RESPONSE TO DRAFT 2024 INTEGRATED SYSTEM PLAN FOR THE NEM

I wish to provide the following comments on the Draft Integrated System Plan. I provide these comments as a result of my experience working for over forty years in the electricity distribution networks in NSW. This experience included most facets of the DNSP's business. After experiencing loss of electricity supply for over three days as a result of the summer 2019-2020 bushfires, I resolved to improve the reliability and security of the family home's electricity supply.

I installed a 6.6kW solar system, a 13.6kW net LFP battery and a Victron Energy grid isolation inverter charger. This allowed part of the house to be configured with a no-break electricity supply. The system is equipped with substantial energy management and data systems. The home is fully electric with storage hot water, and is capable of charging our hybrid plug-in electric car (net battery capacity 10.2kWh).

In order to supply appropriate performance data of the solar system, please see the Appendix with data from our home installation and two other solar installations which we have had quoted in Sydney.

I refer to your Figure 6 and the projected residential electricity consumption supplied by rooftop solar in 2050, being approximately 60TWh. As shown in the Appendix, the average generation for a 6.6kW solar system is 8.67MWh. To provide 60TWh, the estimated kW of solar panels required is 46 million kW. With the average domestic solar configuration being 6.6kW (maximum single phase sanctioned by NSW DNSPs), this means that 6.9 million homes will need to be equipped with solar panel systems. This represents approximately 95% of the homes estimated to be in the NEM in 2050. As shown in the Appendix, the average cost of a 6.6kW solar system with a 5kW inverter is $12,438, resulting in a total cost to the community of $85.8 billion. The undiversified maximum generation into the low voltage network will be 3,450 MW, typically between 10am and 3pm under full sun conditions and latitude 35 degrees South.

Historically, DNSPs have designed the low voltage distribution network, including distribution substations, using after diversified maximum demands (ADMDs) of 2.5 to 4kVA per customer. More recently this has been increased to 6kVA or more in non-coastal areas such as western Sydney. Typically, low voltage networks are designed to supply the ADMD with a maximum of 10 volts drop in the LV mains. With solar generation, the direction of load may reverse and this will result in voltage increases in the LV network. This will be approximately in direct proportion to the ratio of maximum solar generation compared to designed ADMD. For example, a network designed with an ADMD of 4, at maximum solar generation, assuming 100% penetration of solar systems, will experience a voltage rise of approximately 12.5V in the LV distributor. When there is no solar generation, it is expected that customers' demands will be such to change this into a low voltage drop. In the above example, the swing of volts at consumers' terminals attributable to the LV distributor impedance will be 22.5V, rather than 10V. DNSPs are required to maintain voltages to all customers as required by the Australian Standard. If voltages fall outside these standards, DNSPs are obliged to augment their networks to provide the voltages as determined by the appropriate Australian Standard. All appropriate prudent capital expenditures will be included in the DNSP capital base and the return on and of will be recovered via DUOS charges paid as part of electricity tariffs.

The voltage rises will also occur in the 11/22kV and subtransmission networks, but the magnitudes will be dependant on the export loads caused by the solar generation. Zone substation transformers are generally designed with very limited tapping range to reduce distribution network voltage levels. This may result in a large number of zone substation transformers having to be retired early in order to maintain voltages with the Australian Standards. It is not inconceivable that distribution networks that supply principally residential areas fitted with solar generation to the extent proposed in the Integrated System Plan, may require very substantial investment to keep voltages within prescribed levels. There doesn't appear to be any allowance in the ISP for capital costs associated with this issue.

As a further example, our home is in a residential area in which less than 20% of the homes currently have solar panels. At times of maximum solar generation, I note that our voltage approaches the maximum as prescribed by the Australian Standard, and is only currently limited by the solar inverters ramping down the solar output as required. This results in substantial spillage of available solar energy unless action is taken to increase local consumption via, in our case, HWS, car charging, dishwasher etc. Control systems are available to do this automatically by means of voltage control and export control, but there is a capital cost associated with this.

Regarding Figure 14, the coordinated Customer Energy Response (CER) storage is projected to be approximately 40 GW in 2050. Assuming the following: 3 hour discharge rate; battery discharge limitation to 30% SOC; battery at 90% SOC at time coordinated response required; average home battery size 13.5kW net; and average cost of 13.5kW battery $13,777 (see Appendix), the number of batteries required will be 4.9 million, which represents a penetration of 71% of all homes fitted with solar panels. The total cost to the community for these batteries will be $68 billion.

I am unaware if AEMO have included the cost of solar systems and batteries in the total amount of investment by the community as calculated above, being in excess of $140 billion. The annual cost to customers, based upon a similar methodology used by network DNSPs for network solutions, for solar systems including batteries, assuming 5% cost of capital and effective life span of the solar systems including inverters of 20 years, batteries systems 15 years, can be calculated as follows:

- 5kW solar system: capital cost $12438, annual depreciation	$621
- 13.5kW battery: capital cost $13777, annual depreciation	$920
- Annual cost of capital:	$1316
- Annual maintenance cost at 0.5% pa:	$130
- Total annual cost:	$2987

The above calculation, if done by DNSPs, would use their WACC for the cost of capital calculation. For private individuals a rate equivalent to the customer's opportunity cost of capital is more appropriate. For many customers with mortgages, the opportunity cost is the cost of the interest on their mortgage, which is currently in the order of 6.5%. 5% has been used for the calculation which is probably closer to the long term mortgage rate.

