20 August 2024

Electricity Authority
PO Box 10041
Wellington 6143

Submitted via email to fsr@ea.govt.nz

Consultation Paper – Addressing larger voltage deviations and network performance issues in New Zealand's power system

Introduction

1. Thank you for the opportunity to submit on the consultation paper 'Addressing larger voltage deviations and network performance issues in New Zealand's power system'.[1] This submission is not confidential and can be publicly disclosed.
2. Orion owns and operates the electricity distribution infrastructure in Central Canterbury, including Ōtautahi Christchurch city and Selwyn District. Our network is both rural and urban and extends over 8,000 square kilometers from the Waimakariri River in the north to the Rakaia River in the south; from the Canterbury coast to Arthur's Pass. We deliver electricity to more than 225,000 homes and businesses and are New Zealand's third largest Electricity Distribution Business (EDB).

Orion summary points

3. We have reviewed the consultation paper, and our specific responses to the 18 questions posed by the Authority as well as other feedback we consider appropriate to the consultation are set out in Appendix A.
4. We are committed to working collaboratively with the Authority and other industry stakeholders to develop a robust, flexible, and future-proof framework for voltage management that supports innovation while maintaining network stability and reliability.

Concluding remarks

5. Thank you for the opportunity to provide feedback on this consultation.
6. If you have any questions or queries on aspects of this submission which you would like to discuss, please contact us on 03 363 9898.

Yours sincerely,

Connor Reich

Regulatory Lead – Electricity Authority

[1] https://www.ea.govt.nz/documents/5152/Paper_2-_Addressing_larger_voltage_deviations_in_New_Zealands_power_system.pdf

Orion New Zealand Ltd
565 Wairakei Road
PO Box 13896
Christchurch 8141
+64 3 363 9898
oriongroup.co.nz

Appendix A

Submitter	Orion New Zealand Limited ("Orion")

Questions	Comments
Q1. Do you consider it likely that distributors will, in the absence of a Code requirement, place voltage support obligations on some or all generating stations and energy storage systems (when discharging) that connect to their networks? **Please give reasons for your answer**	Yes, we believe that distributors are likely to place voltage support obligations on generators and energy storage systems (when discharging), particularly those 5MW and above. While to-date, Orion has taken a hands-off approach to ensuring compliance with fault ride-through and voltage support, we intend to implement such obligations in the future. Our Network Code already requires high voltage installation owners to coordinate with us regarding connection, operation, and modification of their installations. For new connections in the future, we would continue to impose restrictions and require compliance with AS/NZS 4777 for smaller connections; for larger connections, as noted above, we require feasibility studies and request that generators share their controller settings. However, we have concerns about the practicality and fairness of implementing these obligations, as placing voltage support obligations on existing distributed generation would be challenging and potentially expensive, necessitating a scheme to compensate generators for the additional costs. There's also uncertainty regarding when voltage support would be required – during peak times, non-peak times, or both.

Q2. Do you agree generating stations and energy storage systems connected to local distribution networks at the GXP voltage (which varies by local distribution network) should be required to support voltage, or do you consider the obligation should be placed on generating stations and energy storage systems connected at a uniform voltage (eg, 33kV)? **Please give reasons for your answer.**	We agree that generating stations and energy storage systems should be required to support voltage, but we believe the obligation should be based on the point-of-common coupling voltage, which is likely to be at the GXP level, rather than the connection voltage level. The point-of-connection voltage often depends on transformer ownership, which can lead to inconsistencies in voltage support obligations. For example, on our network, the connection at one location is at 33kV because we own the 66/33kV transformer. However, the voltage we're concerned with is 66kV, as these are dedicated transformers. At another location, where the customer owns the 66/33kV transformer, the connection is effectively at 66kV. This distinction is crucial because it affects how voltage can be controlled and regulated. Generators connected at 66kV can directly manipulate voltages at that level, while those connected at 33kV may have limited ability to regulate the 66kV voltage. This raises important questions about voltage control versus VAr Dispatch Schedule System, and who should bear the responsibility and costs for maintaining uniform voltage. Orion's view is that if uniform voltage support is required across the network, there should be a clear mechanism for compensation, as the primary value accrues to Transpower. If Transpower wishes to opt out of this responsibility, it's important to understand why and determine who should bear the associated costs. This issue highlights the need for a more comprehensive discussion about the allocation of responsibilities and costs in maintaining voltage stability across the network. Any solution should consider the varied nature of local distribution networks and ensure that voltage support obligations are placed where they can be most effective and efficient.
Q3. Do you consider there should be a capacity threshold (eg, a nominal net export or nameplate capacity of 5MW or 10MW) for generating stations and energy storage systems connected to local distribution networks to support voltage?	While we agree that a capacity threshold should exist, we believe it should be relative to each distribution network, rather than a fixed value. Specifying a minimum number may not accurately reflect the impact on our network and could lead to unintended consequences. For instance, new generators might install just below the minimum capacity to avoid regulations.

