Amendments to the Electricity Safety Regulations

To expand the permitted voltage range for electricity supply

OCTOBER 2024

MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Te Kāwanatanga o Aotearoa
New Zealand Government

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The Ministry of Business, Innovation and Employment (MBIE) seeks written submissions on the issues raised in this document **by 5pm on 29 November 2024**.

Your submission may respond to any or all of these issues. Where possible, please explain the reasons for your answer, include evidence to support your views, for example references to independent research, facts and figures, and include relevant examples.

- You can send your submission as a Microsoft Word document to electricitymarkets@mbie.govt.nz
- mailing your submission to:
  Electricity Markets Policy Team, Building, Resources and Markets
  Ministry of Business, Innovation & Employment
  PO Box 1473 Wellington 6140
  New Zealand

Please include your name and (if applicable) the name of your organisation in your submission. Please also include your contact details in the cover letter or e-mail accompanying your submission and direct any questions concerning the submissions process to electricitymarkets@mbie.govt.nz

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PART 1: CONTEXT, THE CASE FOR CHANGE, AND OPTIONS

Homes and businesses get power through low voltage networks

1. Most homes and businesses connect to the electricity system through low voltage distribution networks. The power supplied from a low voltage network is sometimes called ‘mains supply’.

2. Electricity typically flows from generators to consumers through progressively lower voltage lines (transmission, sub-transmission, and distribution). The voltage is transformed at each point by a transformer.

3. Most electricity is generated by large power stations connected to Transpower’s high voltage transmission network. High voltages in Transpower’s national transmission network allow large amounts of electricity to be transported over long distances with minimal losses. Lower voltages in sub-transmission and distribution networks allow electricity to be safely transported to homes and businesses, and at each point of supply, the low supply voltage enables electricity to be used by a wide variety of electrical appliances.

Standard low voltage can currently only vary by ±6%

4. In New Zealand (NZ), regulation 28 of the Electricity (Safety) Regulations 2010 requires single phase low voltage electricity to be supplied at a nominal voltage of 230 Volts (V) alternating current (AC), and except for momentary fluctuations must be kept within 6% of that nominal voltage.[1]

5. NZ regulations allow the standard low voltage to vary by ±6% because voltage cannot easily be maintained at 230 volts at every supply point due to constantly varying demand and generation in the low voltage network. The voltage at a point of supply typically falls when demand in the vicinity increases and rises when generation increases.

6. Regulation 23 of the Electricity (Safety) Regulations 2010 requires electrical appliances sold in NZ must comply with regulated standards to ensure they operate safely and efficiently with low voltage mains supply. The relevant standards for appliances and fittings in New Zealand are either shared standards with Australia or standards from the European-based International Electrotechnical Commission (IEC).[2]

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[1] A higher nominal voltage of 400 volts applies to multiple-phase supplies, which are used in some industrial or larger commercial environments – but must also remain within 6%.

[2] Relevant standards are listed in Schedule 4 of the Electricity (Safety) Regulations 2010.

The demands on low voltage networks are changing

7. The demands on low voltage networks are evolving as homes and businesses change the way they use interact with the electricity system. More homes and businesses are investing in rooftop solar photovoltaic (solar PV) generation and in electric vehicles (EVs).[3] This is expected to accelerate in the years ahead as the costs of these resources fall and their performance improves. Electricity consumption may also increase as homes and business switch from using natural gas to electricity to heat their properties and hot water.

8. The increasing use of distributed generation (particularly rooftop solar panels) is expected to change the pattern of power flows in low voltage networks. During the day, a large amount of solar PV generation flowing into the network (often refer to as exporting) coinciding with relatively low household demand could result in overvoltage (voltage exceeding the regulated upper limit) if no mitigating actions are taken.

9. Similarly, the advent of electric vehicles (EVs) that are charged at home (or stationary in-home battery systems) could significantly change the scale and pattern of demand. In particular, a large number of EVs charging at home around 6pm could exacerbate the high demand typical at that time in winter. This could potentially result in undervoltage (voltage falling below the regulated lower limit) if no mitigation is taken.

We are proposing to modernise our voltage range

10. We are proposing changing NZ’s regulated voltage range from 230 Volts ±6% to 230 Volts +10% and -6%. This proposal would bring NZ closer to alignment with Australia[4] and is expected to be the least cost option for mitigating potential constraints on low voltage networks. The evidence you provide in your submission will help inform analysis of the benefits and risks of changing voltage regulations.

