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To: Future Security and Resilience (FSR) Team, Electricity Authority Te Mana Hiko
By email: fsr@ea.govt.nz
Subject: Consultation – Options to address a harmonics issue

Tēnā koutou,

Submission on Promoting reliable electricity supply: Options to address a harmonics issue

Nexbe Limited welcomes the opportunity to provide feedback on the Electricity Authority's consultation regarding the regulatory arrangements governing the management of harmonics in New Zealand's power system.

As the penetration of inverter-based resources (IBR) and bidirectional power flows continues to accelerate across New Zealand, the limitations of the current regulatory framework—primarily the outdated NZECP 36:1993—have become a critical bottleneck. A consistent national approach is required to ensure unbiased outcomes, reduce project risk, and support developers in reaching financial close for large-scale connections.

Nexbe strongly supports **Option 1** (mandating AS/NZS 61000 for transmission and the EEA Power Quality Guidelines for distribution), coupled with the establishment of a centralized harmonics measurement database (**Sub-option 1a**). However, we emphasize that simply mandating planning levels is insufficient. A truly fit-for-purpose framework must also establish consistent, mandated processes for harmonic monitoring equipment, measurement methodologies, and standardized data reporting across Transpower and all Electricity Distribution Businesses (EDBs).

Without mandatory standardisation in how harmonics are measured and allocated, there is a severe risk that differing interpretations between Transpower and EDBs will lead to inconsistent compliance outcomes. We advocate for a regime that provides transparent data throughout the entire project lifecycle—from design and network modelling to commissioning and ongoing operation.

Our detailed responses to the consultation questions, including technical considerations around measurement techniques and allocation methodologies, are provided in the following submission form. We look forward to continuing to work with the Authority to ensure New Zealand's power system remains reliable, equitable, and future-ready.

Ngā mihi,

Richard Oswald

Chief Commercial Officer
Nexbe Limited

Submission Form

Submitter: Nexbe Limited

Questions	Comments
Q1. Do you agree the Authority should be short listing Option 1 for further consideration? If you disagree, please explain why.	**Yes.** Nexbe strongly supports Option 1. It provides a transparent, clearly defined framework for harmonic calculation, allocation, and measurement. For example, NZECP 36:1993 relies on simplistic current emission limits that fail to account for phase angle diversity and harmonic cancellation between multiple Inverter-Based Resources (IBRs). AS/NZS 61000.3.6 utilizes more advanced concepts like the general summation law, which accurately reflects the complex vector addition of harmonic currents in a modern grid.
Q2. Do you agree the Code should not mandate harmonics management requirements, other than harmonics planning levels? If you disagree, please explain why.	**Disagree.** While mandating planning levels is essential, it is insufficient on its own. The Code (or the mandated EEA guidelines) must also specify minimum standards for harmonic monitoring equipment and measurement methodologies. *Technical Example:* If network owners are not mandated to use Class A power quality instruments (AS/NZS 61000.4.30), differences in measurement windowing or aggregation intervals (e.g., 3-second vs. 10-minute aggregation) will yield conflicting harmonic distortion values. This creates a scenario where a generation asset might "pass" under one EDB's measurement regime but "fail" under Transpower's, simply due to instrumentation discrepancies.
Q3. What regulatory instrument (i.e., the Code or the Electricity (Safety) Regulations) do you consider should be used to regulate installation standards for harmonics?	The **Code** is the most appropriate instrument to regulate network installation and connection standards for harmonics. The Code allows for more agile integration of industry guidelines (e.g., EEA guidelines) and directly governs the behaviour of market participants, Transpower, and EDBs. Device-level emission limits (e.g., AS/NZS 4777.2 for small inverters) may remain under the ESR, but grid/network integration and system-level allocation must be managed via the Code to ensure whole-of-system coordination.

Q4. Which, if any, aspects of AS/NZS 61000 do you consider need substituting or adapting in order to accommodate New Zealand conditions?	Adaptations are necessary to reflect New Zealand's specific network topologies (long, low-system-strength radial lines). *Technical Example:* High impedance in rural NZ networks can cause distinct resonant peaks at lower harmonic orders (e.g., 5th or 7th). The default "voltage droop" allocation methodology assumes shorter line lengths and detuned capacitors; applying this blindly to a 66kV or 110kV radial network could misallocate available headroom. Furthermore, adaptation is required to handle the lack of phase angle diversity when connecting identical utility-scale inverters, which can lead to rapid constructive interference rather than the statistical cancellation assumed in the standard.
Q5. Do you consider the establishment, monitoring and enforcement of harmonics requirements should be a contractual matter between electricity network owners and their customers, or a Code-enforceable matter? Please give reasons with your answer.	They should be a Code-enforceable matter, particularly regarding the baseline rules for monitoring, allocation equity, and data transparency. Leaving enforcement entirely to bespoke bilateral contracts creates vast information asymmetry. Code enforcement ensures standardisation, enables independent verification of compliance, and reduces the potential for disputes where network operators might apply overly conservative models (e.g., forcing developers to install unnecessary, lossy passive filters) without regulatory oversight.
Q6. Do you consider distributors should have a mandated responsibility to investigate and resolve security of supply or reliability issues caused by non-compliance with the harmonic levels specified for distribution networks?	**Yes.** As distribution networks become increasingly bidirectional, EDBs must actively manage harmonic capacity. *Technical Example:* Widespread residential adoption of single-phase solar PV and EV chargers can inject significant triplen (3rd, 9th) zero-sequence harmonic currents, stressing network neutrals and distribution transformers. EDBs must be mandated to investigate and manage this holistically at the network level rather than imposing punitive, pre-emptive filtering costs on a single, new commercial renewable energy developer attempting to connect to that same constrained feeder.