Please give reasons for your answer, including any implications of having / not having a capacity threshold.	We propose that everyone connecting at certain voltage levels (e.g., 11, 33, 66kV) should be required to support voltage, regardless of capacity. This aligns with our response to Option 3 (Q14) – we should avoid implementing unwieldy limits. Drawing parallels with the Authority's consultation on Option 3 and the proposed revision to the 30MW threshold, we believe taking a wide-net approach to what is included would make the regulations more future-proof. This approach would prevent us from repeating past mistakes of implementing minimum numbers that later require revision to the Code.
Q4. What do you consider to be the pros and cons of requiring generating stations / energy storage systems connected to local distribution networks to have a reactive power range of ±33% rather than the +50%/-33% range specified in clause 8.23 of the Code?	The proposed ±33% reactive power range is generally reasonable and achievable, based on our conversations with solar developers.
Q5. Do you agree the Authority should be short listing the first voltage-related option to help address Issues 2 and 3? **If you disagree, please explain why.**	Yes, we agree that the Authority should shortlist the first voltage-related option to address Issues 2 and 3. While we support placing voltage support obligations on generators, particularly those 5MW and above, we have concerns about the practicality and fairness of implementing these obligations on existing distributed generation. The varied nature of local distribution networks and the need for a comprehensive approach to voltage support that doesn't rely solely on fixed capacity thresholds should also be considered.
Q6. What do you consider to be the main benefits and costs associated with the first voltage-related option?	No comment.

Q7. Under the first voltage-related option, what costs are likely to arise for the owners of distributed generation, embedded generating stations, and energy storage systems with a point of connection to the local distribution network?	While we don't have specific cost estimates, we anticipate that owners of existing distributed generation, embedded generating stations, and energy storage systems could face significant costs if required to retrofit their systems to meet new voltage support obligations.
Q8. Under the first voltage-related option, what costs are likely to arise for the owners of energy storage systems with a point of connection to the transmission network?	No comment.
Q9. Do you agree the Authority should be short listing the second voltage-related option to help address Issues 2 and 3? **If you disagree, please explain why**	Yes, we agree that the Authority should shortlist the second voltage-related option, but we have several concerns about its implementation: • We question how this option would be implemented in practice, as it adds complexity to the process. • Our preference is for the System Operator to engage distributed generators to provide GXP voltage support. Distributed generators on our network are generally close to a GXP and can provide support. • If implemented as written, this option would require distributors to control, manage, and set power quality limits in our networks. We would intend to leverage the EEA Power Quality Guidelines to assist with this. • We agree with the cons set out by the Authority; implementing this option would require capabilities (processes, tools, and methods) that could be difficult for distributors to obtain and would be inefficient to duplicate across all distributors. This could be an argument for implementing a Distribution System Operator (DSO) function to assist EDBs with replicating the traditional System Operator function.

	• We question how the amendment to Part 8, requiring the System Operator and distributors to coordinate reactive power flows at GXPs in either direction, would function in practice. This would require dynamic operating envelopes and could have implications on whether a DSO would be needed to bid reactive power in. • We note that the proposed amendment to Schedule 12.6, requiring distributors' voltage support assets at a GXP to be capable of operating within a power factor range of 0.95 lagging to 0.95 leading, would not apply to Orion, as our voltage support assets are not at a GXP.
Q10. What do you consider to be the main benefits and costs associated with the second voltage-related option?	The main benefits of the second voltage-related option include improved voltage stability and better coordination between the System Operator and distributors. However, implementing this option would incur significant costs for distributors, and is not a 'quick fix' solution: • A distributed energy resources management system (e.g., DERMS) allowing for real-time visibility and forecasting would be required at the distributor level. This would replicate System Operator functionality. Implementing this for all distributors would be inefficient compared to developing a DSO function. • As mentioned in our response to Q9, substantial investments in new processes, tools, and methods would be necessary for distributors to effectively manage voltage support across their networks. • There would likely be ongoing operational costs associated with the increased complexity of managing voltage support and coordinating with the System Operator.
Q11. Under the second voltage related option, what costs are likely to arise for the owners of energy storage systems with a point of connection to the transmission network?	No comment.