11. Alternatively moving to ±10% would align NZ with other countries that have a nominal voltage of 230 Volts, including the United Kingdom (UK) and countries in Europe. This range would also bring NZ’s supply voltage range into alignment with the voltage range that has been reflected in NZ’s regulated appliance standards for many years.

12. The Electricity (Safety) Regulations 2010 are made under section 169(1)(7) of the Electricity Act 1992. The proposal would change the prescribed requirements for standardisation of systems of supply and the preservation of the quality of electricity supplied in NZ. The proposal is consistent with the purposes in section 1A of the Electricity Act 2010 to provide for the regulation, supply, and use of electricity in NZ, to protect the health and safety of members of the public in connection with the supply of electricity in NZ, and to promote the prevention of damage to property in connection with the supply and use of electricity in NZ. This discussion document focuses on whether expanding the voltage range is likely to impact those purposes.

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[3] Information about investment in solar PV can be found on the Electricity Authority’s EMI website: https://www.emi.ea.govt.nz/Retail/Dashboards/5YPBXT?_si=db|5YPBXT,v|0

[4] Australian states and territories, except Western Australia, have harmonised their supply voltage at 230 Volts with a range of +10% to -6%. Western Australia remains at 240 Volts ±6%. In practice, this means the upper voltage limit in Western Australia is 254 Volts, compared to 253 in the rest of Australia.

Objectives and potential trade-offs

13. Our overall objective is to ensure low voltage networks continue to be operated safely and cost-effectively. In the future, achieving this will require managing trade-offs between three goals:

    a. **Reducing the curtailment of distributed energy resources (DER)** – Solar PV and EVs could make valuable contributions to the security of the electricity system, give households greater control over their energy bills, and play a significant role in helping reduce carbon emissions.

       However, unless there is additional investment to low voltage network infrastructure, the increasing generation from solar PV (and potentially demand from EVs) may need to be curtailed at times to keep voltages within the regulated ±6% range. This would cause opportunity-costs and disruption to owners of DER and may discourage other consumers considering investing in them. Ultimately reducing the resources available to generate electricity could harm the security and cost of the electricity system, while limiting the use of EVs would disrupt the Government's plans to reduce transport emissions.

    b. **Mitigating costly upgrades to low voltage network infrastructure –** The curtailment of DER could be managed by altering network topography (re-designing low voltage networks) or installing additional equipment to manage fluctuations in voltage more dynamically. We have not sought to estimate the costs of such network upgrades, but they would exacerbate the upward cost pressures already anticipated from investments needed to enable electrification and to improve network resilience to extreme weather.

    c. **Maintaining the safety of low voltage networks** – Appliances are designed and optimised for a certain input voltage. NZ's appliance standards have been aligned with international standards for many years, including the wider voltage ranges permitted in Australia and Europe. It is therefore likely that newer appliances sold in New Zealand are designed for a supply voltage of 230 Volts ±10%. It is also likely that older appliances can tolerate the upper end of this voltage range, if designed to operate at the higher nominal voltage of 240 Volts + 6% that was historically used in parts of Australia (and still used in Western Australia).

       However, allowing higher or lower supply voltage could adversely affect the performance of some appliances or shorten their life. Through this discussion paper we are seeking evidence of the risks to appliances, so we can properly assess the cost and safety implications of the proposal on households and businesses.

14. If the regulated voltage range remains at ±6%, a greater amount of DER curtailment and/or network investment is likely to be required. However, if the voltage range can be expanded without materially risking the safety of the supply to homes and businesses, it may be possible to mitigate or delay those impacts. Gathering evidence on the safety risks of expanding the voltage range is therefore the focus of this discussion document.

DER will likely be curtailed with current voltage ranges

VOLTAGE CONTRAINTS ARE LIKELY TO IMPACT SOLAR PV GENERATION

15. With current voltage ranges and infrastructure, it is likely that the increasing demands on low voltage networks will be managed by curtailing distributed generation.

16. The term ‘hosting capacity’ is sometimes used to describe the amount of generation, or the amount of additional peak demand, that can be accommodated in a low voltage network before remedial actions are needed. That remedial action may be required to avoid exceeded the permitted voltage range (voltage constraints) or avoid exceeding physical operating limitations (thermal constraints).

