra length of the route via Kerang will reduce interconnector transfer limits to below 1,475 MW
- It suggests Sub-synchronous resonance (SSR) studies should have been undertaken to prove the practicality of the proposed series compensation in VNIW
- It suggests "*AEMO has not costed the additional 500 kV and other augmentations in Victoria that flow from the decision to construct WRL-VNI*"
- It suggests the rationale for VNIW-WRL has changed from the VNIW PADR to the PACR and the Base Case assumptions have changed, particularly a change in the assumed closure dates for brown coal.
- It suggests that there was a removal of a cost associated with the WRL due to VNIW being built that was not "charged" to VNIW
- It suggests that the benefit of avoided storage in VNIW PACR was not in the previous assessment
- It suggests there is no diversity benefit from wind and solar across regions
- It suggests AVP has ignored the consequential transmission expansion that follows WRL-VNI
- It suggests that there are non-compliances in the RIT-T process undertaken by AEMO/Transgrid with the RIT-T rules and the NER

Many of the matters are discussed directly or indirectly in the balance of this report. Jacobs also note:

- The cost queries are dealt with by AEMO/Transgrid in the "VNI West Project Assessment Conclusions Report Volume 2: Additional Consultation Report Submissions" circa page 48. With respect to capex, AEMO/Transgrid noted[31] that "*costs were increased since the 2022 ISP as outlined in the July 2022 PADR report and also as similarly described in the Additional Consultation Report. The cost increase applied in the Additional Consultation Report was primarily due to additional contingency being added to account*

[31] At page 51

for known project risks. Further, as outlined in this PACR: Volume 1, some categories of costs have been increased in light of observed trends in costs such as underlying materials and labour. For example, the net market benefit assessment in this PACR incorporates updated cost estimates on the Victorian side, reflecting the latest trends identified in AEMO's 2023 Transmission Cost Database".

- The issues related to the RIT-T method and completeness have been the subject of the Australian Energy Regulator's (AER) request for further explanations dated 21 June 2023 and AEMO/Transgrid's Final Compliance Report 7 July 2023. We also note that a dispute on the RIT-T process undertaken was lodged with AER by Moorabool and Central Highlands Power Alliance Inc. (MCHPA) on 26 June 2023. In October 2023 AER published its determination on the dispute that none of the grounds raised provided a basis to require AVP and Transgrid to amend the RIT-T PACR. Of the nine grounds of dispute assessed, AER concluded for the first five grounds that the RIT-T was compliant and for grounds 6 to 9 that each of these grounds of dispute are misconceived or lacking in substance
- System restart measures will be required in each region regardless of VNIW proceeding. These measures are already in place[32]. VNIW will make no difference to what is required – if Victoria needed to recover from a system black independently from NSW then AEMO could choose when in the process to separately restore elements of the interconnector. VNIW could be left until late in the procedure if that ha been determined to be the best plan.

Area A -4	**Merits of interconnection** Plan B: "To get a "first-principles" assessment of the value of increased interconnection between NSW and Victoria we compared the value that would arise if the cheapest wind or solar in NSW displaced the most expensive wind or solar in Victoria (and vice versa) using CSIRO's latest assumptions of costs (AEMO will use these in its forthcoming ISP) and AEMO's latest assessment of all other relevant parameters. We found that the value per MW is less than a quarter of the cost of VNI-West per MW"
Area A -5	**Merits of interconnection** Plan B: "With reference to data on the correlation of wind/solar resources in some REZs in NSW with others in VIC, AEMO also suggests that interconnection is valuable in being able to diversify variable renewable generation. The value of diversification of variable renewable resources is difficult to estimate and it is not yet well understood. But AEMO's data suggests no greater diversification of variable renewable generation between NSW and VIC than it finds within REZs in VIC, or within REZs in NSW"

Jacobs undertook an analysis of historical half-hourly generation and demand data to see if this purported benefit has any support from historical data. This was done by matching generation and demand across NEM regions to see if there is an opportunity for sharing through natural differences across the regions.

Using data from 2019 Jacobs observed:

- From a demand point of view, monthly average demand patterns are similar across NSW and Victoria, with a pronounced higher demand during winter months in both States, and lower demand patterns in the spring and autumn months. However, the summer months demand is more affected by type of year in NSW than in Victoria (so during hotter than normal summer it is more pronounced increase in demand – equivalent to winter averages – in NSW).
- Wind generation in Victoria, has pronounced seasonal pattern with higher proportion of wind generation occurring in the late winter and spring months and lower proportions in the later summer autumn and early winter months. Wind generation tends to be more even across the year in NSW.

[32] As various existing simple cycle gas turbine generators retire the current methods will need updating in due course

- However, these trends are not consistent across every year. For example, wind generation levels have been high in May and June, across the last two years. Although not perfect as dependent on the shares of wind and solar in each State, the monthly generation patterns for total variable renewable generation still show variation in generation patterns across the States, especially in the key early winter and mid to late summer months.

Jacobs also looked for evidence of curtailment in Victoria at times when prices are negative in Victoria and positive in NSW. Recently, there have been times when prices are positive in NSW but negative in Victoria, and northward flow of available renewable energy generation is constrained. Volume 2 Section 2.5 indicates the level of available renewable generation constrained off in Victoria in half hour periods where prices averaged negative in Victoria and positive in NSW, showing an increasing trend for curtailment during these trading intervals, which would be indicative of market curtailment in Victoria.

Relieving network constraints is only valuable at times when the relevant generation would not otherwise be curtailed off by a market curtailment, or at times when the value of electricity was very low or negative.

Whilst not in itself definitive, this analysis does point to a potential benefit from enhanced interconnection, particularly in years where climatic conditions impact on demand levels in each region and lead to variations in wind generation in particular.

Jacobs also undertook its own correlation analysis between the outputs of existing generation in the NEM and also using the ISP traces for each REZ across the NEM. The analysis calculated normalised (Pearson) Correlation Coefficient.[33]. This type of analysis provides insights such as those discussed above but it is not fully able to evaluate the amount or value of diversity in the NEM context.

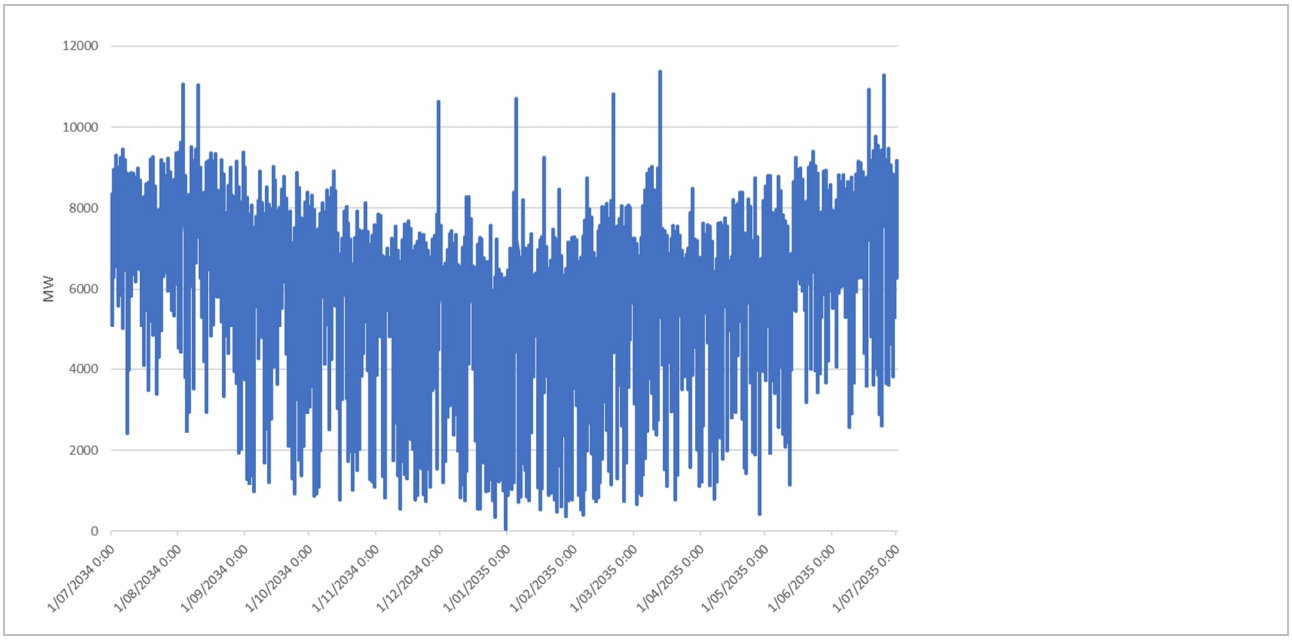
The main reason for this is that each time interval in the correlation calculation is given the same weighting (in the recognition of how much it is above or below its annual mean in the time interval) to every other time interval. This is a poor metric in a market like the NEM where the value of the output of a generator can vary across five orders of magnitude in the year (from minus hundreds of dollars per MWh to over $10,000/MWh).

As there are particularly difficult periods in a typical year to source generation to meet the load at all times (without adding the cost of storage), such as the early evening in a shoulder season in Victoria, if there are generators that tend to have a higher output at that time, even though they may be in a different region, they may be the best choice to make up part of the generation mix. It is possible for a particular generator (a wind generator in a particular REZ for example) to have a very high correlation coefficient over a year with a load or another generator yet may tend to have different and very attractive (valuable) outputs at particular times.

To illustrate, a representative load shape for Victoria in FY2035 is shown in Figure 2. Note that the data is for a financial year and hence summer is in the middle of the chart. While summer may have some short-duration load peaks, in general its load is lower but more variable than the winter load. The impacts of heating and rooftop PV affect the winter and summer more respectively.

[33] The data itself is first normalised such that the outputs of the generators varies from 0 to 1 so that the relative scale of the units is not a factor. The Pearson Coefficient, cov(x1, x2) / (sd(x1)sd(x2)) is itself normalised to the range -1 to 1. It is a measure of how the deviation of variable x1 from its mean value is linearly related to the deviation of the other variable, x2, from its mean. If the coefficient is 1 it means whenever variable 1 is higher than its mean by n standard deviations then variable 2 will tend to be higher than its mean value by n of its standard deviations., The values can be qualitatively described in broad ranges, such as to say values above 0.7 are strongly positively correlated, values from (say) -0.3 to +0.3 are not correlated (or only weakly so) and values less than (say) -0.7 are strongly negatively correlated.

Figure 2. Representative Victorian load net of distributed PV, 30-minute granularity, FY35[34]



To meet this load in every single period (the market presently operates on five-minute dispatch and settlement intervals) requires a mix of generation that largely equates to the load profile, with interconnectors and storage used to substantially make up the difference[35].

Measured at the transmission system (which means non-scheduled embedded generation such as rooftop PV is deducted from the load), and considering a region (Victoria in this case), in each five minutes:

- Generation plus
- Net discharge from storage (ie generation from storage less charging of storage), plus
- Imports via interconnectors, minus
- Exports via interconnectors, must equal
- Load

This must be solved across all regions (the imports of one region being the exports of another). An individual region may have imports on some interconnectors and exports on others at the same time – in this way for example the Tasmania hydro system can contribute to South Australia by (effectively) flowing through Victoria.

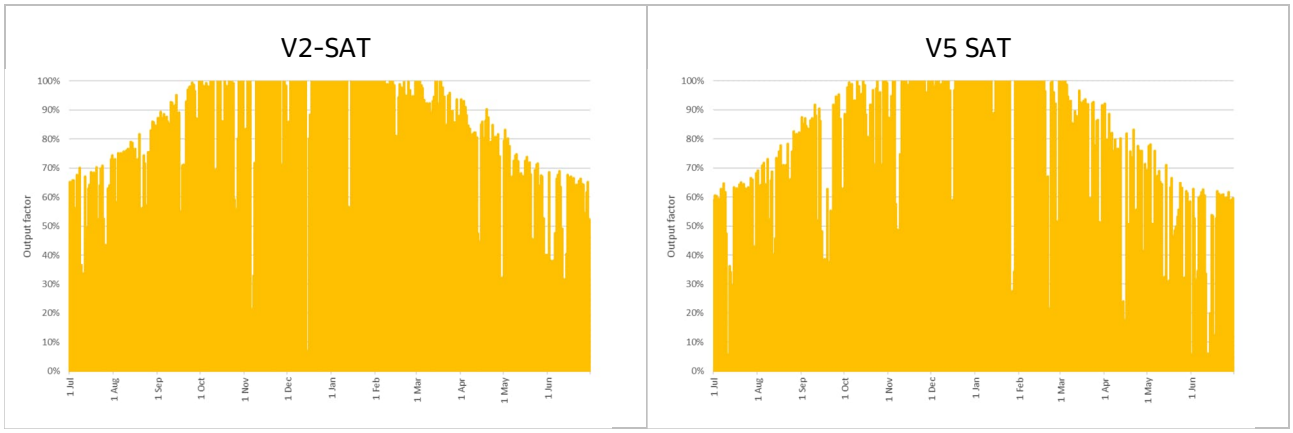
Unless storage facilities are massively sized (i.e. of scale that is a material percentage of annual system energy), the optimum mix will have various generation capacities of different technologies and locations such that the solution is met in every five-minute period of the year.

Figure 3 shows representative output "traces" across a year for utility solar plants (per MW of capacity) for the V2 REZ in the west and the V5 REZ in the east of the state. Again, summer is in the centre of the chart.

[34] AEMO ISP2022, Step change, operational load, sent out for Victoria. OPSO load does not include EV charging, storage charging/pumping, and has not deducted interconnector losses

[35] Demand reduction and unserved load are the other elements. In this simplified depiction network losses etc are ignored.