Q12. Do you consider it likely that distributors will, in the absence of a Code requirement, place fault ride through obligations on some or all <30MW generating stations that connect to their networks? **Please give reasons for your answer.**	Yes, we do consider it likely that distributors will place fault ride through obligations on some or all <30MW generating stations, in the absence of a Code requirement. However, we prefer a Code requirement on fault ride through obligations for <30MW generating stations. In the absence of a Code requirement, we can request compliance, but we can't enforce this requirement on connected generating stations. However, we note that to-date, we have not had an issue with generating stations meeting fault ride through obligations on our network. We consider this relatively easy to implement, with no excessive costs, down to the 10MW level, as standard inverters meet Code requirements. Having a clear Code requirement on all <30MW generating stations would ensure consistency across the industry and provide a basis for enforcement, which is crucial for maintaining system stability and reliability.
Q13. Do you consider it appropriate to include in the Code fault ride through curves for generating stations connected to a local distribution network at a nominal voltage equal to the GXP voltage, which take into account network protection considerations? **Please give reasons for your answer.**	Yes, we consider it appropriate to include fault ride through curves in the Code for generating stations connected to a local distribution network at a nominal voltage equal to the GXP voltage. We agree that network protection considerations must be taken into account, but note that these are traditionally focused on the transmission network, not distribution. This may require substantial process and system changes to accommodate. Additionally, local protection should be required for DER and embedded generation. Including these curves in the Code would provide clarity and consistency for all stakeholders. However, the Authority should ensure that the requirements are appropriate for distribution networks and don't place undue burden on smaller networks.
Q14. Do you consider there should be a threshold based on connection voltage and capacity (eg, a nameplate capacity or nominal net export of 5MW or 10MW) for generating stations connected to distribution networks to ride through faults?	While we believe that a threshold is reasonable, we suggest it should be more relevant to voltage rather than capacity. It's important to note that connecting small capacity installations to large voltages is generally uneconomic. Drawing parallels with our response to Q3, we advocate for an approach that would make the regulations more future-proof. This approach would prevent us from repeating past mistakes of implementing minimum numbers that later require revision to the Code.

Please give reasons for your answer, including any implications of having / not having a capacity threshold.	We question the actual risk if 5MW and 10MW generating stations are not compliant, for the System Operator. While we acknowledge the risk if grouped 5MW and 10MW generating stations fail and create an avalanche risk, we question if there is a genuine risk of network failure? On our network, during disturbances that we have observed, load typically falls; DER are not significant enough to become a problem. However, it's worth noting that the impact of voltage dips can vary, depending on how strong the network is in the area that the generators are located, as different areas will experience different voltage dips. Our observations noted above primarily relate to situations in the summer when large quantities of irrigation load are lost due to pumps tripping; we're not certain if this has the same response in other distribution networks. While having both a voltage and capacity threshold could simplify compliance for smaller generators, it might miss some important contributors to system stability. Conversely, not having a threshold ensures all generators contribute to system stability but could place undue burden on very small generators. We believe a voltage-based threshold might be more appropriate, ensuring that generators connected at higher voltages have ride-through capabilities regardless of their capacity.
Q15. Do you agree the Authority should be short listing for further investigation the third voltage-related option to help address Issue 4? **If you disagree, please explain why.**	Yes, we agree that the Authority should shortlist the third voltage-related option for further investigation.
Q16. What do you consider to be the main benefits and costs associated with the third voltage-related option?	From Orion's perspective, we do not anticipate significant costs associated with the third voltage-related option.

Q17. What costs are likely to arise for the owners of (single site and virtual) generating stations under the 30MW threshold if these generating stations must comply with the fault ride through AOPOs because they are connected to a distribution network at a nominal voltage equal to the GXP voltage?	No comment.
Q18. Do you have any comments on the Authority's assessment of options to help address Issues 2, 3 and 4 identified in our 2023 Issues paper?	Yes, we believe the Authority's assessment of options to address Issues 2, 3, and 4 is reasonable.