17. High levels of demand can result in electrical currents causing the temperature in parts of the network (usually the network transformer) to exceed their design rating. This is sometimes called meeting a thermal constraint, and preventative action is required to avoid asset damage (e.g. transformer fire). High levels of generation can also reach a thermal constraint, in principle. Most low voltage networks in New Zealand can host small additions of generation and demand but do not have enough hosting capacity to accommodate a high penetration of solar PV and EV charging.

18. For most low voltage networks in New Zealand, increasing rooftop solar generation is expected to be limited by voltage constraints. Some solar PV systems may already be affected by a voltage constraint that limits their output. Electricity distributors set performance requirements for connected generation to ensure they do not cause power quality (including voltage) to move outside the regulated requirements, which could adversely affect other network users. Distributors typically place restrictions on generation output, which reduces the value of the PV system to the owner and reduces the volume of energy available to the whole power system.

19. If regulated voltage limits can be safely increased, solar PV systems could deliver more value for their owners and more generation for the system as a whole. Distributors could adjust their operational requirements for distributed generation. This would increase the flexibility of networks, which might enable investment in network infrastructure to be delayed or not required at all. This would provide benefit for all consumers as system costs would be reduced.

MODELLING THE IMPACT OF VOLTAGE LIMITS ON SOLAR PV UTILISATION

20. To inform this discussion paper, MBIE engaged consultants ANSA[5] to model the impact on solar PV generation of increasing the regulated upper voltage limit from +6% to +10%. ANSA’s report, published alongside this paper on MBIE’s website, draws on modelling of a large number of individual low voltage networks operated by three of New Zealand’s electricity distribution networks (Aurora Energy, Orion and Wellington Electricity). This includes both the increase in PV hosting capacity (kW) of low voltage distribution networks, and the additional energy (kWh) that might be produced and/or exported across PV systems. ANSA extrapolated the results from the modelled low voltage networks to estimate impacts at a national level.

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[5] ANSA specialises in modelling and insights for the grid connection of electric vehicles, solar power, and other low carbon technologies.

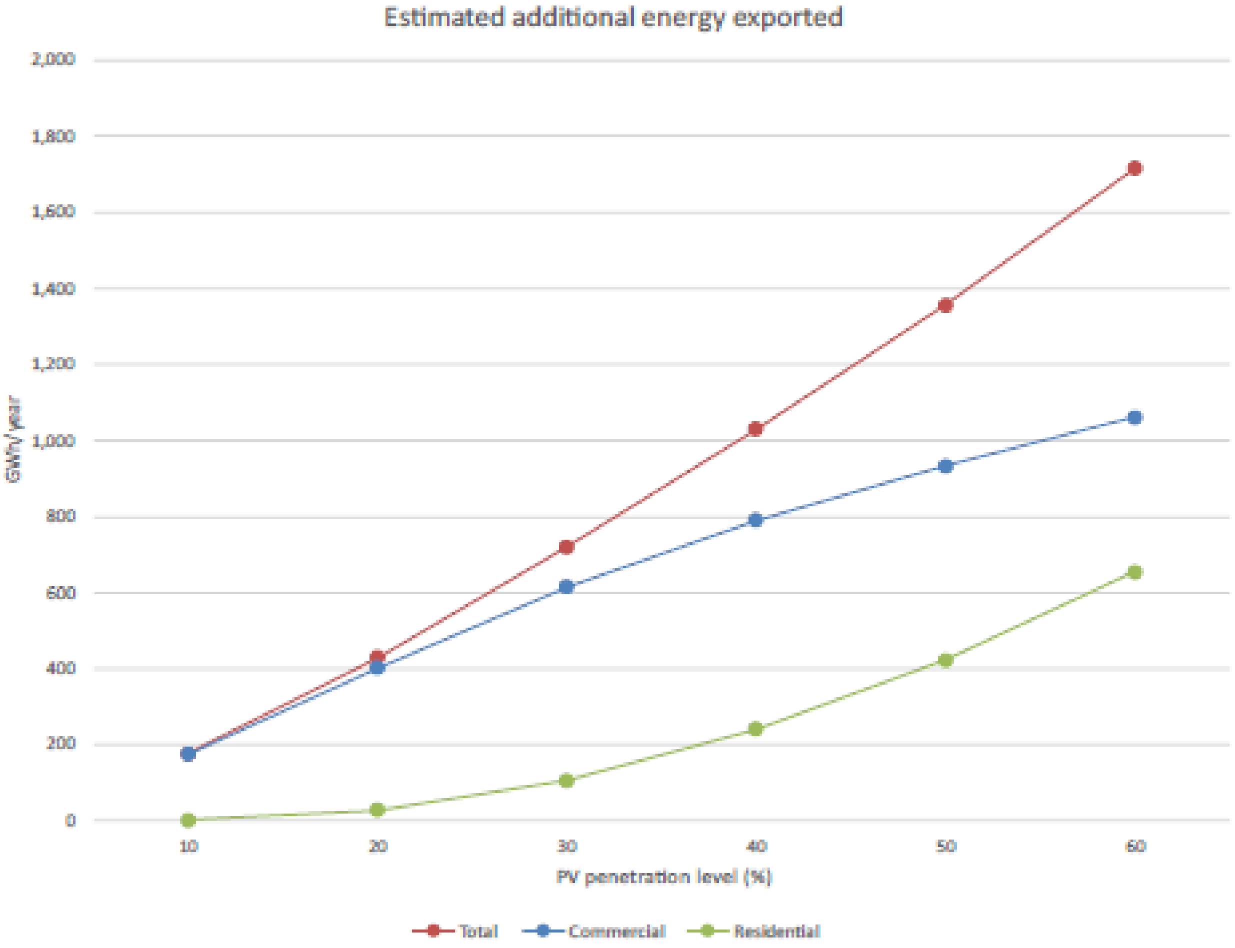
21. ANSA's modelling suggests that at a national level raising the upper voltage limit from +6% to +10% could:

   a. Triple hosting capacity for residential customers and double it for commercial customers, presuming 10% installed solar PV. The increases in hosting capacity diminishes as solar PV penetration rises, because the thermal limits of distribution transformers increasingly become the constraint.

   b. Increase PV generation output by about 24% for commercial connections with 20% uptake and 3% for residential connections with 30% uptake. The combined increase is about 507 GWh more generation rising to 825 GWh if residential solar PV uptake rose to 50%. More information on the potential additional energy that could be generated is illustrated in figure 1.

   c. Enable even more distributed power generation (1,406 GWh at 40% residential PV penetration), if households and distribution networks responded by installing larger solar PV installations (5 KW compared to the current average of 4 KW in capacity).

Figure 1 – Estimates of the additional energy that could be exported from solar PV if the upper voltage limit was expanded from +6% to +10%



Source: ANSA (2024), Rooftop solar PV and increasing the voltage standard. Prepared for MBIE.

22. While the increase in energy exports is estimated by ANSA to be modest at low penetration levels, the additional PV hosting capacity (kW) provides several additional benefits when PV systems are paired with battery storage:

    a. It enables PV systems with batteries to export at higher capacity at times when energy or network capacity is scarce, such as during peak demand. This could potentially help alleviate network voltage and loading constraints, as well as provide further benefit to battery system owners ('value stacking'). However, there is a question over the impact this may have on voltage levels and overvoltage constraints at these times, and how battery exports should best be managed and controlled.

    b. It also enables PV systems with batteries to export at higher capacities to provide more instantaneous reserves. This will again benefit owners of such systems through access to another source of revenue, and may lower the cost of reserves.

23. ANSA also notes that raising the upper voltage limit would avoid network expenditure to upgrade conductors to relieve voltage constraints. Over the many thousands of low voltage networks in New Zealand, this could amount to a substantial avoided investment.

