Clean Energy Council submission to the Department of Environment, Land, Water & Planning Consultation Paper on Voltage Management in Distribution Networks

The Clean Energy Council (CEC) warmly welcomes the Department of Environment, Land, Water and Planning (DELWP) consultation paper on voltage management in distribution networks.

The CEC is the peak body for the clean energy industry in Australia. We represent and work with Australia’s leading renewable energy and energy storage businesses, as well as accredited designers and installers of solar and battery systems, to further the development of clean energy in Australia. We are committed to accelerating the transformation of Australia’s energy system to one that is smarter and cleaner.

We welcome the Victorian government’s contribution to improving the framework for voltage management on distribution networks. The DELWP consultation paper makes a significant contribution to the policy debate and is the first time any government in Australia has quantified the costs and causes of overvoltage in distribution networks. The Victorian government is setting the ‘gold standard’ for regulation of voltage management, thanks to its support for solar-enabling policies, the completion of the smart meter rollout and the use of the data that smart meters can provide.

As the consultation paper makes clear, voltage management is a critical factor influencing the capability to host large amounts of distributed energy resources (DER) on the distribution network. Better voltage management will reduce electricity bills and greenhouse gases, improve equipment performance, and reduce damage to appliances. Overvoltage increases the incidence of solar curtailment, wastes energy and can unnecessarily increase customers’ electricity bills.

We urge DELWP to support moves to align Australia with the European voltage standard (IEC 60038). This would assist networks with their voltage management obligations and increase solar hosting capacity, while reducing network expenses.

We strongly recommend that DELWP consider reforms to enable customers (and their authorised agents) to access local, real-time data from smart meters.

We urge DELWP to consider the feasibility and desirability of establishing a market-based framework for voltage management services.

We welcome the consideration of the potential opportunities, costs and risks of regulatory requirements or financial incentives for distribution businesses to improve their voltage management beyond compliance.

We have provided additional detail on consultation questions in the remainder of this submission. We would be very happy to discuss these issues in further detail. We look forward to contributing further to this important area for policy development.
Summary of Recommendations

1: The Victorian Government should transition to aligning with the European voltage standard (IEC 60038) which is 230V±10% and is centred on 230V.

2: If the Victorian Government decides not to align with the European voltage standard (IEC 60038) it should consider targeting the preferred steady state median voltage range listed in AS 61000.3.100, which is 225V - 244V and is centred on 234.5V.

3: The Victorian Government should consider publishing more granular data (e.g., for the 7am to 9am ‘breakfast hump’, the 11am to 3pm ‘solar hump’ and the 6pm to 8pm ‘dinner hump’) for a representative sample of feeders to help determine whether reporting averages over four-hour intervals is masking useful data.

4: Customers (and their authorised agents) should be given access to their own voltage data, including local, real-time data as well as V1, V50 and V99 values.

5: DELWP should consider the feasibility and desirability of establishing a market-based framework for voltage management services.

6: A framework to encourage investment in voltage management (beyond compliance) should be guided by cost-benefit analysis.
**A potential win-win reform on voltage management**

Aligning Australia with the European voltage standard (IEC 60038) would assist networks with their voltage management obligations and increase solar hosting capacity, while reducing network expenses. Managing high penetration of solar PV on distribution networks will be simpler and cheaper if Australia adopts the European standard. It is very likely to be the ‘lowest hanging fruit’ for solar enablement policies.

In Europe, the IEC 60038 standard allows for 207V to 253V, centred on 230V.

As noted in the consultation paper, the average voltage level in Victoria is 242V, even though the Australian standard (AS 60038:2012) has a nominal voltage of 230V. While the nominal voltage of the Australian standard is indeed 230V, the permitted range (216V - 253V) is not centred on this value but on 234.5V. Targeting a value below 234.5V may limit the ability for distribution businesses to fully utilise the permitted voltage range, which is important for accommodating the full and widening range of demand from peak load to peak generation/reverse flow.

If we move to the European standard, then targeting 230V would make sense. If we remain with the Australian standard, then targeting 234.5V would make more sense. CEC’s preference would be to move to the European standard and target 230V.