20 August 2024

Electricity Authority
PO Box 10041
Wellington 6143

Submitted via email to fsr@ea.govt.nz

Consultation Paper – The governance and management of harmonics in New Zealand's power system

Introduction

1. Thank you for the opportunity to submit on the consultation paper 'the governance and management of harmonics in New Zealand's power system'.[1] This submission is not confidential and can be publicly disclosed.
2. Orion owns and operates the electricity distribution infrastructure in Central Canterbury, including Ōtautahi Christchurch city and Selwyn District. Our network is both rural and urban and extends over 8,000 square kilometers from the Waimakariri River in the north to the Rakaia River in the south; from the Canterbury coast to Arthur's Pass. We deliver electricity to more than 225,000 homes and businesses and are New Zealand's third largest Electricity Distribution Business (EDB).

Orion summary points

3. We have reviewed the consultation paper, and our general views are summarised in this section. Orion's specific responses to the 8 questions posed by the Authority as well as other feedback we consider appropriate to the consultation are set out in Appendix A.
4. Orion largely agrees with the Authority's summary of existing harmonic regulations, and we agree that the current regulatory framework is incompatible with New Zealand's future power system needs. We strongly favour the EEA Power Quality Guidelines over outdated, or inflexible, standards, as the Guidelines better address both current and emerging challenges in our rapidly evolving energy landscape. Flexible guidelines rather than rigid standards, can ensure that the power system is enabled to swiftly adapt to future technological advancements.
5. We support a 'whole of system' approach to harmonic allocation, but request clear guidance on its implementation. Regarding harmonic management strategies, we propose a combined approach of Open Access and Charges for Harmonic Emitters. We oppose requirements for new connections to be net absorbers of harmonics, as this could unfairly burden innocent parties and potentially hinder innovation. Additionally, we advise caution against the pre-emptive installation of harmonic filters, citing concerns about cost distribution and long-term effectiveness in our network.

[1] https://www.ea.govt.nz/documents/5153/Paper_3_The_governance_and_management_of_harmonics_in_New_Zealands_power_system.pdf

Orion New Zealand Ltd
565 Wairakei Road
PO Box 13896
Christchurch 8141
+64 3 363 9898
oriongroup.co.nz

6. Orion is committed to working collaboratively with the Authority and other industry stakeholders to develop a robust, flexible, and future-proof framework for harmonic management that supports innovation while maintaining network quality and reliability.

Concluding remarks

7. Thank you for the opportunity to provide feedback on this consultation.
8. If you have any questions or queries on aspects of this submission which you would like to discuss, please contact us on 03 363 9898.

Yours sincerely,

Connor Reich

Regulatory Lead – Electricity Authority

Appendix A

Submitter	Orion New Zealand Limited ("Orion")

Questions	Comments
Q1. Do you consider the Authority has accurately summarised New Zealand's existing key regulatory requirements for harmonics? If you disagree, please explain why.	Orion largely agrees that the Authority has accurately summarised New Zealand's existing key regulatory requirements for harmonics. However, we would like to highlight several important considerations: 1. While NZECP 36:1993 is included in the summary this standard, based on harmonic limits originally established in 1967, is no longer fit for purpose in today's evolving electrical landscape. 2. The IEEE 519 standard, though comprehensive, may prove to be too specific and inflexible to accommodate future technological developments, such as hydrogen electrolysers. 3. Orion acknowledges the inclusion of AS/NZS 61000, which is adopted from IEC 61000, an internationally accepted standard. 4. Orion particularly favours the EEA Power Quality Guidelines, published 2024, which Orion requires new generation connections to our network to comply with. Orion believes that these guidelines offer a more adaptable and relevant framework for harmonics management in New Zealand. Specifically, the EEA Power Quality Guidelines: a. Take a forward-looking approach by addressing emerging challenges, such as supraharmonics, b. Recognise technological advancements in electrical appliances and devices operating at higher switching frequencies, c. Consider complex interactions between multiple devices that can lead to issues like flickers or equipment malfunction, d. Align with current research, particularly from Europe, on high frequency harmonics and their effects on LV networks and supply quality, and e. Are regularly updated to reflect the latest developments in the field.[2]