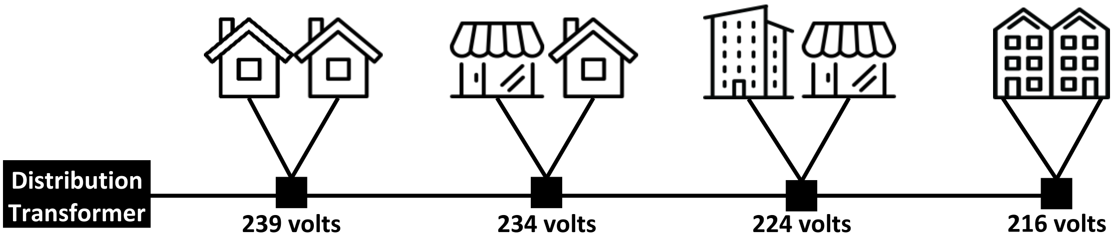
INCREASING LOAD IS MORE LIKELY TO BE LIMITED BY THERMAL THAN VOLTAGE CONSTRAINTS

24. Electricity demand in low voltage networks typically conforms to predictable patterns on a daily, weekly, and seasonal basis. Demand is typically lower overnight, peaking in the morning and again in the evening, and is usually higher in winter than in summer.

25. Experts, including from ANSA, have indicated that networks will primarily be limited from supplying larger loads (for example from increased EV charging during peak demand) by thermal constraints, rather than undervoltage. As a result, we do not expect that decreasing the lower limit from -6% to -10% will have an impact on EV hosting capacity as it would be solar PV, similar to the modelling for the upper limit. We are however keen to hear any evidence to the contrary (see question 2).

26. This also implies that distributors will generally have limited incentives to raise voltage by changing network transformer taps as a measure to increase hosting capacity for EVs. The pattern of electricity demand influences how low voltage networks are designed (for example the number of consumers supplied from a single distribution transformer) which largely determines how voltage is managed within the regulated range. In general, with one-way power flows, voltage at the transformer is set closer to the regulated maximum (+6%) than the regulated minimum (-6%) so that the voltage at the point of supply furthest away, when demand is at its peak (typically around 6pm in winter), will be above the regulated minimum (-6%).

Figure 2 – Illustration of how voltage may vary along a network to keep supply within ±6%



Other options to manage voltage constraints are likely be costly

27. Voltage constraints on the use of distributed energy resources could be managed without expanding permitted voltage ranges by reconfiguring low voltage networks, installing additional equipment, or managing demand for electricity. However, as the table below summarises, these options are likely to be expensive, inconvenient, or ineffective. As the Government is keen to reduce costs and disruptions for electricity consumers these are not the focus of this discussion paper. However, we will still carefully consider any evidence provided to support alternatives to expanding the regulated voltage range (see question 8).

Option	Mitigation route	Limitation
Reconfigure network topology	Figure 2 illustrates how many low voltage networks have been designed to keep voltages within the regulated range. Low voltage networks could be reconfigured to reduce the voltage drop from distrusted energy resources by decreasing the number of connected consumers, reducing length of conductors, and reducing conductor impedance.	This option would be costly and disruptive, requiring outages, traffic management and trenching in driveways and road reserves. Although these costs will initially fall on distribution network companies, they would pass through to New Zealand households and businesses through lines charges in their energy bills.
Install dynamic transformer taps, voltage regulators or network batteries	Low voltage distribution networks are traditionally designed in a 'set and forget' manner, with one-way power flows and predictable demand patterns. New equipment could allow networks to manage fluctuations in voltage from distributed energy resources more dynamically, with less curtailment from distributed generation.	Installing new equipment throughout low voltage networks across New Zealand is likely to be expensive and uneconomical. As above, the costs of additional network equipment would be pass through into energy consumers bills.
Manage demand	Some demand can be controlled or encouraged to shift from peak to off-peak times. Increasing demand at times of peak generation can reduce voltage rise, and reducing peak demand can reduce the voltage fall and reduce risk of thermal overload.	There are limits on how elastic demand will be (not all consumers will be willing and able to invest in batteries or alter their usage patterns). Demand response is also unlikely to help mitigate overvoltage during summer days, when demand is already comparatively low and the generating potential of solar PV is highest.

Many countries have safely expanded their voltage ranges

NEW ZEALANDS VOLTAGE RANGE IS NOW AN OUTLIER

28. Our voltage range of 230 V ± 6% is now an outlier compared to many international counterparts. Historically, different countries have adopted different standards for low voltage supply and for electrical appliances. For example, electricity is supplied in the US and Canada at nominal voltage of 110-120 Volts, and frequency of 60 Hertz. Electricity is supplied in the UK, Europe, India, Australia, and NZ at a nominal 230 Volts and frequency of 50 Hertz. As a result, appliances designed for the US and Canada, where the nominal mains supply is 110 or 120 Volts and frequency of 60 Hertz, cannot safely be used in countries with a nominal voltage of 220, 230, or 240 Volts and frequency of 50 Hertz.