Q7. What guidance for industry participants do you consider would be necessary under Option 1?	Comprehensive guidance is required for network modelling studies and the calculation of Harmonic Impedance Polygons. *Technical Example:* If developers do not have standardized guidance on deriving and applying harmonic impedance sector profiles, they are forced into worst-case assumptions. This frequently leads to the over-design of C-type or high-pass passive filters. These oversized filters can inadvertently act as a "sink" for pre-existing grid harmonics, overloading the developer's equipment and creating destructive parallel resonance with the wider network. Further, Transpower and EDBs manage grid-scale generation and large load connection applications through detailed feasibility studies, which include harmonic assessments. These studies are typically undertaken by approved consultants at the developer's cost. To improve efficiency and consistency, consideration could be given to establishing a national register of consultants approved by Transpower and participating EDBs. This could reduce duplication and overlap between studies, provide greater consistency in methodology and outcomes, and give developers a wider choice when selecting a consultant. Ultimately, this has the potential to reduce feasibility study costs and streamline the connection assessment process.
Q8. What do you consider to be the main benefits and costs associated with Option 1?	**Benefits:** A transparent, non-biased national framework; reduced project risk; greater certainty for developers to reach financial close; and standardized, repeatable compliance assessments using modern summation laws. **Costs:** Initial capital expenditure for network operators to upgrade to Class A monitoring equipment, and administrative costs for upskilling network engineers from legacy NZECP 36 calculations to AS/NZS 61000 Stage 2/Stage 3 assessment methodologies.
Q9. Do you agree the Authority should be short listing Option 2 for	**Disagree.** A purely guidance-based, non-mandatory approach will fail to achieve national consistency. It leaves room for differing

further consideration? If you disagree, please explain why.	interpretations of harmonic allocation requirements between Transpower and individual EDBs, failing to resolve the regulatory ambiguity that currently stifles efficient investment and connection of large-scale assets.
Q10. What do you consider to be the main benefits and costs associated with Option 2?	**Benefits:** Lower immediate regulatory compliance burden and higher flexibility for network owners to dictate local terms. **Costs:** A fragmented national grid, inconsistent compliance outcomes, significant uncertainty for developers, and a high likelihood of drawn-out technical disputes over inequitable harmonic capacity allocations.
Q11. Do you agree the Authority should be short listing Option 3 for further consideration? If you disagree, please explain why.	**Disagree.** NZECP 36:1993 is fundamentally obsolete. It was not designed for the modern reality of inverter-based resources, supraharmonics (e.g., high-frequency switching noise from IGBTs), or dynamic bidirectional networks. Patching a structurally flawed, 30-year-old standard is an inefficient use of industry time and will quickly fall out of step with global IEC developments.
Q12. What do you consider to be the main benefits and costs associated with Option 3?	**Benefits:** Familiarity for industry participants resistant to change. **Costs:** Wasted time and resources attempting a complex multi-agency rewrite that will ultimately yield a sub-optimal standard disconnected from modern equipment manufacturing realities.
Q13. What do you consider to be the benefits and costs of the current arrangements for obtaining harmonics data from distributors and from Transpower, as a transmission network owner?	**Benefits:** Minimal administrative cost to network operators who currently do not proactively maintain accessible, high-resolution data sets. **Costs:** Extreme opacity. *Technical Example:* Currently, developers might receive only a single "worst-case" background harmonic voltage limit rather than time-series phase data. Without temporal data (e.g., day vs. night harmonic profiles), engineers modelling in PSCAD or DIgSILENT PowerFactory must assume simultaneous peak harmonics at all frequencies,

	driving up equipment costs through over-engineered mitigation strategies.
Q14. What do you consider to be the benefits and costs of a database of harmonics measurements?	**Benefits:** Immense value in improving transparency around connection agreements. From a technical standpoint, a database enables developers to identify existing harmonic "headroom" and background resonance frequencies before finalizing inverter procurement. It prevents the "blind" installation of LC filters that might inadvertently tune the network to a destructive resonant frequency. **Costs:** The IT infrastructure costs of hosting the database, data curation, and deploying AS/NZS 61000.4.30 compliant monitoring hardware at key network nodes.
Q15. Would access to raw harmonics measurement data be useful for your organisation? If so, why?	**Yes, absolutely.** Raw data (e.g., 10-minute aggregated voltage/current magnitudes and phase angles up to the 50th harmonic order) is essential. It allows developers to perform accurate harmonic load flow and frequency sweep analyses. Knowing the exact background Total Harmonic Distortion (THD) and individual harmonic vectors (e.g., V_5, V_7, V_{11})) allows developers to optimize active harmonic filters and inverter plant controllers (PPC) to electronically net-absorb or cancel out specific problematic frequencies, which is impossible without rich data.
Q16. Who do you consider should host a database of harmonics measurement data? Please give reasons.	The Electricity Authority, potentially through the existing Electricity Market Information (EMI) platform. An independent, centralized regulator must hold this data to guarantee objectivity, ensure standardized formatting across both Transpower and EDBs, manage cybersecurity/data privacy appropriately, and prevent commercial bias from network monopolies in how harmonic capacity information is shared with developers.