[2] EEA Power Quality Guidelines - January 2024

Q2. Do you agree the Authority has identified the main challenges with the existing arrangements for the governance of harmonics? If there are any additional challenges, please set these out in your response.	Orion agrees that the Authority has identified the main challenges with the existing arrangements for the governance of harmonics; however, we would like to emphasise and expand on several specific issues for the Authority's awareness: 1. **Technical challenges**: The current governance structure struggles to address the increasing complexity of harmonic issues in modern power systems. As our network evolves with the integration of more distributed energy resources and advanced technologies, the technical challenges in managing harmonics have become more intricate and demanding. One specific issue is the generation of reactive power factors by harmonic filters, which can lead to unintended consequences, such as voltage regulation issues, increased system losses, and potential overcompensation of power factor. 2. **Regulatory inconsistency**: Orion notes that the Code (Schedule 12.6, clause 4.7 Harmonic levels) requires Transpower to apply NZECP 36:1993. This creates an inconsistency in the regulatory landscape. 3. **Outdated standards**: As the Authority notes, many of the current standards and regulations are not fit for purpose in today's rapidly changing environment. They were developed in an era with different technological realities, and do not adequately address the complexities of modern power systems. 4. **Lack of futureproofing**: Perhaps most critically, we believe that the current standards and regulations are not adequately prepared for future technological developments. As new technologies, such as hydrogen electrolysers, emerge and become more prevalent, our governance framework for harmonics needs to be flexible enough to accommodate these advancements without becoming quickly obsolete, or requiring a cumbersome legislative or regulation amendment.
Q3. Do you consider the existing regulatory framework for the governance of harmonics in New Zealand is compatible with the uptake of inverter-based resources? Please give reasons for your answer.	No, Orion does not consider the existing regulatory framework for the governance of harmonics in New Zealand to be compatible with the uptake of inverter-based resources.

	The continued use of NZECP 36:1993 is particularly problematic. This standard does not account for modern inverter-based resources with power converters, or address supraharmonics, which are becoming increasingly relevant with the proliferation of EV charging and smart grids.[3] These emissions fall outside the traditional power quality frequency range but may have significant impacts on the future electrical grid. It is Orion's opinion that the EA must consider the broader governance of harmonics, beyond just the uptake of inverter-based resources. The energy landscape is rapidly evolving, and our regulatory framework needs to account for a wider range of technologies and their impacts. Emerging technologies, such as Hiringa Energy's green hydrogen electrolysers and refuelling stations, present new challenges, while offering opportunities to rapidly decarbonise heavy transport.[4] However, both single-stage and two-stage hydrogen electrolysers can cause significant harmonic current content on the grid-side that must be mitigated. This mitigation is not covered by any existing regulatory framework. Additionally, overseas research has noted the potential use of hydrogen as an energy buffer with long-term storage capabilities (Power-to-Hydrogen-to-Power, P2H2P), which could significantly impact future grid stability.[5] We must move away from outdated standards, and utilise flexible guidelines, such as the EEA Power Quality Guidelines, which can be easily updated to accommodate future technologies. This flexibility is crucial as we face rapid technological advancements in the energy sector and ensures that our regulatory framework remains relevant and effective in managing harmonics across a wide range of evolving scenarios.
Q4. Do you have any feedback on the Authority's suggested way forward to help address the challenges with the existing arrangements for the governance of harmonics?	While we acknowledge that AS/NZS 61000 standards are adopted from IEC 61000, which is recognised globally, Orion's preference is for the EEA Power Quality Guidelines. These guidelines offer greater flexibility, and are a local interpretation of the AS/NZS 61000 standards. We believe that they should be the default for the industry, due to their adaptability for New Zealand's specific needs.

[3] Rajkumar, S., Balasubramanian, R. & Kathirvelu, P. A Comprehensive Review on Supraharmonics - The Next Big Power Quality Concern. Smart Grids and Energy 9, 15 (2024). https://doi.org/10.1007/s40866-024-00195-4

[4] Hydrogen Refuelling Network | Hiringa Energy 2022

[5] From green hydrogen to electricity: A review on recent advances, challenges, and opportunities on power-to-hydrogen-to-power systems - ScienceDirect