Figure 3. Representative Victorian solar output factors, 30-minute granularity[36]



At this granularity the traces seem of the same merit. In fact, the correlation coefficient calculated between these two traces is 0.81, which would be considered highly correlated. This does not mean the two zones are the same:

- there are periods where a large cloud system is over the east of the state but the west is clear (or vice versa) – the differences of detail in Figure 3
- The V2 zone has better solar resource – its representative capacity factor is 27.9% versus V5 of 20.5%
- The V2 zone is further west (which is better for matching the afternoon load requirement of the main load centres and as the rooftop PV in the main load centres drops off). Bairnsdale in the east (V5) is 21 minutes ahead of Mildura in the west (V2) in solar output. This may seem small however the NEM works in five minute dispatch intervals. Port Augusta is 54 solar minutes behind (later in the afternoon) the rooftop PV in Sydney, which is advantageous.
- Zones each have individual factors (Build Limits) limiting what generation can or should be built there in a timeframe. Build Limits can be changed, by upgrading transmission for example, or may be impacted by necessary trade-offs in achieving an objective.

Further illustrative data is provided in Volume 2, Sections 2.2 and 2.5.

The method used in the industry to bring all the many factors together in one model to evaluate what might be the best mix is market modelling. Market modelling is undertaken both in the ISP process and in the RIT-T process for this reason. Jacobs does not support an analysis using correlations alone being superior to a market model evaluation. The market modelling in the ISP and the RIT-T has found that interconnections, and specifically VNIW, are valuable.

Market modelling takes many more relevant inputs (including output diversity) to find the optimised mix of sources to meet the loads considering the many constraints and factors.

In our Jacobs' own market modelling (for private clients) our modelling team has reported that VNIW tends to be either included by assumption (because of its status), or is seen to be appropriate around the time of Yallourn closure upon economic assessment (by the model or modeller)

Jacobs accepts that all such modelling (AEMO ISP, EY PACR and our own NEM modelling for other clients) does rest on a substantially common Assumptions workbook, the IASR. The IASR is generally the best current dataset to employ. Jacobs are aware of no material failing in the Assumptions workbook that would affect our conclusions in this review.

Jacobs does not support the Plan B report proposition.

[36] ISP2022 materials

2.4 Curtailment

Area A -6	**VNI West doesn't address curtailment** Plan B :"Leaving to one side our critique of the merits of interconnection, our analysis of the results of AEMO's modelling analysis of VNI-West finds that it is not successful in meaningfully addressing the pressing problem of renewables curtailment in Victoria. AEMO's results show a slight reduction in renewable curtailment in those REZs affected by VNI-West in the decade after VNI-West is commissioned. But this is followed by a return to the pre- VNI-West levels of curtailment a decade after commissioning"

The NEM is an open access system where generation developers make their own decisions on where to site their plants. It is noted that more generators have sited in the north-west of Victoria than matches the transmission capacity from that area to the load centres and that this has led to congestion (resulting in curtailment of generation) and MLF impacts. The reasons that generators have made decisions to locate in areas that are problematic could include (as speculation):

- They were not aware of the issue
- They evaluated the issue at the time but later generators developed and sited nearby and that created more congestion than they had anticipated
- They expected or assumed the transmission network would be upgraded (at the consumer's cost)
- They might be insulated from the effects (for example by having a Power Purchase Agreement with a customer where the customer is taking the dispatch constraint risk because the customer did not know or themselves suitably factored the issue into their thinking)
- It may be that regardless of the constraint the generator expects to make enough revenue on the remaining output to make an adequate return.

The NEM is not set up on the basis of generators getting "firm access" as of right. Generators don't (generally) pay for the transmission network, customers do. There have been reviews in the past on the issue of optional firm access in the NEM, but this has not resulted in a decision to change the rules[37].

Jacobs does recognise that the constraint issue in the north-west has particular notoriety (for example the term "rhombus of regret" as has been applied to the area). If the issue lowers investment confidence in generation in Victoria then that would be a problem. That there is congestion is itself an indication that (for whatever reason) the transmission development has lagged behind the generation development. It may be an indicator of demand for future generation connections and it could be appropriate to facilitate that demand being met.

The NEM objectives are based around the (long term) interests of consumers and it would need to be shown that an appropriate benefit was derived for any cost incurred to relieve the congestion. It may be the case that freeing up capacity on generation where the capital cost is already sunk results in deferred or avoided generation elsewhere and that the benefit of this could appear as lower price outcomes for consumers than would otherwise occur. Whether that is likely or not would be appropriately established by market modelling and a cost-benefit assessment (CBA).

Jacobs suggests that congestion is a parameter of note but is not in itself an objective that necessarily achieves the overall NEM objective.

Notwithstanding this, Jacobs has considered whether VNIW worsens or alleviates congestion in this part of the NEM (the rhombus formed by Redcliffs-Horsham-Ballarat-Kerang, or the V2 and V3 REZs).

[37] Refer to https://www.aemc.gov.au/markets-reviews-advice/optional-firm-access%2C-design-and-testing

Our analysis suggests that the part of the rhombus that is along or to the east of the VNIW alignment (that is, along or to the east of Bulgana/Kerang) will gain some benefit from the change in effective transmission capacity to the loads (both Victoria and NSW) from VNIW. As noted by Plan B this may not be sufficientin the long-term and future (further) transmission upgrades (e.g. on the 220kV system) may be appropriate later. The VNI RIT-T benefits are not overstated in this regard as the longer-term changes are within the economic evaluation.

The side of the rhombus to the west of VNIW will gain no relief from VNIW. Jacobs suggests (Area B-9 in Section 3.11 below) that this may warrant further review.

The AEMO and EY modelling (ISP and RIT-T) does not show extensive future build of generation in V2 and V3[38]. This is caused by the models finding more optimum locations for new generation elsewhere that presently need less transmission augmentation. Indeed, the ISP modelling, which will be driven by the similar assessments) also shows Victoria becoming a significant net importer of electricity in the near future[39]. Given that the Victorian government's policy is to encourage renewable generation and that outcome is faced with a competitiveness barrier, Victoria may need to look for means to stimulate the investment in some other manner. Making a barrier to competition, by stopping VNIW for example, is expected (and shown by the modelling) to have a poorer economic outcome than building VNIW has.

Jacobs does not support this Plan B report proposition.

Area A -7	**VNI West and curtailment** Plan B: "AEMO also defends its projected curtailment on the basis that it has determined the "efficient" outcome. This is not correct: AEMO has failed to account for generation curtailment (i.e. that curtailed generators will require higher prices than uncurtailed generators in order to compensate their curtailment) in its modelling of the relative economics of variable renewable generation and transmission."

The modelling incorporates the effects of market curtailment in finding the optimised locations and sizes of generators, storage and transmission upgrades for least cost to customers.

It is the case that generators have located to the west of Bulgana and Kerang despite the limitations of transmission capacity there.

Customers should only pay for transmission where it is shown that the benefits to customers outweighs the cost to customers.

AEMO assumes that market arrangements will be set to allow for revenue sufficiency of the least cost solution. Jacobs recommend that a sensitivity of their modelling be undertaken assuming that current arrangements prevail.

Jacobs does not support this Plan B report proposition.

[38] 2200MW solar in V2 and 2400MW wind in V3 at 2035 under Step Change scenario (Option 5A in PACR analysis). Generation capacities rise further in the 2040s. These capacities are similar to the additional hosting capacity Plan B adds in V2 and V3. With VNIW however the capacity would be located substantially along the alignment of VNIW itself rather than distributed across the REZs

[39] Victoria has been a net exporter of electricity in every year since at least 2000

2.5 Impact on prices

Area A -8	**Impact on prices (capex, WACC, IDC, opex)** Plan B: "Moving onto the impact on prices as a result of its proposals, AEMO says that VNI-West will only raise transmission charges by 25% in Victoria. But AEMO uses 2021 prices, a cost of capital that does not reflect the re-pricing of risk that AEMO is adopting in its forthcoming ISP, ignores interest during construction and understates capital costs and greatly understates operating costs"

Jacobs finds (elsewhere in our review) that the CAPEX of the "Extension" to VNIW should not be added to the capex of VNIW to evaluate it.

Jacobs agrees that capex for transmission has increased significantly above inflation. Some of this has been recognised in the latest PACR.

Jacobs notes that the capex of new generation/storage has likewise risen above inflation and this has only been reported very recently (after the PACR). Since the "Benefits" of VNIW in the CBA are substantially derived from avoided generation and storage capex this escalation of the "Benefits" has not yet been factored in

Similarly, the increase in real interest rates that underpins the WACC for transmission likewise impacts the WACC for generation and storage (though Jacobs recognise that the transmission capex occurs earlier and is thus more affected).

In considering the costs and benefits of a project (like VNIW) against alternatives it is important that all of the costs and benefits for all of the options are consistent with one another. For this reason, it is generally appropriate to use the same ISP IASR set for a particular evaluation rather than taking some parameters from different versions. Or at least it should be a considered decision to select assumptions from different datasets. It could be conservative then for VNIW PACR capex to have been adjusted upwards using the later Transmission Equipment Cost database that was then recently published, whereas the CSIRO GenCost report update with new entrant generation and storage costs in it (which have also significantly increased in cost) had not at that time been published (and thus not in the PACR market modelling) and hence the benefits of VNIW may be understated against the capex costs.

Jacobs observes that in the CBA financial assessment that the capex is spread across the years prior to commissioning of the link. Thus, Interest During Construction (IDC) is implicitly and appropriately included in the CBA financial model and should not be added explicitly again as a capex component[40]. It is open to the author of a comparison/presentation of the capital costs of alternative projects whether the costs are reported on one of many bases (real (and in what year) or nominal, "overnight" cost basis or with IDC added, EPC equivalent or total project cost etc). Jacobs suggests that provided it is clear and that comparisons are on a like-for-like basis then readers who are familiar with capital project developments should not be confused.

However, the capex that is used in the CBA financial model to evaluate the project against alternatives and against the benefits provided does need to be a particular form. It should be based on the "Expected Value" (ie the mean or average value) of the capex, and likewise the capex that is within the renewable energy generation and storages that are deferred or avoided on the benefits side of the CBA likewise need to be at

[40] It is noted that in the AEMO "Western Renewables Link Project: Analysis for the purposes of clause 5.16.4(z3) of the National Electricity Rules" November 2022, that IDC is added to the TCD capital cost before converting the capex to an annuity equivalent. This is logical if the TCD cost is used as a single cost incurred in Year 0 of the model (the year before the first operating year). This treatment if the TCD is as an "overnight" cost and it is appropriate to add IDC to it before converting to an annuity equivalent. As noted above, if the TCD cost were instead spread out over the years preceding and including Year 0 in line with the expected "S-Curve" of expenditure then it would not be appropriate to add IDC (it would be a double-count). Whether IDC is appropriate depends on how the capex is used in calculations. It is not clear in the WRL document how the capex has been subsequently used.

their Expected Values. Assessments at other points on the statistical distribution of the capex outturn should be as a sensitivity analysis. The CBA financial model is constructed using real $2021 cashflows. All the elements of the model (capex, opex and benefits) need to be on the same basis.

This is not the same value as a project capex budget. A project budget capex amount would often be quoted or approved at (for example) an amount that is assessed as being 90% likely it won't be exceeded, and in nominal terms rather than real terms. A project budget is generally a higher number than the capex that is in the CBA financial model. A project budget would generally not be quoted with IDC included – the financing of the construction period generally being separately managed from the project construction budget.

The capex that ends up in the transmission company's Regulated Asset Base (RAB) and is subsequently charged to customers over its life (as the return of-and-on capital component of the transmission tariffs) will be a value that is a function of the approved capex, the outturn capex and the assessed prudency of the expenditure. There may be some form of IDC within this – for example where Early Works are approved to be included then there may be a few years where the effect of this expenditure is charged to customers or carried forward notwithstanding the project has not been built.

Jacobs do note that the capex in the evaluation of the merits of VNIW is not a project budget capex (it is real dollars, overnight and is the expected value of capex (with sensitivities analysed separately)). The outturn capex will be higher than the modelled capex but this does not make the modelling wrong. The costs and benefits need to be modelled consistently with each other.

The AACI and similar guidelines for capital cost estimating for engineering projects are often based on five estimate classes that characterise the expected accuracy of the estimate based on the level of design completion and the methods employed. Refer to Volume 2 Section 2.4.2 for a guide.

The report accompanying the latest Transmission Cost Database describes the values in the database as Class 3[41] however the usage of this type of cost on concept phase projects (where a preliminary design has not been undertaken) means that the estimate for the project at RIT-T stage is unlikely to be better than Class 4. The form of estimate used in the Plan B report is considered likely to be Class 5. The Plan B costs are considered to be of wider uncertainty than the VNIW costs, which itself has a wide uncertainty band.

The allowance for opex in the CBA modelling of 1% is considered reasonable for the purpose (Jacobs would expect 1 to 2% range). Averages across existing NSPs with aged infrastructure (well into the repex stages) and of varying elements and types quite different from VNIW is not considered appropriate.

Jacobs does not support this Plan B report proposition.

2.6 Geographic diversity

Area A -9	**Geographic diversity** Plan B: "Furthermore, AEMO's work suggests that the temporal diversity of variable renewable generation is no bigger between neighbouring regions of the NEM than it is within regions, contrary to what has long been suggested to be the case. A failure to respond to this new information has resulted in transmission plans that have become superseded by events and new knowledge."

Refer to Area A-5 in Section 2.3 above.

Jacobs does not support this Plan B report proposition.

[41] Mott Macdonald "AEMO Transmission Cost Database, Building Blocks Costs and Risks Factors Update" 24 July 2023

2.7 Extended VNI West

Area A -10	**VNI West needs to be evaluated as VNI West Extended** Plan B: "To fairly compare Plan B to AEMO's plan, we could not limit the analysis to VNI-West and the 1,500 MW augmentation that AEMO anticipates in South Western Victoria. Rather we had to include two major projects to augment the 220 kV networks in the Western Victorian and Murray River REZs without which VNI-West will not be able to offer any increase in hosting capacity in Victoria. We also included a necessary augmentation in Gippsland and between Shepparton and Dederang without which AEMO's renewable hosting capacity increases are obviously impossible to achieve. Together this constitutes what we call AEMO's "Extended VNI-West" project, which can be compared with Plan B. "

Extended VNIW is a proposal within the Plan B report based on its assessment of VNIW and its proposed re-framing of the VRET target to be based on the percentage of load rather than the percentage of generation.