29. Some countries have changed their regulated supply voltages over time. These changes have been carefully considered because some appliances may not operate safely or efficiently outside of their design range. For example, lights can flicker, and motor-based appliances can malfunction if operated below a minimum design voltage. Similarly, operating some appliances above their maximum design voltage can result in appliance damage or shorter lifespan.

30. In recent decades, there has been more harmonisation of supply voltage and appliance standards. This enables appliances sold in one country to be used safety and effectively in another country, expands global trade in electrical appliances, and generally reduces costs for consumers. In particular, the UK and most European countries have harmonised single-phase AC supply to 230 ±10%, which accommodates the previous ranges in those countries, including 220 ±6% and 240 ±6%. Australia (except Western Australia) has a single-phase nominal voltage of 230 with a range of +10% to -6%. We are not aware of any evidence that changing the voltage range in these countries resulted in noticeably more appliance failures.

NEW ZEALAND’S APPLIANCE STANDARDS ARE ALREADY ALIGNED WITH OTHER COUNTRIES

31. NZ’s appliance standards have been aligned with international standards, including design requirement for voltage ranges of 230 ± 10%, for many years. A supply voltage range of ± 10% should safely be tolerated by all appliances in NZ that comply with regulated standards.

32. It is possible that some old appliances in NZ were designed for a narrower voltage range (e.g. ±6%) and these appliances could be adversely affected if operated outside their design range. We consider this risk to be very small, but we are looking for any evidence in submissions about the number and type of such appliances if they exist (see questions 5 to 8).

33. Also, while many countries have harmonised on a supply voltage range of 230 Volts ±10%, Australia has not. Western Australia currently has 240 Volts ± 6%, while all other states and territories have 230 Volts with an upper voltage limit of +10% and a lower voltage limit of –6%. This means a proposed range for NZ of ±10% would align with the upper limit in Australia but not the lower limit. Australia is a key trading partner and many electrical appliances sold in Australia are also available in NZ. This suggests we should think more carefully about adopting a lower limit of -10%. We welcome submissions about potential costs or risks if NZ were to adopt a regulated lower supply voltage limit of -10% while Australia’s lower limit is -6%.

Options for expanding the voltage range

34. As discussed above, expanding the regulated supply voltage range may be a cost-effective option to allow networks to host more distributed energy resources, if appliances sold in New Zealand can tolerate the change.

35. Broadly there are two options under consideration for expanding the supply voltage range:

    a. **Option 1: Expand the range to ±10%**, aligning it with the range in regulated appliance standards and with the supply voltage range in Europe.

    b. **Option 2: Expand the upper limit to +10% and leave the lower limit at -6%**, aligning it with the supply voltage range in Australia.

36. In principle, Option 1 might be expected to have greater benefits because it is more likely to avoid or reduce any voltage constraints at both ends of the range.

37. However, in practice Option 2 may have similar voltage management benefits as Option 1, thermal rather than voltage constraints on transformers dominating EV hosting capacity, as discussed above.

38. Option 2 may also offer lower risks to appliances than Option 1. While recent appliances are likely to have been designed for 230 Volts ±10%, in line with international standards, older appliances in New Zealand are more likely to have been designed to match Australian voltage ranges. Given Australia historically had a higher nominal voltage of 240 Volts and still remains a lower limit of -6% (but +10%) it is possible older appliances may have less tolerance for lower voltages.

39. Also, the technologies that could cause undervoltage (e.g. EVs) at times of peak demand are more likely able to be controlled by equipment (e.g. smart chargers) that can help manage their impact on the network. Such demand management can, in principle, be undertaken in a way that does not reduce the value to the consumer (e.g. an EV can still receive a full charge overnight, even if controlled to charge outside of peak times). Solar PV, in contrast, cannot readily be managed without reducing value, because output is dependent on sunshine hours which cannot be managed.

PART 2: QUESTIONS FOR YOU

40. We want to hear your thoughts on the potential benefits and risks of expanding the regulated voltage range, as well as suggestions for how any changes should be implemented if they were to go ahead.