	If the Authority prefers a regulation-based approach, rather than adopting a flexible guideline, the Authority should consider adopting a similar approach to the proposed Regulatory Systems (Immigration and Workforce) Amendment Bill, which allows for WorkSafe to more quickly and easily update references to standards in electricity safety instruments by way of delegation of ministerial powers. A similar legislative approach should be considered to ensure that regulations governing harmonics are kept up to date with the rapidly evolving energy landscape. Orion agrees with the Authority's comment in clause 4.23 and agrees that standardising harmonic limitation, management and allocation for all market participants will be beneficial. For example, solar installations in Orion's network should be treated the same as in other EDB networks across New Zealand. This consistency is crucial for fair and effective harmonics management. Orion agrees with the Authority's comment in clause 4.25, however we argue that the Authority should go one-step further. Guidelines are our preferred method of regulating and managing harmonics, to allow for flexibility in accommodating future technological developments and changing network conditions.
Q5. Do you have feedback on any of the elements of good industry practice relating to a framework for managing harmonics? This may include feedback relating to elements you consider are missing from the summary provided in section 5 of this paper.	While we agree that the high-level framework is robust, we have several suggestions and concerns regarding specific elements. ***Principles for the management of harmonics*** While we support flexibility in some areas, Orion advocates for a nationwide, consistent and common set of baseline requirements, such as those found within the EEA Power Quality Guidelines. This approach ensures a level playing field across New Zealand, while still allowing for adaptability to technological changes. We believe that consistency in basic requirements, combined with flexible guidelines for implementation, offers the best balance between standardisation and adaptability. Orion prefers to implement a blanket limit above the 50th harmonic to address potential issues affecting earthing system neutrals and performance. There is a regulatory gap for frequencies between 2500Hz and telecommunication bands. ***Planning and compatibility levels***

	We reiterate that the NZECP harmonic levels are extremely outdated. Our preference is for the adoption of EEA Power Quality Guidelines. ***Voltage levels*** We note a clash with other New Zealand standards and regulations regarding the term 'medium voltage'. We suggest either using numerical levels (e.g., 1, 2, 3), or adhering to consistent terminology found in other regulations (e.g. low voltage is ≤ 1kV, high voltage is 1kV < U n ≤ 230kV). ***Measurement of harmonics*** Orion disagrees with the publishing of background harmonic data, and requests that the Authority evaluates the value and practical implementation of this proposal. We seek clarification on expected measurement locations, data requirements and timeframes, noting that GXP monitoring levels can vary on an annual basis, and network reconfigurations completed by Transpower can significantly affect harmonic levels. Clear guidelines should be developed on measurement and publication requirements if this is to be implemented, and if required, this should be added to existing Information Disclosure requirements. We emphasise the importance of monitoring levels both before and after commissioning new equipment. ***Roles and responsibilities*** We request clarification on the Authority's clause 5.23(d): what constitutes a 'key site'? Is this a zone substation, GXP, or solar farm? Is the requirement found in clause 5.23 related to publishing of background harmonic data in clause 5.21? ***Timeframes for various steps required in managing harmonics*** Orion disagrees with adding timeframes to manage harmonics in either the Code, or adopting timeframes found in other standards. While we are open to consistency across EDBs, we caution against mandatory compliance to specific levels. Orion's network code[6] is the most appropriate place for this information. ***A methodology for allocating harmonics***

[6] https://www.oriongroup.co.nz/assets/Connections-and-consents/Network-Code-700015.pdf

	Orion acknowledges that there is no easy way to allocate harmonics, and would welcome further industry discussion on this topic.
Q6. Do you agree with a 'whole of system' approach to allocating harmonics, so that any differences in harmonic allocation methodologies between electricity networks do not cause excessive harmonics? If you disagree, please explain why.	While Orion agrees with a 'whole of system' approach to allocating harmonics and supports the goal of creating a level playing field for the sector, we have included several suggestions regarding the implementation of such an approach. We note that Transpower currently allows for generation connections without fully considering local EDB constraints or ensuring transparency for whole system needs. We agree with the Authority in clause 5.35 – a truly effective 'whole of system' approach should address this by promoting clear communication between Transpower, EDBs, and other industry participants. This would ensure that both local constraints and system-wide needs are properly considered when allocating and managing harmonics across different parts of the network, reducing inconsistencies and challenges in harmonic management. We request that the Authority provide clear guidance on how they envision defining and implementing concepts such as 'harmonic headroom' and 'harmonic allocation'. These are complex issues that require careful consideration and industry-wide agreement to ensure fair and effective implementation. Orion requests that the Authority provide evidence of damage caused by high harmonics. In developing a whole system approach, it's crucial to strike a balance between the costs of harmonic mitigation and the actual impacts of harmonics on the system, to ensure that the costs are passed on to customers are fair. This balance should inform any allocation methodologies or requirements for harmonic management. Any whole system approach should be flexible enough to accommodate future technological developments that may impact harmonic generation or mitigation.
Q7. Do you have any feedback on the suitability for New Zealand's power system of the harmonics standard NZECP 36:1993, or the AS/NZS 61000 series of harmonics standards?	The NZECP 36:1993 standard is severely outdated, and is no longer fit for purpose for New Zealand. This standard, based on harmonic limits established in 1967, fails to account for modern power system technologies and challenges, particularly those related to inverter-based resources and other emerging technologies. While the AS/NZS 61000 series of harmonics standards are more current and generally suitable, we believe that it may not offer the level of flexibility required to address New Zealand's specific needs and future challenges.