Jacobs does not see merit in constructing a portfolio of projects in this form to add to the VNIW project.

If an amended set of objectives are agreed for VNIW then a revised project targeted at the new set of objectives should be devised and tested against a set of alternative means of achieving those objectives. It is unlikely that such a project would look like the Extended VNIW described in the Plan B report.

Given that Plan B does not meet the VNIW objective of increased interconnection with NSW and that Jacobs does not support setting that objective aside, it would be equally arguable that an Extended Plan B should be formulated to compare with VNIW as the other way around.

If it were decided to change the project objectives to those suggested by Plan B report, and it was evaluated that some of the Extended VNIW projects were appropriately included, then Jacobs would have further comments on the Extended VNIW costings. For example, the reasons that some elements of Extended VNIW which are similar to an element of Plan B have considerably different costs, such as the 500 kV D/C Loy Yang to Basslink Transition element, do not appear logical[42].

Jacobs does not support this Plan B report proposition.

2.8 Easements

Area A -11	**Easements** Discuss easement risks and processes. What is the risk profile of 500kV and 220kV regarding easements, and the risk issues of new easements versus extensions or shifts of existing easements.

- See also B-2

The main differences between a 500 kV and 220 kV easement relates to easement width. In Victoria the easement widths as published by AusNet Services is 40 m for 220 kV and 60 m for 500 kV. Generally, that means that the easement costs for a 500 kV double circuit tower easement is higher than a 220 kV double circuit tower easement. However if the intent was to compare the 220 kV to the 500 kV on an equivalent transfer capacity it is likely that two (2) 220 kV double circuit towers would be required compared with one 500 kV double circuit towers and in this instance the easement width for the 220 kV would be wider than the 500 kV.

[42] In the case noted the Plan B report Appendix E appears to attribute the difference to different source references, not to a difference in the project itself.

For either Plan B or VNIW, whether constructing transmission lines in a new easement or an existing easement the Jacobs Environmental Approvals team advised that the following approvals are required under the respective legislation, and that at least 2 years should be allowed for the approval of the Environment Effects Statement (EES) and the Cultural Heritage Management Plan (CHMP):

- Environment Protection and Biodiversity Conservation (EPBC) Act Referral
- EES
- Planning Scheme Amendment
- CHMP
- Consent/Permit from Heritage Victoria

The approvals are assumed to be the same for either Plan B or VNIW due to the level of public interest in the project and the likely impacts to environment, heritage and social values. Timeframes for approvals may be reduced when building in existing easements due to the proposed works area being less than for a new easement.

Table 6 shows the nature of risks associated with greenfield (new easement) versus brownfield (shifting or extending existing easement).

Table 6. Easement risk areas – greenfields versus brownfields

Risk	Greenfield	Brownfield
Land access	Higher risk of being unable to gain access to land for field and geotechnical surveys	Lower risk of being unable to gain access to land for field and geotechnical surveys. It is noted however from other recent projects that this can still be a challenge for certain sections depending on community sentiment.
Compulsory acquisition	Higher risk of needing to rely on compulsory acquisition to obtain easement	Lower risk of needing to rely on compulsory acquisition to shift or extend easement. It is noted however from other recent projects that this can still be a challenge for certain sections depending on community sentiment.
Environmental offsets	Higher risk depending on proposed routes current land use	Lower risk due to clearance within existing easement
Geotechnical findings	Higher risk	Lower risk
Outage restrictions	Low risk. Majority of construction works can be completed offline	High risk and likely to impact project delivery schedule
Construction complexity	Construction complexity depends on terrain and jurisdiction	Higher risk managing construction works in existing easement with live assets

The Plan B report proposes to shift existing easements 10 – 15m and then relinquishing the equivalent portion of easement, not required upon project completion, and rehabilitating the easement. Plan B proposes to either build new towers adjacent to existing towers or to use construction technique that involves the use

of temporary single circuit 220 kV lines with the new 220 kV pole installed at least 12m from the temporary single circuit 220kV line. The construction technique approach is viable however Jacobs review has found that in some instances the minimum clearance requirement between structures is greater than the distances quoted by Plan B and for spans greater than 400m it will become challenging to stay within the existing or shifted easement.

Jacobs have identified some specific constructability issues in the vicinity of Ballarat and on the Ballarat to Moorabool alignment and it is likely that the proposed approach would need to be re-considered in specific locations.

For Plan B project B 2.2 Kerang-Bendigo-Ballarat, in the suburb of Brown Hill, to the east of Ballarat the easement traverses a number of residential properties driveways and backyards. An alternative construction technique was proposed by the Plan B proponents for building a new double circuit within the existing easement however in Jacobs' view there is still a possibility that following a detailed assessment an alternative alignment for this section may be the best option.

For Plan B project B1.8 Ballarat – Moorabool (1) and B2.3 Ballarat – Moorabool (2) the approach is based on rebuilding of existing 220 kV single circuit line with a 220 kV double circuit in its existing easement followed by the demolition of the existing line and the restoration of the 10m of easement width for relinquishment of the easement no longer required to the landowner. However the existing lines from Ballarat to Moorabool are installed on a combination of a double circuit towers and single circuit towers. Installed on the double circuit tower is the Ballarat to Elaine to Moorabool 220 kV line and the Ballarat to Moorabool No.2 220 kV line, and the single circuit tower carries the Ballarat to Moorabool No.1 220 kV line.

On the approach to the Elaine terminal station there is a wind farm transmission line installed adjacent to the double circuit line. This would impact on both project B1.8 and project B1.4. In these instances an alternative approach to that proposed would be required and the overall easement width may need to increase or greater easement adjustments that those suggested.

Jacobs anticipate the constructability issues identified with Plan B are likely to be resolvable however the resolution will likely increase the cost. For example there may need to be some diversion that needs a new alignment/easement, the span spacing may need to be reduced and it is possible that some section(s) may need to be undergrounded.

Jacobs supports this Plan B report proposition.

3. Scope Area B : The Plan B strategy

3.1 Introduction

This Section reviews a series of propositions put forward in the Plan B report on the Plan B concept itself. This informs our conclusions on Plan B as an alternative to VNIW. A summary of Jacobs' assessment of the Area B propositions is shown in **Table 7**, with further discussion below.

Table 7 Area B summary

Item	Matter for review	Does Jacobs support this proposition?
Area B -1	Hosting capacity Plan B: "Plan B offers a total variable renewable hosting capacity of 16.8 GW in order to ensure curtailment below 13% in all REZs and to provide greater flexibility and equity between REZs. By comparison, Extended VNI-West offers total hosting capacity of 14.8 GW and average curtailment across all Victoria's REZs of 20% from 2032 (when VNI-West is assumed to be commissioned) to 2050. Plan B has more hosting capacity in the Murray River, Western Victoria, Central North and Gippsland REZs. It will offer comparable hosting capacity to Extended VNI-West in the Ovens Murray and South West REZs"	No
Area B -2	Need for easements Plan B: "Plan B's total line length is 1,451 km. With the exception of AusNet's proposed G-REZ projects in Gippsland, all Plan B projects use existing or spare easements, thus greatly reducing impacts on landholders. By comparison only 2 of Extended VNI-West's 7 projects (386 km out of total length of 1,659 km) use existing easements. "	Partly
Area B -3	Visual impact Plan B: "Most of Plan B's projects are 220 kV with 41 metre towers, with a small length of single circuit 500 kV towers up to 48 meters high. By comparison 466 km of Extended VNI-West's projects are double-circuit 500 kV, with 70 to 80 metre high towers. Since visual impacts rise as the square of height, shorter towers have substantially smaller visual impact"	No

Item	Matter for review	Does Jacobs support this proposition?
Area B -4	Capex Plan B: "Plan B is projected to cost $6 billion whereas Extended VNI-West is expected to cost $11 billion (about three times the value of Victoria's existing transmission network). "	No
Area B -5	Single Points of Failure Plan B: "Extended VNI-West has more than 1,000 "single points of failure" on transmission lines that are likely to be defined as a System of National Significance under the Security Legislation Amendment (Critical Infrastructure Protection) Act 2022 (SLACIP Act). Plan B eliminates the risk of cascading collapse of the Victorian grid by avoiding double circuit 500 kV single tower lines and by making the most of Victoria's deeply meshed, dual redundant and resilient 220 kV network.."	No
Area B -6	Project delivery risk Plan B: "Extended VNI-West has much greater risks of project delivery delays and cost blow-outs associated with supply chain constraints, skilled labour shortages, insufficient competent contractors, social licence challenges, inadequate competition, and conflicts with other Victorian critical infrastructure provision"	No
Area B -7	MCA Plan B: "Our "multi-criteria assessment" (gives Plan B a score of 23 and Extended VNI-West 79 (the lower the score the better). The biggest differences between Plan B and Extended VNI-West are in the areas of socio-economic & environmental, visual and culture & heritage. At the route of this difference is that Extended VNI-West consumes so much more land than Plan B."	We do not believe the MCAs are comparable in this evaluation
Area B -8	Hosting capacity in Gippsland Plan B "Appendix C: AEMO has unreasonably constrained the development of renewables in Gippsland "	No
Area B -9	Low Hanging Fruit Consider if Plan B elements point to "low hanging fruit" and/or "low regret" options to upgrade Vic intraregional transmission that warrant future consideration	There are elements worth looking at

3.2 Consequential impacts of the Plan B proposed objectives

3.2.1 Plan B versus the Victorian load

The Plan B report includes the following analytical flow[43]:

- The Plan B report proposes an alternative formulation to the VRET target based on %load rather than %generation (as it is enacted)
- The total Victorian electricity consumption in 2034/35 is 50,439 GWh
- Plan B says that in 2035 95% of this load needs to be met by Victorian sited renewables, or 47,832 GWh of Victorian renewables
- Plan B report says VNIW modelling has a 5,141GWh shortfall to this target and that this is equivalent to an extra 2,130MW of generation (50:50 V2 solar and V3 wind). The Plan B report suggests a total of 14,903 MW of hosting capacity is required in Victoria by 2034/35 to meet this target[44].
- Plan B's configuration, and the Plan B report's proposition that VNIW needs to be "Extended VNIW", flow from this argument.

The Plan B's table which calculates the required RE is shown in **Figure 4**. This data is in reasonably close agreement with the AEMO published operational load calculation (**Figure 5**), noting that in the operational load AEMO calculates BESS and PHES pumping losses separately. The differences are not considered material[45].

[43] Only the targets and arrangements in 2034/35 are discussed here. The Plan B report discusses earlier values in transition to 2034/35, the latest current VRET announced target.

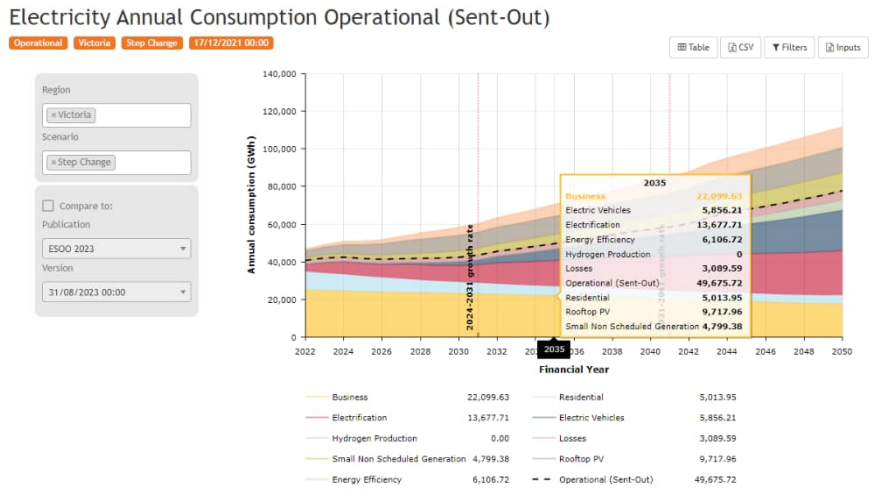
[44] Plan B target 10% spill and 1.5% transmission losses in the calculation of the Plan B requirement

[45] The Draft2024 ISP demand forecasts are now available. Refer to Volume 2 Section 3.1.1 for an extract.

Figure 4. Plan B: "Required renewable electricity meet the VRET target targets in 2023, 2025, 2030 and 2035 (GWh)"[46]

Categories	2023/24	2024/25	2029/30	2034/35
Business	24,729	24,578	23,286	22,100
Residential	9,392	8,903	6,019	5,014
Electrification	5,500	6,563	8,686	13,678
Electric Vehicle charging	41	78	1,983	5,856
Hydrogen production (by AEMO)	nil	nil	nil	nil
Transmission losses	738	738	774	920
Distribution losses	1,638	1,650	1,752	2,170
Losses in grid connected energy storage	31	29	30	129
Losses in VPP's energy storage	7	17	125	213
Losses in distributed batteries	27	45	102	269
Total electricity consumption	42,103	42,601	42,625	50,439
Renewables target	37%[1]	40%	65%	95%
Required renewable energy	15,578	17,040	27,706	47,832

Figure 5. ISP2022 load forecast for Victoria, Step Change[47]



In the RIT-T modelling, the amounts of Victorian renewable generation in 2034/35 for the Step Change scenario are shown in Table 8. The values used in Plan B report's calculation of the shortfall are given in **Figure 6**. The main difference in 2034/35 is seen to be that Plan B significantly reduces the rooftop PV output. The difference in values is more than the indicated shortfall in renewable generation.