There might be a need to consider the impact of lower voltages on old equipment (e.g. from the 1990s or earlier) that pre-dates the transition of Victorian voltages from 240V to 230V. Impacts on new appliances are unlikely because imported appliances are designed and manufactured for a global market with the European voltage standard in mind. We understand that DELWP is undertaking work in collaboration with the University of Wollongong to quantify the impacts and risks of overvoltage on appliances. It would also be worthwhile considering whether there would be any risks to appliances from lower voltages if Australia were to adopt the European (IEC 60038) voltage standard.

**Recommendation 1:**

The Victoria Government should transition to aligning with the European voltage standard (IEC 60038) which is 230V±10% and is centred on 230V.

**Recommendation 2:**

If the Victorian Government decides not to align with the European voltage standard (IEC 60038) it should consider targeting the preferred steady state median voltage range listed in AS61000.3.100, which is 225V - 244V and is centred on 234.5V.
Experience of voltage management in other jurisdictions

Queensland’s experience of the transition to 230V

The amendment to the Queensland Electricity Regulation that instituted Queensland’s transition to the 230V standard in October 2017, also referenced the preferred steady state median voltage of AS61000.3.100 (Limits—Steady state voltage limits in public electricity systems) that is 225V - 244V.

Table 3 shows the preferred steady state median voltage (V_{10min}) at the customer’s connection point for phase-to-neutral, phase-to-phase and single phase centre neutral connections on 230 V low voltage systems.

<table>
<thead>
<tr>
<th>Steady state voltage measure (10 minute r.m.s.)</th>
<th>Phase-to-neutral voltage preferred performance</th>
<th>Phase-to-phase voltage preferred performance</th>
<th>1 phase 3 wire centre neutral phase-to-phase voltage preferred performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>Maximum</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>V_{10min}</td>
<td>225 V</td>
<td>392 V</td>
<td>451 V</td>
</tr>
<tr>
<td></td>
<td>244 V</td>
<td>424 V</td>
<td>488 V</td>
</tr>
</tbody>
</table>

NOTE: Preferred values for guidance purposes only.

While the priority of Energy Queensland’s transition has been reducing the levels of overvoltage, median voltages are also monitored with the objective of maximising the number of connections with a median in the preferred range. The 253V limit applied in Queensland from October 2018 and AS61000.3.100 specifies that no more than 5% of a sample should breach this limit. Refer to the diagrams below for Energy Queensland reports, included in its Distribution Annual Planning reports.

Compliance with 61000.3.100 should be achieved in reasonable time frames, considering most of the assets in the network have 40+ year lifespans and will not be replaced whilst they are in good condition.

Western Power

Western Australia is the only Australian jurisdiction that continues to operate at the 240V standard. All other jurisdictions in Australia have moved to the 230V standard. Western Power has been relatively successful in reducing the voltage using what is available to manage compliance and now in many areas the voltage is regularly 240V - 245V. Reducing it further would incur additional costs without any financial mechanism to pay for the activity. There is no financial mechanism that funds increasing hosting capacity for DER in the Western Electricity Market (WEM), so work so far has been under the banner of compliance with voltage regulations, asset replacements etc.
Responses to questions for consultation

Q1. **How have current distributor voltage reporting requirements been useful since their introduction? How could these requirements be updated to provide more meaningful data for consumers and useful information to support public transparency?**

This process itself demonstrates the usefulness of the distributor voltage reporting requirements. The reporting requirements enable evidence-based policy making and regulation of voltage management. Victoria is the only jurisdiction in Australia able to make policy and regulations based on comprehensive voltage data.

It would be worthwhile considering the time and duration of reporting intervals. The current reporting framework covers four-hour intervals, and it is unclear whether use of averages is masking any useful data. It would be helpful if the next stage of the consultation could include data over shorter durations, which would enable identification of critical periods for voltage management. For example, it would be useful to have more granular data for the 7am to 9am ‘breakfast hump’, the 11am to 3pm ‘solar hump’ and the 6pm to 8pm ‘dinner hump’. Averaging over the periods of 4am to 10am, 10am to 4pm, 4pm to 10pm and 10pm to 4am makes it difficult to understand the scale of voltage issues at the ‘peak congestion’ times when they are most likely to be experienced. We are not proposing at this stage that the reporting regulations should be changed to shorten the reporting period. Rather, we are suggesting that additional, more granular data for a representative sample of feeders would help to establish whether reporting at four-hour intervals is averaging out useful data.