The benefits of changing the voltage range

41. Increasing distributed generation and changing consumption patterns is challenging the traditional approach to network voltage management. Expanding the permitted voltage range has been proposed as a more cost-effective way to help low voltage networks support more solar PVs than reconfiguring or installing additional network resources.

1	Would expanding the upper voltage limit from +6% to +10% help networks host more distributed generation like solar PV? Do you think this is likely to be more, less, or similar in cost to other options, like reconfiguring networks or installing additional infrastructure?

2	Would expanding the lower voltage limit from -6% to -10% help networks host more distributed energy resources like electric vehicles? Do you think this likely to be more, less, or similar in cost to other options, like reconfiguring networks or installing additional infrastructure?

3	Beyond costs, do you think expanding the voltage range will have any wider benefits to the security or sustainability of the electricity system?

4	Are there any other benefits to expanding the voltage range that have not been mentioned?

The risks of changing the voltage range

CURRENT VOLTAGE SETTINGS MAY HAVE A LOWER RISK OF CAUSING APPLIANCES TO FAIL EARLIER

42. Appliances are designed and optimised for a certain input voltage. It is possible that supply voltage above design limits can cause appliances to run too fast and too high, accelerating the speed that they depreciate. Similarly, lights can flicker, and motor-based appliances can malfunction if operated below the voltages they were designed for.

43. We are not aware of any evidence that expanding the voltage range in Australia resulted in noticeably more appliance failures and it is likely that most appliances sold in New Zealand can tolerate a greater range of ± 10%, especially products sold internationally. However, we are interested in any evidence of the risks to appliances, so we can properly assess the cost and safety risks any changes may pose to households or businesses.

THE RISKS MAY BE HIGHER FOR SOME APPLIANCES

44. The failure of some household appliances, especially low value items or products with safety features, may have a limited impact. However, the failure of some more specialised appliances, such as medical equipment, heating systems or devices used to operate essential services, could pose a greater risk to the lives of New Zealanders.

45. It is possible that the age of appliances may be a significant factor. Many modern appliances are designed and tested for a wider range of voltages, especially if they come from or might be exported to, countries that already allow a wider range of voltages. Alternatively, devices that have a long life, for example old water pumps, may be a greater risk from voltage variations.

5	Do you have reason to believe that any appliances you manufacture, sell, or use would be at significant risk of failing if the maximum permitted voltage increased from 244 V to 253 V? If so, what appliance(s), why do you think it could be affected, and what would the impact be?

6	Do you have reason to believe that any appliances you manufacture, sell, or use would be significantly affected if the minimum voltage was allowed to fall from 216 V to 207 V? If so, what appliance(s), why do you think it could be affected, and what would the impact be?

7	Are there any specialised appliances that are at higher risk of failing from wider standard voltage ranges, or where the impacts of failures would be particularly serious?

8	Do you think an alternative approach should be taken to manage the demands of distributed energy resources on low voltage networks? If so, what approach and why would it be preferential to expanding voltage limits?

How changes to voltage regulations should be implemented

INTRODUCING CHANGES TO VOLTAGE REGULATIONS SAFELY

46. A phased approach to expanding voltage limits (for example beginning with specific network areas) could be considered if uncertainty remained about their potential impact. Even if the likelihood of appliance failures is low, there may be specific considerations needed to protect appliances where the potential safety implications of a failure are more severe, such as hospital or home medical equipment.

9 If voltage limits were expanded, do you believe those changes should be phased in? If so, how? If not, why do you think a phased approach is undesirable?

10 If voltage limits were expanded, are there any specific safeguards you believe should be introduced for ‘higher-risk’ appliances, if any?

THE POTENTIAL COSTS OF EXPANDING THE VOLTAGE RANGE

47. It is likely that the costs of expanding the voltage range will be small or negligible, beyond the policy work required to update regulations and potentially one-off work by networks to update transformers settings to use the wider permitted range. However, we are interested in knowing about any other costs you consider might be involved and who they may fall on.

11 What costs would be involved in expanding the regulated voltage range? Who would face those costs?

ARE THERE OTHER REGULATIONS THAT WOULD NEED UPDATING?