[46] Table 1, Page 26

[47] At https://forecasting.aemo.com.au/Electricity/AnnualConsumption/Operational

Table 8: PACR modelling of VNIW Option 5A in 2034/35, Step Change[48]

	GWh	MW
Hydro	3,405	2,264
Wind	29,132	9,881
Solar PV	5,038	2,660
Distributed PV	12,988	10,956
Sum	50,563	25,761

Figure 6. Plan B: "Large scale renewable energy generation shortfall (GWh)"[49]

Row	Source	2023/24	2024/25	2029/30	2034/35
1	Hydro	2,748	3,336	3,418	3,405
2	Wind (after curtailment)	10,177	12,813	20,737	29,132
3	Large-scale PV (after curtailment)	2,205	1,888	1,850	5,154
4	Rooftop PV (after curtailment)	3,872	4,128	5,100	5,460
5	Total Victorian renewables (after curtailment)	19,002	22,165	31,105	42,691
6	VRET target	37%	40%	65%	95%
7	Required renewable generation	15,578	17,040	27,706	47,832
8	Total electricity consumed in Victoria (see Table 1)	42,103	42,601	42,625	50,439
9	Shortfall in renewable generation compliance (GWh) (negative is shortfall)	0	0	0	5,141
10	Shortfall in renewable capacity (MW)	0	0	0	2,130

The values for distributed PV used in the RIT-T and ISP are based on CSIRO capacities (MW) and modelling (GWh) by AEMO. Jacobs' own modelling (for other projects) suggests that Victoria is already approaching the Plan B 2034/35 rooftop PV penetration level (5,460 GWh) this financial year. Behind-The-Meter (BTM) batteries (and batteries generally) and the way EVs will charge are considered to be key in managing the large amount of distributed PV in the market.

If the AEMO/CSIRO rooftop PV generation forecasts are accepted then VNIW has similar amounts of RE generation in Victoria to Plan B's target in 2034/35. However, VNIW would not meet Plan B's formulation of the target because under Step Change in the ISP2022 modelling Victoria is a net importer (approximately 22%[50]) in 2034/35 and beyond.

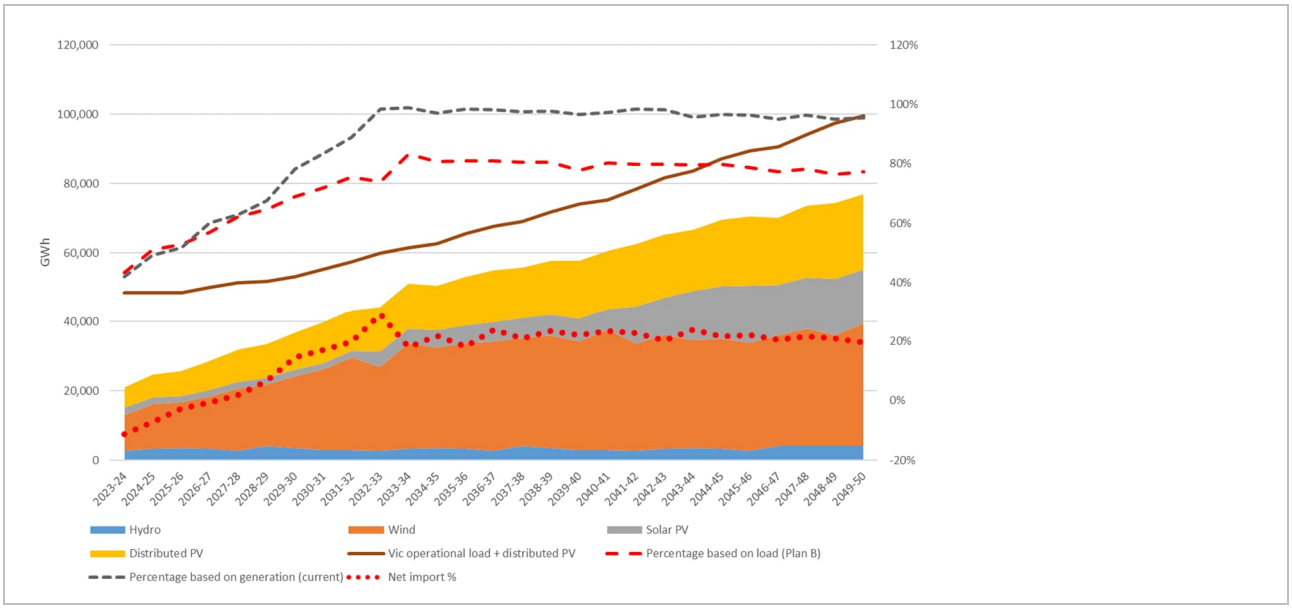
[48] EY results workbook - VNI West Step Change

[49] Table 2, Page 27

[50] ISP2022 Step Change for CDP2

The forecast load for Victoria (Step Change scenario) can be compared with the PACR modelling Victorian renewable generation for VNIW (Option 5A). This is shown in Figure 7. The net import into Victoria as a percentage of the load is shown (dotted). The calculated VRET percentages under the legislation (% of generation) and under the Plan B report's proposed alternative formulation (%load) are shown (dashed).

Figure 7. Victorian renewable energy generation with VNIW[51]



Because of the net import, the VNIW case cannot meet the Plan B formulation target despite that it has similar renewable energy generation in Victoria to Plan B. To meet the Plan B formulation of the target overbuild of RE in Victoria would be required to supress the net import of electricity so that net imports + fossil fuel generation < 5% of load.

If the Plan B report rooftop PV value and the amended VRET formulation are accepted then, as stated above, of the order of 5,141 GWh requiring approximately 2,130 MW of extra RE than expected in the VNIW modelling is required. For Plan B it assesses a total of 14,903 MW of hosting capacity in Victoria. The Plan B additional hosting capacity is suggested in the Plan B report as 11,485 MW[52].

An amount of existing hosting capacity already exists. There are several possible Build Limits that might apply in the IASR assumptions and for the purposes of this illustration Jacobs has selected some indicative values to add to the Plan B report's additional hosting capacity. This is shown in Table 9. The amount of current RE (and BESS) in each REZ is also shown.

[51] Generation data is from "EY results workbook - VNI West Step Change" option 5A Generation. Load is from AEMO NATIONAL ELECTRICITY FORECASTING (aemo.com.au), Step change, Victoria, ISP2022

[52] At Table 5, Page 35

Table 9. Plan B additional hosting capacity along with existing RE and build limits

	Existing + in-construction + committed				IASR[53]	Plan B[54]	Total Hosting Capacity with Plan B
REZ	Wind MW	Solar MW	BESS MW	MW	Limit MW	Additional MW	MW
V1					350	0	350
V2	0	698	25	723	440	2471	2911
V3	2,016	0	50	2,066	440	1914	2354
V4	2,528	0	0	2,528	2,585	3000	5585
V5	0	0	200	200	0	3000	3000
V6	0	547	0	547	650	1100	1750
Non-REZ	723	0	505	1,228			1,228
Total	5,266	1,245	780	7,292			17,178

Jacobs has constructed a simulation model to gain insight into how the Plan B generation across Victoria would work with the Victorian load forecast in 2034/35 at 30-minute granularity (Step Change, as shown in Figure 2) given the correlation/non-correlation between them. The simple analysis applied used the AEMO ISP2022 representative output "traces" for wind and solar generation by REZ, the FY2023 Victorian hydro dispatch profile[55], the current interconnector limits into and out of Victoria, and the ISP Victorian gas generation capacity. An amount of storage is allowed (an independent variable the user can change). There are no network losses or storage losses in the model.

The model steps through each 30 minute period in the year and calculates how much RE could be produced (available RE) and subtracts the load in the half hour. If there is excess energy the model tries to export it to another region (assuming the other regions can always give/take energy at the interconnection limit), put it in storage (if the storage is not full), or spill/curtail the excess. If there is a shortfall of energy the model tries to import from another region, use gas fired generation subject to its capacity, or take the energy from storage (if the storage is not empty). RE capacity can be built up to the hosting capacity in the model – an optimiser attempts to minimise spill (ie get the best mix) without having an annual shortfall (curtailed load) and

[53] IASR Initial Build Limit can be selected from amongst several limits. For V4 and non-REZ Jacobs have used the existing generation levels for the illustration. For V5 Jacobs have used zero to be consistent that any material amount of new RE in the zone will require some augmentation to the east of Latrobe Valley (or numerous connecting assets crossing the zone to the current terminal stations)

[54] Plan B Report Table 5 Page 36

[55] In practice the hydro would dispatch somewhat differently under the changed conditions of 2034-35. There is no "look ahead" optimisation done for hydro or storage dispatch. Market modelling would be required to determine how it would dispatch. The FY23 data for Victorian hydro totalled 4,366 GWh however and this was aa relatively high (wet) dispatch year. Compare with Table 8 and **Figure 4**.

attempting to have the storage end the year at the same inventory level as the starting inventory (ie not borrowing/lending energy to an adjoining year).

Running this model with 0.2% of Victoria's annual consumption, or 100,000 MWh, of storage available – which is about 30% of the Snowy 2.0 storage of 350,000 MWh[56] but is four times the likely storage in the Victorian Energy Storage Target[57] for 2035 – the model will not successfully meet all the criteria even with all hosting capacity of Plan B built-out with renewable generation. The model in that case had nearly 10% of load served by gas, 0.2% load shortfall, 13% spill and was not able to end the year with the same storage inventory as at the start of the year. Despite the gas use modelled, the simulation almost achieved the Plan B formulation of the VRET target achieving 95% of the load as Victorian sited RE due to the net export of electricity. The simulation would not meet the current formulation of VRET (being only 91% of generation as RE due to the gas usage).

Without additional support from interconnector upgrades or more storage the model struggled to meet the load in the June to August period of the representative year. Other years (with different generation load traces and potentially drought) would in some cases be more difficult to serve.

Further outputs from the model are provided in Volume 2 at Section 3.1.

Market modelling would be necessary to find the optimum mix and to determine if the storage amount was practical and at what cost impact. Plan B does not specify an amount of storage.

3.2.2 Victorian greenhouse gas emissions

With the current specification in the VRET legislation that RE must meet at least 95% of Victorian generation (proposed) in 2035, Victoria's greenhouse gas emissions are effectively capped from the sector – gas fired generation must be less than 5% of Victoria's (load + exports). Since it appears that Victoria will be a net importer of electricity that means that the maximum amount of gas fired generation will be a lower value at 95% of Victorian load minus imports).

On the other hand, Plan B's proposed change to the calculation means that Victorian gas fired generation can be up to 100% of the annual exported energy plus 5% of Victoria's load. Since it appears that in Plan B there is likely to be a large net exporter (of excess RE) and that gas generation will be required more at other times to meet the supply shortfall during RE lulls, it is expected that greenhouse gas emissions from the Victorian generation sector will be higher with Plan B than VNIW. Although the gas generation is not operating at the time Victoria is exporting the excess RE, this export amount raises the annual budget for possible gas generation. Once the RE in Victoria passes the 95% of annual load threshold (which may occur early if there is export), there is no longer a constraint on gas fired generation.

[56] https://www.snowyhydro.com.au/snowy-20/about/

[57] Of 6.3 GW by 2035 (https://www.energy.vic.gov.au/renewable-energy/victorian-renewable-energy-and-storage-targets?_gl=1*1pw85mz*_ga*MzIyNjU3MjQ3LjE2OTYzMzg3OTM.*_ga_LM2C7KTW90*MTY5OTQyNTU2Ni4yLjEuMTY5OTQyNTU3OS40Ny4wLjA.&_ga=2.146909559.1107173271.1699425567-322657247.1696338793). Assuming four hours average duration over the portfolio.

3.3 Hosting capacity

Area B -1	**Hosting capacity** Plan B: "Plan B offers a total variable renewable hosting capacity of 16.8 GW in order to ensure curtailment below 13% in all REZs and to provide greater flexibility and equity between REZs. By comparison, Extended VNI-West offers total hosting capacity of 14.8 GW and average curtailment across all Victoria's REZs of 20% from 2032 (when VNI-West is assumed to be commissioned) to 2050. Plan B has more hosting capacity in the Murray River, Western Victoria, Central North and Gippsland REZs. It will offer comparable hosting capacity to Extended VNI-West in the Ovens Murray and South West REZs"

3.3.1 V2 and V3

This Section reviews the Plan B's report's (and subsequent correspondence) assessment of hosting capacities for both V2 and V3 REZs.

REZ V2 is the Murray River REZ and is supplied by a single circuit 220kV line from Red Cliffs to Bendigo (via Wemen and Kerang). The circuit has a capacity of just over 400MVA.

REZ V3 is the Western Victoria REZ and is supplied by a single 220kV circuit from Red Cliffs to Ballarat (via Kiamal SF, Murra Warra Wind Farm, Horsham and Bulgana). The circuit also has a capacity of just over 400MVA.