Where it exists, data on power flows experienced by transformers at different times of the day would also assist with planning for infrastructure such as ‘Neighbourhood Batteries’ and for provision of network services.

Consumers should be able to access real time, local voltage data for their National Metering Identifier (NMI), rather than averaged data for their feeder. This would enable customers considering the purchase of rooftop solar to understand the risks of curtailment reducing the benefits of their investment. The Australian Energy Market Commission (AEMC) is currently undertaking a review of metering services and the CEC is advocating that the AEMC should enable consumers (and their authorised agents) to have access to local, real-time data. Victoria is not bound by the AEMC’s ‘Competition in metering’ policy, and we urge the Victorian government to introduce policy enabling consumers to have local, real-time access to the data from their smart meters.

**Recommendation 3:**

The Victorian Government should consider publishing more granular data (e.g., for the 7am to 9am ‘breakfast hump’, the 11am to 3pm ‘solar hump’ and the 6pm to 8pm ‘dinner hump’) for a representative sample of feeders to help determine whether reporting averages over four-hour intervals is masking useful data.

**Recommendation 4:**

Customers (and their authorised agents) should be given access to their own voltage data, including local, real-time data as well as V1, V50 and V99 values.

Q2. **Can third-parties who wish to provide non-network solutions (such as neighbourhood batteries and electric vehicle chargers) currently access voltage data to support their needs? Is there other data and information from distributors that could cover this need? Are there any privacy issues associated with sharing this data and if so, how can they be managed?**

We commend the Victorian Government for being the first jurisdiction in Australia to regulate the reporting and publication of voltage data at the feeder level. More granular data, especially data for the ‘breakfast hump’, ‘solar hump’ and ‘dinner hump’ periods could be useful to inform the business case for implementing non-network solutions.
for non-network solutions. Even more useful would be for customers (and their authorised agents) to have access to local, real-time data from their own smart meters.

Some distribution businesses may have quite sophisticated metering and measuring equipment on their sub-stations and transformers that would be extremely useful for third parties establishing a business case for provision of non-network solutions.

Q3. Do you have any comments about the analysis presented on voltage levels in Victoria’s distribution networks? What further evidence or investigations should be considered to understand the voltage in Victoria’s distribution networks?

The trend revealed by the analysis is encouraging. We welcome the improvements in voltage management on distribution networks that is demonstrated by the data.

The analysis is useful. It would be even more useful if it were more nuanced and went beyond average voltages, comparable to the median or V50. The experience of virtual power plant (VPP) operators has demonstrated there can be very significant voltage issues that are not revealed by analysis of average voltages. It is often the ‘outliers’ and the worst-case scenarios that are the biggest concern and they do not show up in analysis based on averages. More granular data for ‘worst-case scenario’ days (which may be linked to weather conditions) would allow more insights into what is happening under worst-case scenario conditions.

If DELWP undertakes a voltage management study, we recommend obtaining a record from distribution businesses of all the times action was taken to reduce voltages. Even though this creates an additional reporting requirement, it needs to be taken into account in the data analysis to obtain a true picture of voltages and whether there is scope to make further reductions.

Q4. How could regulatory arrangements for voltage management be enhanced to accommodate high levels of DER and new technologies such as electric vehicles and batteries and deliver better value for consumers?

As already noted, the simplest and cheapest measure would be for the Victorian Government to align voltage standards with the European voltage standard (IEC 60038) which is 230V±10% and is centred on 230V.

Reducing the voltage on the distribution and transmission network is not trivial and not a low-cost issue. Financial incentives and penalties could be used to encourage distribution networks to go beyond compliance with the ‘hard’ limits set by regulation and to shift average voltages closer to 230V.

There is a common cultural view within the electricity industry that high voltages on distribution networks constitute better voltage management than lower voltages. There were grounds for this view when electricity only flowed one way. The view needs to change in the context of two-way electricity flow. Distribution businesses need to be able to deliver within the standard (preferably the European standard) and there needs to be a change in opinions to recognise that managing a feeder at an average voltage of 220V (for example) is not inherently better or worse than managing it at 240V.