Based on an annual solar generation of 8,677kWh, the cost per kWh is 34.4 cents . This compares with electricity retailers currently offering 7 cents per kWh for solar generation exported to the grid. Assuming all solar generation is exported to the grid, the customer's average rebate off their electricity account is $1.68 per day. In many cases, this is less than the fixed charges charged by electricity retailers. As more and more solar is connected, there will be more and more solar energy spill. Consequently, it is expected that retailers will in the future offer substantially less than 7 cents per kWh.

Essentially, the annual cost of electricity for customers with solar systems can be expressed:

- Annual cost as calculated above
- Less exports to the grid at 7c/kWh
- Plus annual supply fee
- Plus annual imported energy from the grid costs

For many customers, this is likely to be in the order of $3,500 per annum and this compares with a typical annual cost when taken exclusively from the grid in the order of $2,500 per annum. The import of energy cost will be a prime determinant of the variations to the annual cost. Minimisation of this component will depend on how effectively individual customers maximise self-consumption of the available solar generation, especially for EV charging and electric hot water heating. I expect that many customers that do not actively maximise solar energy self-consumption will pay considerably more for total electricity costs with solar, compared with importing all electricity from the grid. It is acknowledged that many people adopt solar for many reasons other than financial benefit.

Over the past four years, the minimum solar generation from my 5kW AC coupled solar system has been:

YEAR	MIN DAILY kWh
2020	1.31
2021	2.72
2022	3.74
2023	3.57
Average	2.83

This compares with approximately 35 kWh on a sunny day. The 2.83 kWh average minimum represents only 8% of the typical maximum daily figure.

There are a considerable number of days each year where there has been insufficient solar generation to replace the overnight home usage from the 13.6 kWh battery, let alone charge the electric car, recharge the storage HWS or run reverse cycle air conditioners. Consequently, considerable energy has to be drawn from the grid to supplement solar generation. The availability and cost of the energy required from the grid will have a large bearing on the dispatchable energy available from the solar battery system. The cost of this energy from the grid is subject to energy retailers' tariffs and distribution network availability. The existing three part time of use tariffs currently available are very blunt instruments to minimise recharge costs. There needs to be at least a fourth block to the tariff structure when there is a spill of renewable energy generation in the NEM. Also customers are at risk of DNSPs and retailers tariff changes. For example, this year Essential Energy charge a maximum demand that occurs any time during the month, compared to last year when the maximum demand charge was limited to peak demand times, ie 5pm-8pm Monday to Friday. So regardless of energy rate, customers will be charged for their maximum demand at all times when recharging the battery from the grid. Also this year, our retailer has charged the maximum demand to include maximum demand of energy exported to the grid. In previous years, demand charge was only levied on imports from the grid. Neither of these two changes were clearly signalled to the customers prior to implementation of the changes. We only found out about them when we received our first bill for the year.

It is acknowledged that fully electric EVs equipped with vehicle to load and vehicle to grid will provide future opportunities that are not considered in the above discussion. There are only a limited number of vehicles available on the market at the moment that offer vehicle to load capability. These vehicles can only deliver 2.4kW to customers' loads and are yet to be able to be integrated with household stationary batteries. The vehicle to grid technology is yet to evolve into workable economic propositions. In order to use this technology, individual customers will still require a stationary battery in their premises as many vehicles are not at the customers' premises for many days when solar generation is available.

I believe all of the above points discourage home owners from adopting behind the meter generation.

SUMMARY

Given the current economics of behind the meter solar/battery systems, I believe it is very unlikely that sufficient dispatchable generation will consistently be provided by rooftop generation to achieve the objectives of the Integrated System Plan.

Your statement that the ISP in its current form delivers the lowest, most reliable outcome for power supply to the NEM for the period up to 2050 is unsupported by your document. There is no economic modelling contained in the document that takes into account the normal lowest overall customer cost, when behind the meter consumers' costs are not covered, nor the potentially very large increases in distribution network expenditures that will increase the network use of system charges (NUOS). Also given the magnitude of expenditure on the transmission network, the transmission use of system charge (TUOS) will increase substantially. These projected increases need to be estimated and included in your document.

There are some obvious concerns regarding security of the electricity supply when up to seven million homes are being relied upon to generate sufficient electricity to ensure reliability of electricity supply. For example, the grid isolation devices will be of various manufacturers and designs and connected to the internet. These devices may be open to coordinated cyber attacks that will degrade the quantity of electricity supplied in the future. Also, it is a very simple matter for individual customers to isolate the supply to their batteries from the grid at peak demand times if they choose not to participate in supplying electricity from batteries that they own, even if this is mandated by regulation.

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