The Plan B proponent's provided a response to a suggestion from AEMO that the Plan B concept may not achieve its stated additional hosting capacities. The Plan B proponents' response included that:

> *The purpose of this report is to verify that the hosting capacities in Plan B are technically valid. It does this thought the following steps:*
>
> *a. Recapping the claimed renewables hosting capacity for plan B and the Extended VNI West plan*
>
> *b. Clarification of the individual REZ hosting capacities*
>
> *c. Assumed geographical location of energy storage batteries incorporated in the VRET target of 2.6 GW by 2035*
>
> *d. Geographical location of existing and new renewable energy generation based on the latest queueing map provided by AEMO.*
>
> *e. Application of Kundur's St Clair curve to estimate transmission capacity for various locations for Plan B*
>
> *f. Use of battery storage to shift peak solar power generation, in particular from sunny daytimes to the morning as evening peak load periods, and its impact of Plan B transmission requirements.*
>
> *g. Consideration of N-1 and N-2 transmission outages*
>
> *h. Overall verification of renewable hosting capacities of Plan B, REZ by REZ*
>
> *The same methodology has been applied to the Extended VNI West Plan to verify the claimed renewable hosting capacities for each REZ in that Plan, as well as the assumed scope of that plan. In, particular the requirement for WRL-VNI West to also include substantial amounts of new 220 kV transmission line in V2 (Murray River) REZ and V3 (Western Victoria) REZ.*

Jacobs has undertaken an indicative assessment (refer to Volume 2 Section 3.1.2). The findings were:

- Based on the Jacobs' sample calculations and their assumptions regarding hosting capacity for the "Rhombus of Regret" Jacobs generally agrees with the Plan B assessments

- The hosting capacities shown in Plan B project 1.2 include 2 x 160MVA increments (for increasing maximum temperature on some 220kV lines). Jacobs does not support including these increments as the 220kV lines are proposed to be replaced under Plan B and/or AEMO advise that these upgrades have been previously undertaken
- Jacobs expects that the Plan B Project 1.4 (Elaine to Moorabool) that Plan B says "could extend to Ballarat" will likely need such an extension (a low capacity line in parallel with high capacity lines with similar impedance will result in a limitation)
- Similarly, it would be expected that the capacity of the first upgraded circuits from Ballarat to Moorabool in Phase 1 at Project 1.8 will be limited in capacity until such time as the other circuit is upgraded in Phase 2 under Project 2.3.

3.3.2 V5 (Gippsland)

Refer to Section 3.10

3.3.3 Hosting capacity and curtailment generally

Hosting capacity and curtailment are not objectives of the NEM, they are indirect outcomes of the search for an optimised, acceptable solution at least cost to consumers.

Where the solution is adjusted away from the apparent least-cost solution (because of other factors as assessed by external constraints or trade-offs such as an MCA might consider) the reasons for doing so should be aligned with the NEM or Victorian objectives.

As noted in Section 3.2.1, Jacobs anticipate difficulties with the hosting capacity proposed in Plan B in the absence of stronger interconnectors due to market curtailment (as opposed to network curtailment). Significantly increased storage would be needed to manage the mis-match between generation and load in Victoria. That a percentage of any storage program should be directed or encouraged to (particularly) V2 and V3 would make sense.

Jacobs supports the hosting capacities put forward in the Plan B report for Plan B itself but only if sufficient additional storage were added to Plan B. This additional storage is not included in the Plan B concept or capex. It is likely to be significantly larger than the storage amount described in the Victorian energy storage targets[57 above].

3.4 Easements

Area B -2	**Need for easements** Plan B: "Plan B's total line length is 1,451 km. With the exception of AusNet's proposed G-REZ projects in Gippsland, all Plan B projects use existing or spare easements, thus greatly reducing impacts on landholders. By comparison only 2 of Extended VNI-West's 7 projects (386 km out of total length of 1,659 km) use existing easements. "

- See also A-11 above

Jacobs does not agree that the "Extended" part of VNIW is an appropriate part of the evaluation.

Jacobs agree that using existing easements or co-locating with existing easements can have reduced impacts however not to the extent described by Plan B. For Plan B projects B1.6, B1.7, B2.1 and B2.3 the costs were adjusted to provide only a 1% cultural heritage allowance as Plan B stated that the 6% cultural heritage allowance applies to civil and structural works, however the construction of footings regardless of whether in a existing easement or new easment does require cultural heritage investigations. Cultural heritage investigations are required wherever there will be ground distrubance in order to determine areas of cultural sensitivity, and additionally the approvals are the same for Plan B as for VNIW (see A-11).

Plan B project B1.4, B2.4 and B3.1 are proposed to be installed in spare easements. Jacobs have been unable to find any details indicating that there is a spare easement from Elaine to Moorabool or Shepparton to Glenrowan to Ballarat, https://vic.digitaltwin.terria.io/ shows only the easement to accommodate the existing towers. Noting this Plan B's use of existing easements length is 1040 km and new easement (including suggested spare easements) is 411 km. VNIW together with WRL involves 426 km of new easement from Bulgana to New Kerang (near Swan Hill) and Sydenham to Bulgana. Overall Plan B results in more dispersed easement requirements around the state and this in itself presents approvals risk as it relies on community support and approvals with a larger set of stakeholders than VNIW. VNIW and WRL easement requirements are localised to Western and Northern Victoria with a total easement length that is shorter than the overall Plan B easement length.

Jacobs partly supports the Plan B report proposition.

3.5 Visual impact

Area B -3	**Visual impact** Plan B: "Most of Plan B's projects are 220 kV with 41 metre towers, with a small length of single circuit 500 kV towers up to 48 meters high. By comparison 466 km of Extended VNI-West's projects are double-circuit 500 kV, with 70 to 80 metre high towers. Since visual impacts rise as the square of height, shorter towers have substantially smaller visual impact"

Jacobs have reviewed a number of landscape and visual impact assessments undertaken for new and existing transmission lines. These include:

- UPC Renewables Robbins Island Transmission Lines Landscape and Visual Impact Analysis
- Australia-Asia Powerlink Project Landscape and Visual Impact Assessment
- Landscape and Visual Impact Assessment of Existing Electricity Transmission Infrastructure in Nationally Protected Landscapes in England and Wales
- Wambo Wind Farm Connection Project Visual Impact Assessment
- Project Energy Connect Visual Amenity Chapter of EIS

All of these assess visual impact based on some or all of the following:

- Landscape character
- Sensitivity of visual receptors (residents, visitors to the area)
- Frequency of change in view (depends on viewpoint)
- Magnitude of change in view (depends on viewpoint)

As per "The Guidance for Landscape and Visual Impact Assessment (GLVIA)" these factors are all interrelated and need to be considered in an integrated way rather than as a series of separate steps.

Jacobs have found no information that visual impacts rise as the square of height, but have found that sensitivity of visual receptors is a consequence of two factors, viewer exposure and viewer awareness. Whereby viewer exposure is a measure of proximity (i.e. the distance between the viewer and the visual resource being viewed), extent (the number of viewers viewing), and the duration (how long of a time visual resources are viewed), and viewer awareness which is a measure of attention, focus and protection.[58] There are a number of articles and guidelines that indicate that the visual acuity of a viewer decreases with distance from the object viewed (as opposed to height of the object).

Plan B involves co-locating projects in existing corridors for the 220 kV which does have the benefit of minimising visual impact. Most of Plan B's projects are 220 kV with 41 metre towers, with a small length of single circuit 500 kV towers up to 48 meters high. This would imply steel pole type designs which aligns also

[58] Guidelines for the Visual Impact Assessment of Highway Projects, January 2015, US DoT, Washington, DC

with information provided on the construction of Plan B and easements. Consideration would need to be given to the use of poles versus lattice towers in a given landscape setting as part of a visual impact assessment. Lattice towers are generally less visually obtrusive when seen from long distances and when viewed against non-contrasting backgrounds can have a high level of integration are often more appropriate for built up or partially built-up environments where they are typically seen from close range.

It is apparent from the landscape and visual impact assessment guidelines and visual impact assessments undertaken for new and existing transmission lines is that as part of the route selection and alignment there are mitigation measures than can be adopted to help minimise visual impact. It is recommended that VNIW consider these mitigation measures as part of developing the project.

Jacobs does not support this Plan B report proposition.

3.6 Capex

Area B -4	**Capex** Plan B: "Plan B is projected to cost $6 billion whereas Extended VNI-West is expected to cost $11 billion (about three times the value of Victoria's existing transmission network). "

Jacobs do not agree that it is appropriate to add in the "Extended" part to VNIW. Comparing VNIW (+WRL) with Plan B based on their respective estimated capex suggests the capex values are very similar. Refer to Table 10:

Table 10. Capex comparison[59]

VNIW	Plan B
VNIW: $3.499M (June 2021 real incl WRL extension) WRL[60] $737M in $2021[61]	$4.952M, $2022

However, as noted above, Plan B capex does not include the cost of the expected additional storage requirement.

Jacobs does not support this Plan B report proposition.

[59] "Overnight" basis (ie excluding IDC)

[60] Note Plan B bundle VNIW and WR

[61] https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/victorian_transmission/2022/aemo--clause-5164z3-analysis--wrl-project--november-2022.pdf?la=en&hash=6C69FC7AAEB1C36FE0A3F65AC99BB614. This is the TCD estimate without IDC and without deducting sunk costs

3.7 Single points of failure

Area B -5	**Single Points of Failure** Plan B: "Extended VNI-West has more than 1,000 "single points of failure" on transmission lines that are likely to be defined as a System of National Significance under the Security Legislation Amendment (Critical Infrastructure Protection) Act 2022 (SLACIP Act). Plan B eliminates the risk of cascading collapse of the Victorian grid by avoiding double circuit 500 kV single tower lines and by making the most of Victoria's deeply meshed, dual redundant and resilient 220 kV network"

3.7.1 Load flow

The Victoria to NSW interconnector inclusive of VNIW comprises three main flow paths:

- VNIW – the proposed 500kV double circuit link from Kerang to Dinawan
- The main existing link in the Snowy Mountains (Tumut-Murray) and at Wodonga. These paths are joined at Dederang
- The smaller link in the west of the state (near Mildura) between Buronga and Redcliffs

Because the paths normally operate in parallel, the overall flow is shared between the paths according to their electrical characteristics. AEMO would operate the system so that none of the links were overloaded (and within stability requirements).

A load flow assessment assists in understanding how much of the overall interconnector flow is carried on each path. This establishes what the conditions might be prior to a contingency event that the system would need to be designed to cope with.

Jacobs has undertaken a load flow study to compare against the PACR information for the flow capacity from NSW to Victoria. Refer to Volume 2 Section 3.5.1.

Jacobs noted:

- The 330kV flows (into Dederang) are about the same as the 500kV flows (into Kerang). The 330kV flows will limit the import capacity as they are close to the thermal limits.
- The import results are consistent with figures from the PACR (2,200MW)

3.7.2 Transient stability

The Plan B report has raised the issue of reduced system security associated with building VNIW based on using a double circuit single tower 500kV construction. It stated that a tower failure would lead to a cascading system black situation due to the concurrent loss of both 500kV circuits. The report references "1000 points of failure" – referring to 1000 towers.

AEMO has described tower failures as a "non-credible" contingencies. However, the Plan B proponents reasonably argue that such failures have occurred in the past and will occur in the future (due to extreme wind events, bushfires, or deliberate attack)

A cascading system black event is a system planner's worst outcome. It implies that the system has gotten completely out of control and will utterly fail and need to be restarted. However, Jacobs' experience is that a large amount of work goes into designing power systems world-wide such that a cascading system black event is an extreme rarity. The Australian Transmission Network Service Providers (TNSPs) are no exception.

The first point to consider is that, in the NEM, there are numerous special control schemes designed to prevent cascading system black events, including:

- System splitting scheme to limit impact of a major contingency to one region e.g., split the Vic-NSW 330kV interconnector at Murray Power Station for a blackout in Victoria (or NSW).
- Special control schemes in use today e.g., Emergency Generation Reduction Scheme for loss of both 500kV circuits into Heywood and consequential loss of both South Australia and the Portland smelter. The EGRS is designed to be high speed.
- Under-frequency tripping of smelters (Under Frequency Load Shedding or UFLS)
- Special Protection Schemes in Tasmania to protect against loss of the HVDC connection to Victoria.
- Special Protection Schemes in NSW for loss of Line 63 (Wagga-Darlington Point 330kV)

These examples are not exhaustive but do show that considerable attention is paid to keep the network as intact as possible even in the event of extreme (i.e., non-credible) contingencies.

The next point to consider is whether or not a 500kV double circuit outage will actually result in system collapse. Plan B report and submissions[62] has stated that any 500kV double circuit outage will definitely result in system collapse. This clearly would not occur under every circumstance as tripping of both circuits under zero transfer conditions would have no significant impact.

Leaving aside this trivial example, it is reasonable to consider what would happen in the event of a 500kV double circuit outage at times of maximum transfer.

Jacobs has studied this outage scenario and has shown that the network is actually reasnably resilient and can withstand this non-credible 500kV contingency. Similarly, Jacobs has analysed an additional transient stability case for tripping of 500kV double circuit lines between Kerang and Dinawan These transient stability analyses were consucted with an additional load flow assessment at maximum Vic Import from NSW (2,600MW). This is beyond AEMO's published expected transfer limit of 2,200MW.

A description of the analysis and results are provided in Volume 2 Section 3.5.2.

Jacobs believes the results demonstrate:

- The assertions made by Plan B proponets regarding the impact of double circuit 500kV lines on power system security are **not** correct.
- VNIW is estimated to **improve** power system security of the NEM with respect to Victorian Import limits

It is important to note that the studies above do **NOT** demonstrate that there will never be any circumstance when a 500kV double circuit outage will not result in major impact on power system security. These study results should be taken as indicative only. Jacobs would expect that there would be hundreds (if not thousands) of detailed studies to properly examine a major new interconnector as the design progresses. However, the studies indicate that the outcomes described in the Plan B report are not to be expected.

For these reasons, Jacobs would expect AEMO would, in due course, give consideration to the installation of Special Protection Schemes to trip load (e.g., smelter) or generation, as the case may be.

3.7.3 St Clair Curve

Professor Bartlett has used the St Clair curve approach to estimate the capability of transmission lines. The concept of a St Clair curve is that it can provide a generalised assessment of transmission line capability as a function of line length alone. Jacobs' view is that this is a tool for preliminary analysis. However, the results

[62] Plan B report Page 55, submission by Prof Bartlett and Mountain 5 April 2023 on the VNI West Consultation – Options Assessment, at Page 29

become problematic when assessing a line connecting into an actual network with significant reactive compensation. Thus, use of the St Clair curve can under-estimate the transmission capability by ignoring the impact of reactive support.

Refer to Volume 2 Section 3.5.3 for more detailed evaluation.