Q5. What levers would support greater accountability for distribution businesses to deliver investments for network voltage?

A good place to start would be to give customers (and their authorised agents) access to their own voltage data and other local, real time data that the smart meter can provide. This would assist with identification of the possible cause of problems with inverter tripping and would also greatly assist solar designers and retailers with providing advice to prospective customers regarding issues that might be experienced due to local voltage conditions. This should be coupled with communications to

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1 The 50th percentile of voltage (V50) is the median and statistically this can differ from the average, usually because of a bias in the data set. Average voltages are comparable to the median or V50. For the sake of brevity this submission has used the terms interchangeably, however for the sake of precision it is worthwhile noting that they are not identical.
consumers, explaining that individual users of the network cannot expect to export all their excess energy into the grid 100% of the time. Better management of voltage should complement the introduction and use of Dynamic Operating Envelopes.

Q6. What is the role of energy users in providing services to manage network voltages and how can others, such as aggregators, operationalise this? What opportunities are there to ensure energy users and others are fairly compensated for delivering network voltage support?

Currently, customers are required to provide voltage management services free of charge as a condition of grid connection approval. This is embedded within AS/NZS 4777.2:2020 in the form of Volt-Watt and Volt-var responses, which are currently provided as an unpaid service from inverters to distribution businesses. This was a reasonable approach in 2019 and 2020, when the AS/NZS 4777.2:2020 standard was being developed. At that time, Australian standards for interoperability were nascent and autonomous response modes by inverters were the most practical means to ensure that DER could contribute to voltage management on distribution networks.

Standards and regulatory requirements for interoperability will be introduced from 1 December 2022, commencing in South Australia (SA), with all inverters required to be capable of interacting with the SA Power Networks utility server. The introduction of this capability will enable the development of a market-based framework for voltage management as a service.

Markets for distribution-level services is an active area of policy development in Australia. To ensure that the development of markets for distribution level DER services is not hampered unnecessarily, the CEC recommends that this issue be revisited in the context of the introduction of new requirements for interoperability between inverters and the distribution businesses’ utility server. When this capability is available it will no longer be necessary to rely on inverters to autonomously respond to conditions on the grid. They will be capable of replying to market signals, including bids for provision of voltage management as a service.

We encourage DELWP to consider the feasibility and desirability of establishing a market-based framework for voltage management services, noting that:

- There could be practical impediments, such as network latency,
- The cost of establishing a market framework might exceed the net societal benefits,
- There could be transitional issues creating a market if distribution businesses expect to be able to mandate provision of the service as a condition of grid connection, and
- The Australian Common Smart Inverter Profile (CSIP-Aus), which is expected to the form the basis of an Australian standard for inverter interoperability, currently only caters for use cases by distribution businesses. Additional development work is required for CSIP-Aus to also support electricity retailer and customer use cases.

Recommendation 5:
DELWP should consider the feasibility and desirability of establishing a market-based framework for voltage management services.

Q7. Do you agree with how the impacts of undervoltage and overvoltage have been characterised? What further impacts should be considered?

We have no issues with the way the impacts of undervoltage and overvoltage have been characterised. It is worth noting that two issues related to operating distribution networks at lower voltages (including the lower voltages allowed under the European standard) would be the potential impacts on appliances and potential impacts on the AS/NZS 4777.2:2020 standard. These issues have already been addressed however it would be worth bringing to the attention of the industry and the public that this is the case. Appliances are already designed so that they can operate safely to international standards.
There is a proposal with Standards Australia for adoption of IEC 60038 as an Australian standard to help manage power flows in both directions. If IEC 60038 were adopted as an Australian standard there would be no need to update AS/NZS 4777.2:2020 because it was written in the expectation of adoption of IEC 60038 as an Australian standard.

Q8. What further evidence and studies are required to better understand the impacts of voltage on consumers, appliances, and DER?

The impacts of voltage on consumers, appliances and DER are already well understood. Reforms can proceed based on the current knowledge. There is not a lack of understanding that would present any significant barrier to improving the regulatory framework.