48. We are aware that altering the permitted voltage ranges may have knock-on impacts to other regulations, or standards incorporated in regulations, such as the AS/NZS 4777 standards on grid connection of energy systems via inverters. Various standards are used for appliances and fittings in New Zealand. A more complete list is available in Schedule 4 of the Electricity (Safety) Regulations 2010.

12 Are there other regulations or standards that would need updating if regulated voltage ranges were changed? Please be specific where possible.

Any further information

13 Is there anything which has not been covered by the previous questions that you believe we should consider?

PART 3: NEXT STEPS AND IMPLEMENTATION

Relevant legislation and regulation

49. To expand the regulated voltage ranges we would amend certain provisions relating to 'standard low voltage' in the Electricity (Safety) Regulations 2010. The regulations generally provide for the management of electrical safety and power quality (voltage, frequency, and harmonic distortion).

50. The regulations governing voltage are made under section 169(1)(7) of the Electricity Act 1992, for the purpose of prescribing the requirements for standardisation of systems of supply and the preservation of the quality of electricity supplied in New Zealand.

51. The relevant purposes of the Electricity Act 1992, as set out in section 1A, are:

    a. to provide for the regulation, supply, and use of electricity in New Zealand, and

    b. to protect the health and safety of members of the public in connection with the supply and use of electricity in New Zealand, and

    c. to promote the prevention of damage to property in connection with the supply and use of electricity in New Zealand.

Feedback to this paper will inform further analysis

52. The evidence provided in response to this discussion document will inform further analysis of whether it is likely that voltage ranges could be expanded without significantly risking the health, safety, and property of New Zealand households and businesses (as required by the Electricity Act 1992). The feedback will also help test our initial analysis that expanding voltage ranges could help mitigate or delay upgrades to low voltage network infrastructure to reduce the curtailment of distributed energy resources (especially solar PV). The Minister will be advised on options for this work to proceed and a decision on whether to proceed will be agreed with Cabinet.

53. If that further analysis supports expanding the voltage range, we will develop proposals to amend provisions concerning 'standard low voltage' in the Electricity (Safety) Regulations 2010 and any relevant regulations or standards identified from the responses to question 12. The design of any amendments to regulation will consider feedback about the best option for expanding voltage ranges (expanding the range to ±10% or expanding only the upper limit to +10%) and suggestions concerning their implementation (such as the use of a phased approach or additional safeguards discussed in questions 9 and 10).

54. If the feedback to this discussion document or subsequent analysis does not support expanding the voltage ranges, we will focus on whether alternative approaches, including upgrades to network infrastructure, will be required to support the utilisation of distributed energy resources.

Annex One: Mitigating overvoltage from generation at the inverter

55. Distributed generation must be connected to the low voltage network through an inverter that complies with a regulated standard (AS/NZS 4777).[6] These inverters can monitor the local voltage and limit or reduce the generator’s power output when voltage exceeds a threshold.

56. Electricity distributors set technical requirements for connection and operation of generation in their low voltage networks. Some distributors require inverter-based generation to be curtailed, by activating so-called power-quality response modes, when voltage approaches or exceeds the regulated maximum of +6%. Different power-quality response modes can be selected at the inverter when it is installed, or by a technician during a site visit. Power-quality response modes can be set remotely for some inverters.

57. The same power-quality response requirements can apply to distributed batteries when discharging into a low voltage network. This includes EV batteries providing a vehicle-to-grid (V2G) service. The rate of electricity discharge can be limited to avoid overvoltage, albeit at an opportunity cost.

58. Batteries can be a valuable source of flexibility to the power system if they are controlled to charge and discharge in a coordinated manner. The coordinated management of distributed batteries could be particularly valuable at times of system stress (such as when total generation on the system is insufficient to meet total demand with an acceptable reserve margin). This value can, in principle, be realised by offering interruptible load into the national instantaneous reserves market. However, this potential value could be limited if battery discharge is limited by power-quality response if the network supply voltage is at or above the allowable voltage when the service is required.

59. More generally, while power-quality response can be an effective way to avoid or minimise overvoltage, it imposes an opportunity cost on the person who would otherwise benefit from using or selling the electricity that is curtailed. The greater the penetration of distributed generation, the greater the curtailment, and the greater the opportunity cost.

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[6] Regulation 60(2)(f) of the Electricity (Safety) Regulations 2010.

Te Kāwanatanga o Aotearoa
New Zealand Government

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