3.7.4 Series Compensation

Prof. Bartlett stated that the proposed 500kV series compensation between Kerang and Bulgana is "*unlikely to be successfully implemented for a range of reasons*"[63]. He has stated that the issue of sub-synchronous resonance (SSR) will be the main cause – specifically Sub-Synchronous Control Instability (SSCI) with renewable generation.

Jacobs notes that there is existing 50% Series Compensation on the Dederang-South Morang 330kV lines, and that this has been in service for nearly 30 years without any SSR/SSCI issues. Jacobs does accept that this may be due to the absence of nearby renewable generation.

In addition, SSR protection relays can be installed on series compensation facilities. These relays are designed to detect SSR and switch out the series compensation. A CIGRE/American Electric Power paper[64] describes such devices.

3.7.5 Conclusion

Jacobs finds that VNIW does not constitute an inevitable risk of cascading failure leading to widespread blackouts in Victoria. Jacobs' analysis indicates that this risk is within engineering norms.

Jacobs does not support this Plan B report proposition.

3.8 Project delivery risk

Area B -6	**Project delivery risk** Plan B: "Extended VNI-West has much greater risks of project delivery delays and cost blow-outs associated with supply chain constraints, skilled labour shortages, insufficient competent contractors, social licence challenges, inadequate competition, and conflicts with other Victorian critical infrastructure provision"

Jacobs does not agree that the "Extended" part of VNIW is an appropriate part of the evaluation.

Both Plan B and VNIW are major projects and come with delivery risks and impacts on stakeholders. Compared with VNIW the Plan B projects proposed to be built in existing easements have a higher risk of outage restrictions and higher construction complexity due to constructing within existing easements with live assets, these risks could contribute to project delivery delays. VNIW has a higher risk of needing to rely on compulsory acquisition along with higher environmental offset and geotechnical risks than Plan B, these risks could contribute to project delivery delays.

The equipment, materials and skills required for Plan B and VNIW are generally very similar, that is steel towers and/or poles, conductors and switchgear. Where supply chain constraints and/or skilled labour shortages exist, these would impact both Plan B and VNIW.

[63] Note dated 9 October 2023

[64] "A New Subsynchronous Oscillation Relay for Renewable Generation and Series Compensated Transmission Systems" by Yanfeng Gong, Yiyan Xue and Ben Mehraban 2015

Plan B would have less immediate social licence challenges in the VNI-W alignment location (it is noted that Plan B only goes to 2035 and relies on Gippsland onshore more which may have separate social licence factors (refer to Section 3.10).

Project delivery risk needs to be managed on all large projects. As stated, the key risks for Plan B are different to the key risks for VNIW and different mitigation measures would need to be employed to manage these.

Jacobs does not agree that VNIW conflicts with the Victorian critical infrastructure provisions. There is no reason why the risk management planning approach taken to building infrastructure should be different between Plan B and VNIW.

Jacobs does not support this Plan B report proposition.

3.9 Multi Criteria Analysis

Area B -7	**MCA** Plan B: "Our "multi-criteria assessment" (gives Plan B a score of 23 and Extended VNI-West 79 (the lower the score the better). The biggest differences between Plan B and Extended VNI-West are in the areas of socio-economic & environmental, visual and culture & heritage. At the route of this difference is that Extended VNI-West consumes so much more land than Plan B."

Jacobs do not agree with adding the "Extended" part to VNIW is appropriate in the evaluation.

VNIW and Plan B are different projects with different objectives. An MCA comparison of projects with such different objectives (VNI-W and Plan B are not alternatives to one another) is not considered meaningful.

Jacobs agree that Plan B would need less "greenfield" land than VNIW. The land required for Plan B has not yet been addressed for environmental or cultural heritage impacts.

Jacobs have provided further information in Part C.

3.10 Hosting capacity in Gippsland

Area B -8	**Hosting capacity in Gippsland** Plan B "Appendix C: AEMO has unreasonably constrained the development of renewables in Gippsland "

There is significant transmission capacity from the westernmost point of the Gippsland V5 REZ to the Victorian major load centres (Melbourne/Geelong), comprising the four 500kV and six 220kV circuits from the Latrobe Valley to Melbourne. These circuits were established to carry the generation from the major brown coal generators (Hazelwood, Yallourn, Loy Yang A and B), and the simple cycle gas turbine power generators at Jeeralang and Valley Peaker to Melbourne[65].

[65] The EnergyBrix Morwell facility (closed) and the Bairnsdale gas turbine facility are also noted. There is now a 200MW BESS at the former Hazelwood power station

There is presently a transmission limit (listed as 6000MW, SEVIC1 – refer to the Volume 2 Section 3.8) applicable from Loy Yang/Hazelwood Terminals Stations to Melbourne. As brown coal fired generation retires then transmission capacity will be freed up from this western point of V5. This capacity could serve onshore wind/solar in V5 and Gippsland offshore wind (V7). Given that brown coal generation is still in-place a limit of 2000MW is applied for "spare" transmission, but this will increase to 6800MW as brown coal retires[66].

The east of the state (east of Morwell) is serviced only by a weak 66kV system. In Jacobs' view, any material amount of generation east of Morwell would require new transmission (either via a grid extension or by connection assets) across to the existing EHV system at Loy Yang, Hazelwood or Yallourn.

In any case, AEMO applies land use limits in Gippsland onshore areas. AEMO notes[67] that land use limits of 1,031MW of wind and 2,474MW of solar are applied[68].

In the VNIW RIT-T PACR modelling (Step Change, 5A and Base Case) it indicates a modelled development of 2500MW of solar (transitioning in over the period 2039/40 to 2044/45) and 2000MW of onshore wind transitioning in over the period to 2030/31.

Plan B allows for a grid extension in Gippsland of 2 x single circuit 500kV lines and a terminal station at Giffard (near Basslink). This location is proposed in the 2023 Transmission Expansion Options Report[69] as a connection point for offshore wind. To suit onshore developments rather than offshore an alternative transmission concept would be more suitable (more to the north), however in general it may be of similar length and cost to that identified. The Plan B report suggests a 3000MW hosting capacity increase for V5 (presumably in addition to the 2000MW current initial build limit). The Plan B report suggests that the land use constraints "*are simply arbitrary AEMO assertions*"[70].

Jacobs does recognise that there is significant land-use and population density differences in Gippsland compared with the far west of the State. Jacobs would expect significant on shore solar and wind development in Gippsland to be relatively impactful. Jacobs agree with AEMO that land use limits are important and likely to be a limiting factor in assessing REZ V5 (further materials are provided in Volume 2 Section 3.8).

For comparison, the overlay of the population density with the REZs and major relevant interconnectors is shown in **Figure 8**:

[66] Noted in Plan B report at page 71

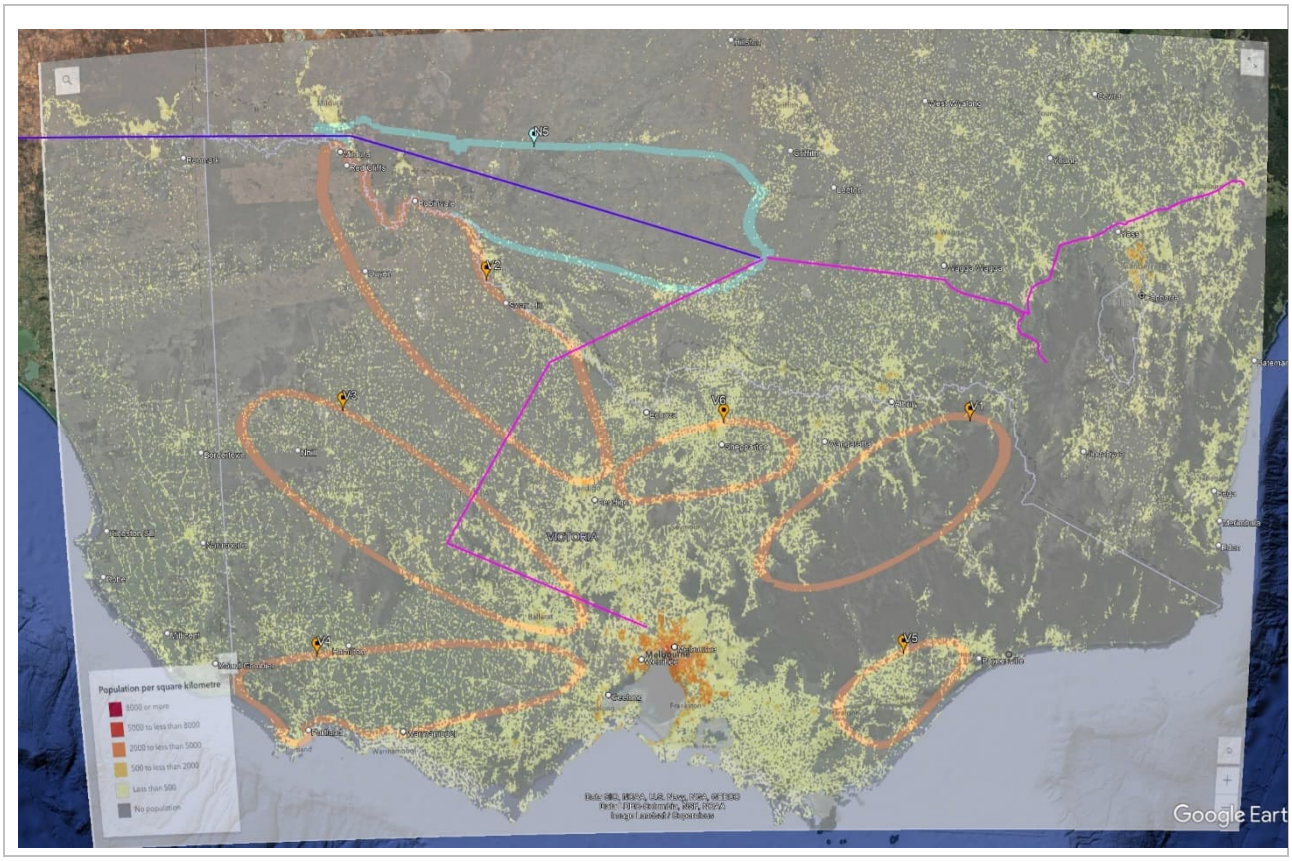
[67] IASR workbook, Sept 2023 version

[68] Larger amounts 5,153MW of wind and 12,368MW of solar, are identified for the Green Energy Exports scenario

[69] At Section 4.6.7 Page 132

[70] At Page 72

Figure 8. Overlay of population density, REZs and major proposed interconnectors[71]



The Gippsland V5 REZ is much more heavily populated than the west of the state and any other Victorian REZ besides V6.

Further, Jacobs does not believe the onshore V5 region is highly attractive for new renewable energy:

- The wind capacity factors are less than V3 and V4 and the best resources in V5 are immediately along the coastline, which would be considered sensitive, and
- The solar resource is materially worse than V2 for example and has the added disadvantage that it is to the east of the rooftops of Melbourne and more in competition with the rooftop PV in Sydney. Solar to the west of the load centres is more considered valuable as it operates closer to the afternoon/evening transition and it is less in direct competition with rooftop PV in the major load centres.

Offshore wind does not feature in VNIW or Plan B modelling (it is a sensitivity case in VNIW) and this is considered a separate prospect. Offshore wind would not be subject to the land use constraint (other than its connecting infrastructure).

If offshore wind is developed in Victoria of a scale as described in Victoria's Offshore Wind Policy Directions paper (ie of scale comparable to Victoria's load) then this would use up (and likely itself require some reinforcement) of the main transmission system. Further, Jacobs expects that unless significant interconnector upgrades or very extensive energy storage solutions are in-place in Victoria that very high curtailments will result with large scale offshore wind in relatively concentrated locations. That is, VNIW and Marinus would assist in distributing the large volume of highly correlated wind generation interstate and to

[71] Population density overlay is from: Australian Bureau of Statistics "Regional Population 2021-22: Population Grid accessed at https://storymaps.arcgis.com/stories/e2eac66d11984d0e86e6d795b0ca0eec

storage (Snowy 2.0 in NSW and Battery of the Nation in Tasmania), whereas Plan B would require major storages to be built in Victoria (or suffer increased curtailment).

Jacobs does not support this Plan B report proposition.

3.11 Elements that may be worth exploring

Area B -9	**Low Hanging Fruit** Consider if Plan B elements point to "low hanging fruit" and/or "low regret" options to upgrade Vic intraregional transmission that warrant future consideration

The part of the network west of Bulgana and Kerang warrants another specific review that looks at the existing, in-construction and committed generation in the area.

Jacobs see merit in evaluating whether drawing new solar and wind away (to the west) of VNIW's alignment rather than having VNIW attract development to itself may have benefits in stakeholder impacts and land use competition.

Evaluation of the optimum locations for wind/solar should consider all the factors including the impacts of the wind and solar farms themselves at large scale (including the wind/solar farm and the associated connections across to the main grid). As shown in **Figure 8** above the eastern areas of REZ V2 and V3 are more densely populated than the west. This was one of the drivers for the western alignment of VNIW (Option 5A) being more preferred than the earlier alignment (Option 5).