The Victorian distribution businesses publish their average voltage data in the Distribution Annual Planning Reports. This is extremely helpful but does not provide the complete picture. The highest and lowest voltages are also key data points. Data on correlations between weather conditions and voltage fluctuations would also be helpful.

Q9. Do the current regulatory arrangements adequately protect consumers from the impacts of undervoltage and overvoltage? If no, what improvements are required?

Many consumers have been suffering the impacts of overvoltage for a considerable period. Clearly there is room for improvement.

Giving consumers access to their own voltage data (V1, V50 and V99) would allow them to bring voltage management issues to the attention of their local distribution business. Giving consumers (and their authorised agents) access to local, real-time data from their smart meter would enable them to optimise design for DER and other smart appliances behind the connection point.

A framework of financial incentives and penalties would encourage distribution businesses to go beyond regulatory compliance.

Q10. How can the objective of voltage management which maximises consumer benefits in the high DER future be balanced with the need to ensure network investment is prudent and efficient?

A framework to encourage investment in voltage management should be guided by cost-benefit analysis. The analysis should include the benefits to consumers delivered by DER in reducing wholesale electricity prices, greenhouse gas emission reductions and other system-wide benefits.

Recommendation 6:

A framework to encourage investment in voltage management (beyond compliance) should be guided by cost-benefit analysis.

Q11. What steps and strategies could help to maximise voltage compliance and deliver value for consumers?

V1 and V99 are relevant for compliance purposes. Reporting and publication of averages voltages (V50) is useful for illustrative purposes. Victorian regulations enable reporting and publication of V50 values. Reporting and publication of V1 and V99 values would help to improve transparency regarding compliance. A regulator that takes enforcement actions when breaches occur would improve compliance.

Neighbourhood-scale batteries could play an important role in delivering value for consumers and where there are significant network benefits, for the system more broadly. The recommendations of this review could assist with the rollout of the Victorian Government’s neighbourhood-scale battery initiatives.
It is also important to note that the last part of the network is the customer connection, and this is often the highest contributor to voltage drop and rise across the network to the individual load or inverter. Quite often that will account for 2-3% of voltage rise.

Q12. What are your views on the risks and benefits of going beyond compliance? What other risks and benefits should be considered?

Voltage management on low voltage (LV) networks is a key component of the provision of ‘export services’ and ‘hosting capacity’. Going beyond compliance would improve network hosting capacity and enable more consumers to connect DER and export electricity, which would help to reduce greenhouse gas emissions and put downward pressure on electricity prices. The risk depends on the strategy used. If not carefully designed, more stringent regulations could place costs on networks that exceed net societal benefits. Financial incentives to go beyond compliance could cost more than the net benefits if the incentive scheme is not well designed.

Q13. Is pursuing policy and regulatory reform to improve voltage management beyond compliance a worthwhile exercise? If yes, which options in Error! Reference source not found. are most worthwhile pursuing further that have a low potential to increase consumer electricity bills from upgrading the network? What other options which should be considered?

Yes.

In addition to the options suggested in Figure 15, we strongly urge the Victorian Government to consider the adoption of the European standard for voltage (IEC 60038) which is 230V±10% and is centred on 230V. This is likely to be the solar enablement policy with the largest benefit to cost ratio.

The other approaches proposed in Figure 15 all have merit and should be pursued.

A consumer awareness campaign would be more effective if consumers (and their authorised agents) were able to access their own voltage data, including V1, V50 and V99 values.

A regulatory target requiring distribution businesses to centre their voltage management at 230V and report on progress would be beneficial, provided the scheme works within a cost-benefit framework and noting that a 230V target would only make sense if the European voltage standard were adopted. A target of 234.5V would make more sense if Victoria continues to target the steady state median voltage range listed in AS61000.3.100, which is 225V - 244V and is centred on 234.5V.

Expanding the Victorian Energy Upgrades (VEU) scheme to include initiatives which improve voltage management should be considered if the benefits can be shown to exceed the costs. Similarly, a voltage related incentive target in the Service Target Performance Incentive Scheme (STPIS) would be a sensible approach, provided the net societal benefits would exceed costs.