	Orion strongly prefers the EEA Power Quality Guidelines over both NZECP 36:1993 and AS/NZS 61000. These guidelines offer the most flexibility in responding to harmonic issues and can be more easily adapted to address emerging future challenges and technology in New Zealand. As outlined in our response to Q3, the potential for widespread adoption of electric or hydrogen vehicles and emerging technologies, such as hydrogen electrolysers should be considered when determining which set of standards are adopted for New Zealand. This is particularly important given the ambitious targets recently proposed in two Government consultations: MBIE's Interim Hydrogen Roadmap, which outlines plans for increased uptake of hydrogen vehicles and supporting infrastructure[7]; and MFE's consultation on the second emissions reduction plan, which aims for 10,000 public EV charging points by 2030, and increased uptake of zero-emission heavy vehicles (both hydrogen and electric)[8]. We need a flexible approach to harmonic management, rather than rigid, compliance-based regulations, to accommodate this anticipated future growth in electrification of transport and hydrogen technologies. However, as outlined in our response to Q4, if a regulation-based approach is decided upon, it is critical that the Authority considers adopting a similar approach to the proposed Regulatory Systems (Immigration and Workforce) Amendment Bill, to allow the Authority to more quickly and easily update references to standards in the Code by way of delegation of ministerial powers[9].
Q8. Do you have any feedback on the alternative approaches to limiting harmonic emissions, including alternative approaches you consider to be appropriate for New Zealand's electricity industry?	Orion's preference is for a combined approach that incorporates elements of both **open access** and **charges applied to emitters of harmonics**. This hybrid model aligns with our overarching view that harmonic management should be flexible and future-proof. We believe it would provide the necessary flexibility for adaptation to new technologies and changing network conditions, while also creating appropriate incentives for responsible harmonic management. It supports innovation by not imposing blanket restrictions yet maintains network quality through financial mechanisms.

[7] https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-strategies-for-new-zealand/hydrogen-in-new-zealand/roadmap-for-hydrogen-in-new-zealand
[8] https://environment.govt.nz/news/erp2/
[9] https://www.legislation.govt.nz/bill/government/2024/0049/latest/whole.html

	We strongly disagree with the approach of **requiring connecting parties to be a net absorber of harmonic emissions**. This approach is not feasible for several reasons: 1. The connecting party may not be the source of significant harmonic emissions yet would be forced to bear the cost of mitigation due to upstream harmonic emitters. 2. Such requirements could lead to increased costs that render new connections or technologies economically unfeasible, potentially impacting New Zealand's ability to support decarbonisation and the transition to Net Zero. 3. This approach essentially imposes costs on parties who would otherwise not be responsible for paying them, which we consider to be both unfair and potentially detrimental to innovation and network development. We favour a bill-based system for harmonic emitters, similar to the approach outlined in clause 5.52 of the consultation document. We believe that penalising bad power factor through financial mechanisms is an effective way to incentivise proper harmonic management. However, it is critical that any approach to limiting harmonic emissions strikes a balance between encouraging innovation and maintaining network quality. The penalisation should not unduly hinder the adoption of new technologies or connection of new participants to the network. We disagree with the approach of **pre-emptive installation of harmonic filters**. As harmonic filters absorb harmonics from all upstream network emitters, this potentially forces innocent parties to resolve others' issues, at significant cost. Additionally, as previously outlined in our response to Q5, network reconfigurations completed by Transpower can significantly impact harmonic levels. This may impact the effectiveness of any existing filters operating on the network. It is essential for the Authority to consider how harmonic filters interact with each other and the wider network before pursuing this approach.