Additionally, reducing constraints to existing wind/solar producers may result in a downstream deferment of some new capacity build elsewhere and hence reduced prices to consumers. Market modelling should assess this potential

The long term strategic outlook for Redcliffs/Buronga as a key NEM node should be considered before settling on a project configuration option (along with the other factors and consultations in deciding the merits of a plan)

Some database values (eg in Transmission Equipment Ratings) should be made up to date so that industry uses the latest information, noting that NCIPAP upgrades don't appear to be included yet

4. Scope item C : Consequential considerations

Jacobs suggests that the following matters be further considered by VicGrid in future processes:

- MCA process - governance arrangements should be transparent. Governance body should set the criteria and weightings and should sign off on the scoring (scoring typically done by working team). Criteria should include all objectives of the relevant policy and legislation (NER, planning and environment, GHG policies, industry development policies etc). Criteria should cover those areas where a hard-to-quantify cost or benefit has not been included in the CBA but is material to decision making (reliability, security, strategic fit, resilience, stakeholder impact, planning and environment, do-ability/risk).
- VicGrid should review whether the current framework produces incrementalism. For example if in 2050+ it would be preferable to have multiple 500kV circuits to an area instead of three times as many 220kV circuits. What is the balance between under-build regret and over-build regret under the specific issue of the energy transition?
- Critical infrastructure should be identified and formal risk/hazard assessments (likelihood, consequence, mitigation, conclusion) should be brought forward in the planning cycle to recognise this in decision making
- Where an element in an MCA assessment (such as visual impact) could be adjusted or mitigated using things like alternative tower designs, then this should be considered in the concept stage (and any consequential cost impacts in the CBA) and the MCA should be adjusted before the MCA process is finalised and decisions made

Jacobs notes that increasing community engagement and enabling it earlier in the planning process is an area being considered (noting rule change process underway). Jacobs suggest reviewing the arrangements to see if they are adequate. Engaging with stakeholders in the broader community in earlier processes (such as ISP) for example.

5. Response to Plan B proponents' comments on Jacobs' draft report

5.1 Introduction

Jacobs provided a draft version of this report to the Advisory Group for the study on 17th November 2023. The Advisory Group included the authors of the Plan B report, the Plan B proponents. The Plan B authors provided a submission in response to the draft report on 3rd December 2023. This submission is included at Appendix C18 of Volume 2 of this report.

This section addresses the matters raised in the submission.

The submission is comprised of two sections –

- a letter directed to VicGrid and the Victorian Government discussing the matter of the objectives of Plan B (as opposed to the objectives of VNIW) and the interpretation of the government's policy on renewable energy development and deployment in Victoria. This is discussed in Section 5.2 below, and
- An attachment discussing other matters within Jacobs' Draft Report. This is discussed in Section 5.3 below.

Besides the addition of this Section 5 and the associated note included at the end of the Executive Summary, the Draft Report was the same as this version of the report in all substantive matters. The Volume 2 of this report (the information repository) has been updated from the draft report with additional materials consequent on addressing the submission and minor (non-substantive) updates.

5.2 Objectives and policy matters

The submission by the Plan B authors notes the differences between the objectives of VNIW and Plan B and restates and emphasises one of Plan B's objectives being "that 95% of Victoria's electricity demand should be supplied by renewable electricity produced in Victoria by 2035 (and 65% by 2030)". The submission infers that this objective flows from it being:

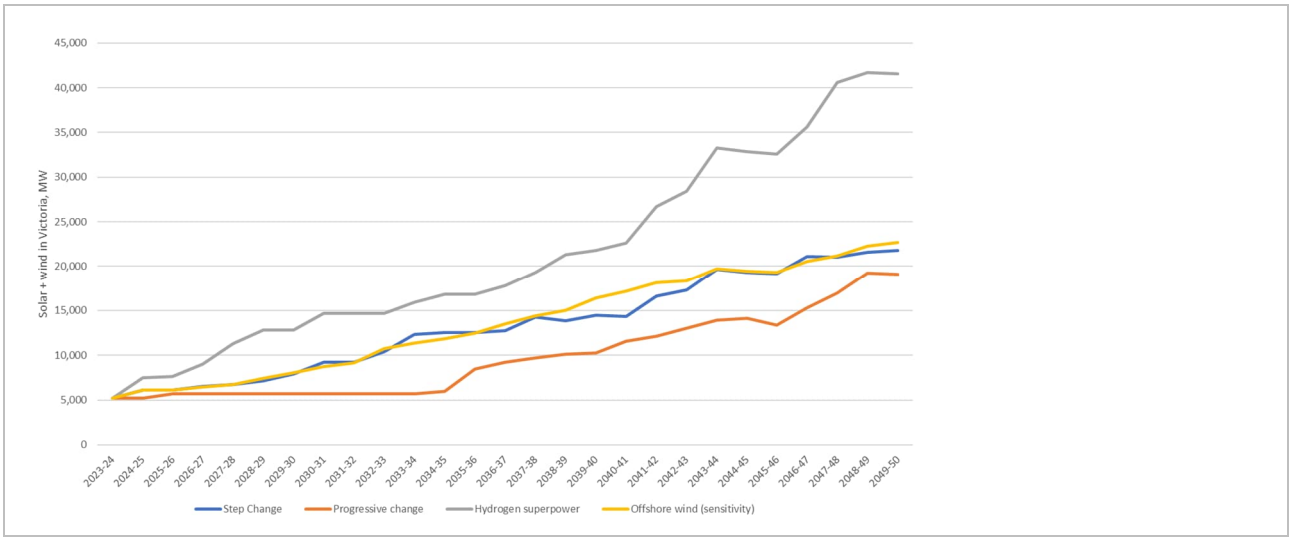
> *[…]consistent with the Government's election promises[72] and the Objects of the existing Renewable Energy (Jobs and Investment) Act 2017 in which these election commitments will be legislated (we understand in 2024).*
>
> *Specifically, these Objects include "to support the development of projects and initiatives to encourage investment, employment and technology development in Victoria in relation to renewable electricity generation; and to contribute to the reduction of greenhouse gas emissions in Victoria and to achieve associated environmental and social benefits".*

Neither the linked policy document nor the objects of the referenced Act (which are listed in Volume 2, Appendix A.4) suggest a change to the manner of calculation of the target in the way suggested under Plan B. They do refer to supporting projects in Victoria.

It is not the case that under VNIW there will not be significant future renewable energy development in Victoria. This is shown in the materials provided with the RIT-T which is shown in **Figure 9**. Under each of the scenarios analysed in the PACR there is significant new renewables generation constructed (besides ongoing rooftop PV development).

[72] A link to https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0028/635590/Victorias-2035-Climate-Target_Driving-Real-Climate-Action.pdf is provided

Figure 9. Wind + (non-rooftop) solar capacity in Victoria with VNI West (PACR case 5A)



The modelling does show that under Plan B there would be more constructed in Victoria by 2035 (except perhaps for the Hydrogen Superpower scenario) than under VNIW. From **Figure 9**, in 2034-35 under the Step Change scenario with VNIW there is expected to be 12.5 GW of (non-rooftop) solar + wind in Victoria – about 2.5 times the current amount. Plan B does not disclose the amount of wind and solar developed but rather makes provision for a "total variable hosting capacity of 16.8 GW". Jacobs' modelling suggests that this is about what would be required for Plan B in 2035[73]. This would be approximately 3.4 x the current levels. The Plan B authors describe this difference as a drastic reduction. **Figure 9** also shows that under VNIW the (non-rooftop) solar + wind generation requirement in Victoria surpasses the Plan B hosting capacity provision in the early 2040s. Plan B does not deal with the future requirement for additional renewables beyond its stated hosting capacity.

The VNIW RIT-T does show that under VNIW and under the current Victorian VRET there is expected to be net imports into Victoria.

However, contrary to the Plan B authors' submission that:

> *Jacobs insists that "Unless decision makers adopt the changed VRET formulation … it is unnecessary to evaluate VNIW as Extended VNIW in the way described in the Plan B report …" Jacobs has therefore necessarily assumed that Victoria will become a substantial net importer of electricity from NSW. Victoria must necessarily become a substantial net importer in order to satisfy Jacob's claim of a "fundamental" difference between a target specified as a percentage of demand and a target specified as a percentage of generation.*

Jacobs did not assume that Victoria would become a substantial net importer from NSW. That is an outcome shown by the VNIW RIT-T modelling (and the ISP2022), not an assumption. That outcome flows from the modelled least-cost configuration of the NEM by the RIT-T and the ISP. Further, it does not follow from Jacobs' considerations that Victoria must necessarily become a net importer to identify that the two versions of VRET formulation are "fundamentally" different. The alternative formulation of VRET proposed by the Plan B authors produces fundamentally different outcomes and it is the large difference in outcomes that justifies the objectives being identified as fundamentally different by Jacobs.

The submission then asserts that "*since we* [the Plan B authors] *do not make such an assumption, Jacobs has decided that our objectives are not plausible and so it* [Jacobs] *refuses to assess Plan B against Extended VNI West.*" Jacobs' assessment of the Plan B objectives does not follow from any assumption about net imports

[73] Refer to Section 3.3 above and to Section 3.1 of Volume 2 of this report.

being in some way a necessity. Jacobs assessed the outcomes that flow from the Plan B objectives and presents the assessed outcomes for VicGrid to decide if there is any value in those outcomes. Further, Jacobs does not agree with the Plan B authors' setting-aside of the value of increased interconnection (an objective of VNIW) as having no value. Plan B as a configuration does not meet this objective.

Jacobs did not refuse to evaluate Extended VNIW against Plan B, instead Jacobs assesses that Extended VNIW as an "add on" to VNIW so that Extended VNIW would meet Plan B's objectives as well as its own objectives is an illogical comparison. This is because Plan B is no match for VNIW on the interconnection criterion (and Jacobs recommends this objective should not be set-aside), and if Plan B's alternative objectives were favoured by the government then the alternative projects that would be evaluated against Plan B in the assessment would be unlikely to include Extended VNIW as configured by the Plan B authors. If Plan B's objectives were accepted, then Jacobs expect that network planning for Victoria would need to be wholly re-done applying the new objectives.

It is only by defining and enforcing new objectives for Victoria in the form advocated by the Plan B authors - in changing the VRET definition to force more renewables into Victoria, and now (as the Plan B submission seems to suggest) by making it a requirement that Victoria must be a net exporter to NSW - that the "Extended" portions that the Plan B report adds onto VNIW become applicable, but then the Plan B report ignores the interconnection benefits which are why the "VNIW" part of "Extended VNIW" is there.

Jacobs evaluates that it is not relevant nor logical to forming the conclusions of this review to assess Extended VNIW in the manner suggested in Plan B.

The balance of the first section of the Plan B authors' submission is directed towards whether a new specific policy that Victoria must not be a net importer of electricity from NSW should be embraced by the government. They say: "*Plan B assumes that Victoria has a policy not to become a major net importer of electricity from NSW*".

In this review Jacobs has identified the expected outcomes of not proceeding with VNIW and instead proceeding with Plan B and, by extension, what the outcomes of adopting the objectives advocated by the Plan B authors would be. Whether these Plan B objectives (redefining VRET and requiring Victoria to not be a net importer) have merit to balance the expected outcomes is a matter for government.

Based on Jacobs' assessment the expected outcomes of Plan B as an alternative to VNIW include:

- Higher costs to consumers
- A much larger amount of storage required in Victoria at a cost that has not been included in the Plan B costings (and/or more spillage of excess renewables relative to the Victorian load due to the need to over-build, and/or more gas fired generation).
- Other important parts of the energy transition would be blocked or hindered (such as Victoria's offshore wind policy and other important interconnectors across the NEM, including Marinus Link), and it hinders Victoria gaining benefit from the Commonwealth's investment in Snowy 2.0 long-duration energy storage.
- The benefits of VNIW which have not been valued into the RIT-T cost-benefit-analysis such as enhancing energy security and reliability by the sharing of reserves between regions, would not be realised.
- It allows (and may require) greater levels of greenhouse gas emissions from Victoria's generation sector than are allowed under the current definition of VRET and are expected with VNIW.

Jacobs rejects the assertions made in the Plan B authors' submission that Jacobs has refused to do what was instructed. The terms of reference for the review are appended (Appendix A below) and these terms have been addressed in the review. In undertaking this review Jacobs has appropriately applied the tools and analyses that in Jacobs' experience are used by professional practitioners in the industry to draw its conclusions on whether Plan B is an appropriate replacement for VNIW (including whether VNIW presents the

certainty of catastrophic cascading failure suggested in the Plan B report), and whether Plan B has merit in itself.

No time-step simulation analysis, electricity market modelling results, cost-benefit analysis, load flow or transient stability study analysis have been provided with the Plan B report.

5.3 Supplementary matters

This section addresses the matters in the Attachment to the submission made by the Plan B.

5.3.1 "Jacobs has failed to provide any evidence for its conclusion that a second interconnector is justified"

The arguments put forward by Professor Mountain in the two articles[74] published in RenewEconomy cited in the Plan B authors' submission, and the similar analysis provided in the Plan B report, have been dealt with in this report (and are unchanged from the draft report that the submission relates to in these regards).

In each of the cases the analysis applied by Prof. Mountain ignores that each of the time periods in the analysis (5 minute, or 30 minute etc) are individually important and instead rolls-up the periods he analysed to being based on averages or aggregates over a long period – the year to October 2023 in the case of the papers where the individual time-step data is "normalised" by Prof. Mountain to be the averages for each hour of the day in the year to October – and over the whole life of a solar or wind farm in the use of the long-run marginal costs of solar and wind derived from the CSIRO GenCost data (published by AEMO as part of the ISP inputs and assumptions reports) noted in the Plan B report and in the first paper cited by Prof Mountain.

Market modelling (as conducted by AEMO in ISP processes, and by EY for the RIT-T, and by Jacobs in manifold assignments advising clients developing or reviewing solar, wind and BESS projects all over Australia) is the tool generally applied within the industry to assess each time-step individually and to fit the least-cost solution (or to assess a configuration or project) that meets the NEM reliability objectives for supply in each and every time-step, not just on a long-term averaged basis.

In this review Jacobs has noted the market modelling undertaken by AEMO (ISP) and EY (PACR) and has observed that the least-cost solutions in those models do support a net benefit being derived from VNIW in the associated cost-benefit analyses. Further, for this review Jacobs undertook a simplified time-step evaluation of Plan B and VNIW on serving Victoria's loads and found that there was indeed particular periods in the year that Plan B would not be likely to service without a large amount of additional and uncosted storage being also developed in Victoria, and that the relative amount of storage needed would be much reduced (and broadly consistent with the AEMO/EY model results) with VNIW.

Jacobs has also conducted correlation analysis under more refined timescales and geographic consideration than have been used by the Plan B authors and observes that there are relevant differences between outputs in those analyses.

The separate market modelling analyses done by multiple modellers, the simple simulation analysis, the correlation analyses done on more refined timescales, and the issues around averaging (or normalising) over long periods all support Jacobs' conclusion that the Plan B proposition is not able to be supported.

Jacobs does not support that the Plan B authors' submitted material is sufficient nor probative in assessing whether there is value in interconnection between regions generally nor specifically in the VNIW case.

Despite the utility of market modelling, there remains benefits of interconnection that are not valued in the process. Types of benefits that cannot be appropriately valued are not included within the allowed benefits

[74] https://reneweconomy.com.au/is-there-a-case-for-building-new-grid-interconnectors-aemos-own-data-suggests-not/ and https://reneweconomy.com.au/the-diversity-argument-for-this-new-transmission-link-doesnt-stack-up/

included in a RIT-T cost benefit analysis. Services that provide benefits below the level of time-scale granularity of the market modelling such as potential reductions in required quantities of frequency control ancillary services, new forms of ancillary services (such as 1-second FCAS and inertia-like services), changes in network control services such as provision of network strength[75], sharing (to the extent possible) of system restart services, and the sharing of capacity to respond to N-2 and higher contingencies are services that are typically not modelled.

The RIT-T with/without test (or Take-Out-One-At-A-Time) process adopted to ensure there is no double-counting of benefits between projects assessed and approved at different times (such as WRL, VNIW, Project Energy Connect, HumeLink and Marinus) is conservative and does not fully capture the inter-relationships between the functionality and benefits of the overall system development[76].

Decarbonisation measures, which are of course the measures and policies adopted by jurisdictions to reduce greenhouse gas emissions from the energy sector by pursuing the energy transition, are evolving and not all the policies/measures can be part of the market benefits analysis in the RIT-T. For example, new policies can be announced after the modelling assumptions are established for the RIT-T, and in recent times new policies tend to advance the energy transition or to lower-emission targets. As many of these policies include more or faster development of variable renewable energy generation projects, and as greater interconnection will support more variable renewable energy generation as coal plants retire because of the diversity and sharing attributes of interconnectors, interconnection enhancements do provide additional benefits that have not been fully costed into the RIT-T.

Jacobs has noted the Plan B comments regarding their previous submission made to the earlier RIT-T option report. In that previous submission, they suggested that substitution of BESS in NSW for PHES in Victoria was the main driver of the assessed benefit of VNIW, and they questioned "*why an interconnector is needed to access battery storage in NSW that can be built just as cheaply in Victoria*". Jacobs' view, along the lines that AEMO also noted in the VNI West Consultation Report – Options Assessment (e.g., at page 41), is that PHES and BESS are serving different purposes in the assessments – the PHES being of longer duration than the BESS and (presumably being selected in the analysis at that time) because at the needed duration the PHES was assessed as cheaper. Whereas in the "with" VNI case and given the sharing of diversity effects provided, presumably the model selected a BESS option and found it cheaper (or no more expensive/effective) to locate it where it did. This is consistent with Jacobs' assessment on the (later) PACR analysis and Jacobs' own analysis that "without" VNIW there is a need for more storage in Victoria and this extra storage is not costed in Plan B.

5.3.2 "Jacobs recognises that VNI-West will fail to reduce curtailment but, like AEMO, dismisses this"

Jacobs has noted the network related congestion in the V2 and V3 REZs in Victoria. This congestion is a matter of notoriety, and Jacobs has also noted that further assessment should be made of whether reinforcing the network to alleviate the congestion (and possible additional benefits such as spreading new V2 and V3 RE-build further westward than would otherwise occur) is appropriate.

Jacobs' assessment has been neither "blithely" dismissive nor "patronising" of the congestion issue in V2 and V3.

Relieving congestion is a benefit that must be established (by appropriate analysis) to be worthy of its cost, and also that the resulting cost should be borne by customers if the network investment is undertaken as a regulated investment in the NEM. To make relief of congestion an objective of itself without assessing

[75] Some RIT-T's targeted at establishing the need for network elements such as synchronous condensers do include a wider range of potential benefits in the assessment as appropriate to the case

[76] The ISP process looks at portfolios of projects to try and capture the benefits of overall system development – VNIW's status as an "Actionable Project" under the NER arose from this ISP process.

whether that relief is worthy of its cost, and that the allocation of that cost to customers is appropriate, is not justified.

Jacobs has suggested that a further review of network investment, particularly in the western side of the V2 and V3 zones and in conjunction with VNIW, be undertaken to see if that investment is justified.

5.3.3 "Jacobs accepted AEMO's false claims that additional transmission expansion beyond WRL- VNI is not required in Victoria"

AEMO has not made the claim.

The PACR and Options report modelling is a "with" versus "without" assessment that only needs to explicitly cover the benefits (and the associated costs) provided by the asset investment under consideration, in this case VNIW. All the other future needs of Victoria beyond those provided by VNIW are the same in the with and without case and cancel out. It is not the objective of VNIW, nor of the RIT-T evaluation, to be a complete roadmap of electricity development in Victoria.

As the Plan B authors' submission notes, there is further and ongoing planning for Victoria's electricity supply and transmission needs being undertaken by VicGrid (and AEMO).

5.3.4 "Jacobs' conclusions on power system stability impacts of VNI-West are not plausible"

Jacobs has undertaken analyses using appropriate tools of the expected consequences of double circuit failures of both the VNIW part and the WRL part of the overall link.

Jacobs has evaluated the results and considered what responses and mitigations are likely to be utilised in the eventual power system configuration to make the risk of "total collapse" despite a double circuit 500kV outage, one that fits within normal industry practice.

The claims made by the Plan B authors are not supported. Those claims have not been supported by analysis using industry appropriate tools such as load flows and transient analyses.

5.3.5 "Jacobs ignores the inability to run all Snowy 2.0 pumps and the implication of this for VNI West's claimed benefits"

Plan B have asserted:

- *The Plan B authors advised Jacobs that a fault on the 500 kV network near Loy Yang is certain to cause transient instability of the Victorian Power system when all of the Snowy 2.0 pumps are on-line, and*
- *Jacobs were also advised that a fault on the 330 kV transmission lines near Lobe's Hole near Snowy 2.0 when all pumps are on-line is certain to cause all units to "pole-slip" which could destroy them.*

The Plan B authors have not provided load-flow nor transient stability analyses (using the tools and models normally used by the industry) to support these assertions.

With respect to the Snowy 2.0 pumping design and configuration, these are being undertaken by Snowy Hydro with Transgrid and AEMO as the relevant connection counterparties who will assess how to configure and protect Snowy 2.0 and the NEM. The model parameters for Snowy 2.0 pumping or generation stability analysis are not yet published (to Jacobs' knowledge) to allow analysis.

Using an extant model (including some parameters from the existing Tumut pumps as a proxy for the unknown parameters of Snowy 2.0) and assuming HumeLink is in-service (as well as VNIW and WRL), Jacobs has not seen the severe outcomes asserted by the Plan B authors in modelled results.

Jacobs advise the Plan B authors that if they have further concerns and evidence regarding the Snowy 2.0 engineering that they should take these concerns up with Snowy Hydro, TransGrid and AEMO.

5.3.6 "Socio-environmental impacts of Plan B vs WRL-VNI West"

The Plan B authors state in their submission that, to them, a pole-type structure is more aesthetically pleasing than a lattice tower.

This material does not constitute a visual impact assessment. Whether a pole structure of a type similar to Plan B's proposal is better in some or all cases for VNIW (or Plan B for that matter) than a lattice structure considering visual impact, cost or technical characteristics and performance is not established and is not a material component of Jacobs' current assessment of VNIW (VNIW is at the concept level development of function, main parameters and route corridor).

Jacobs did not "blithely" ignore the information provided as the Plan B submission asserts. It is (and was) described in Jacobs' report (at Section 3.5).

As is already noted in Jacobs' report, an MCA comparison of projects with such different objectives (VNI-W and Plan B are not alternatives to one another) is not considered meaningful.

5.3.7 "Jacobs claim that the deliverability of Plan B is similar to WRL-VNI West"

There are already several examples of double circuit 500kV in Victoria and the NEM, and there are numerous examples of the types of equipment (such as 500 kV/220kV transformers and switchgear etc) that would be applied. Besides the issues of securing the final route and easements (which Jacobs notes and does not consider an immaterial or unimportant factor), the differences between 500kV and 220kV as electrical transmission arrangements are not such that Jacobs would suggest materially special or different approaches that would change this report's evaluation.

Neither is the potential for 500kV elements to have a longer lead time than 220 kV elements sufficient to materially impact this evaluation. This is a downstream project management and procurement issue.

The capital cost of VNIW (+WRL) and Plan B are similar (though Plan B's capex omits the additional storage likely to be required), and the spatial extent of both projects is similar magnitude (Plan B has longer route length than WRL+VNIW but is mostly along existing alignments (which has benefits and disbenefits).

Besides the route selection and easement issue differences, Jacobs does not evaluate VNIW and Plan B as being substantially different from a project deliverability perspective.

5.3.8 "Jacobs fails to assess comparative capital costs"

The Plan B authors' submission again suggests that Jacobs has "blithely ignored" the Plan B submissions on capital costs. Again, this assertion is rejected.

Jacobs restates:

- The Plan B report's assessment that VNIW should be evaluated as Extended VNIW (which roughly doubles its capex) is not supported by Jacobs. Without this addition the VNIW (+WRL) and Plan B projects are of similar magnitude of (network) cost, to the extent that capex is not the primary differentiator between the projects (versus the Plan B report where the difference in capex dominates).
- The Plan B capex does not consider the significant additional cost of storage that is expected to be required for Plan B.
- The Plan B presentation of capex on different bases (escalation to $2023 and addition of IDC for example), while noted and not ignored by Jacobs, does not factor materially in Jacobs' final conclusions.

5.3.9 “Jacobs fails to assess comparative price impacts”

There is no substance or merit in the Plan B authors’ remarks. Jacobs rejects these.

Appendix A. Jacobs' terms of reference from VicGrid/DEECA

Mountain-Bartlett Report – Review – Project Scope

Project Purpose:

To undertake an independent technical assessment of the feasibility and merits of the proposal by professors Bartlett and Mountain and Darren Edwards entitled 'No Longer Lost in Transmission' (Aug 2023).

Background:

The Victoria-New South Wales Interconnector (VNI) West is a project to build a double-circuit, 500kv connection between Bulgana, in Victoria, to Dinnawan in New South Wales. The need for this interconnector was identified in AEMO's 2018 ISP (where it was titled 'Snowy Link South'). Since that time it has changed names (first 'Kerang Link'; now VNI-West), as well as location (it has shifted progressively west, reflecting government's effort to both minimise community opposition and maximise the potential to enable new renewable energy developments in Victoria).

VNI-West has deviated from the transmission planning process provided by the NEL and NER due to the intercession of the Victorian Minister to address community landscape values. In spite of these efforts, the project has met significant community opposition, including litigation and protests.

Some key dates:

- December 2019 - Project Specification Consultation Report (PSCR) published
- July 2022 – Project Assessment Draft Report (PADR) published
- February 2023 – Minister makes Order under NEVA, requiring AEMO to take into account community values in selecting an optimal route
- April 2023 – Moorabool and Central Highlands Power Alliance (MCHPA) commence litigation against the Minister in the Supreme Court regarding her NEVA Orders (second NEVA order subsequently added to proceedings)
- May 2023 – Project Assessment Conclusions Report (PACR) published
- May 2023 - Minister makes second Order under NEVA, conferring on AEMO the responsibility for undertaking early works on VNI-West (and anticipating a further order conferring responsibility for contracting for project delivery).
- July 2023 – MCHPA lodge objection with AER to VNI-West RIT-T
- August 2023 – sizeable protest outside Parliament House (Victoria) objecting to VNI-West
- August 2023 – Bartlett, Edwards and Mountain release 'No Longer Lost in Transmission' – an alternative proposal for meeting the electricity system needs that VNI-West is intended to address.

Issues:

The Bartlett, Edwards and Mountain Report (also referred to by the authors as 'Plan B') finds that existing transmission easements in Victoria can host sufficient new transmission capacity to address the State's supply needs going forward. The report is critical of AEMO's analysis and calls on VicGrid to take a stronger role in planning the State's transmission needs.

The report has received widespread attention in media and amongst groups opposed to VNI-West. 92a2aa_76c7e6d656a6439b8ad5488f0a37c941.pdf (vepc.org.au)

Project Scope

- Independent third party review of the Mountain/Bartlett/Edwards Plan B report by VicGrid's technical advisor Jacobs

- Review will assess and provide recommendations on:

    - The Plan B report's assessment of VNI-West
    - The Plan B strategy outlined in the report
    - Consequential actions/considerations for VicGrid when undertaking further planning of the Victorian transmission network, including the development of the Victorian Transmission Plan

- The results of the review will be publicly communicated by VicGrid

Governance

- VicGrid project steering committee oversighting work of Jacobs – meets weekly

- Advisory Committee consisting Mountain/Bartlett/Edwards and AEMO which provides input into analysis and comments on the results – meets periodically

Process

- Phase 1: Jacobs assessment of the Plan B report, including provision of exploratory/clarification questions to Mountain/Bartlett/Edwards and AEMO to assist in assessment

- Phase 2: Provision of initial analysis to Advisory Committee for comment

- Phase 3: Finalisation of assessment for publication

Timing

- 8 September: Advisory Committee meeting – outline process of review and discuss initial exploratory/clarification questions from Jacobs

- 19 September: Advisory Committee meeting – discuss further exploratory/clarification questions from Jacobs

- Early October: Advisory Committee meeting – presentation of initial analysis and seek commentary from Committee members

- End of October: Advisory Committee meeting – presentation of final analysis incorporating commentary from Committee members