

Discussion paper

16 November 2021

# Future security and resilience

Phase 1 draft report



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# 1 Our motivation: the low-emissions energy transition

- 1.1 New Zealand has committed to achieving net zero emissions by 2050. As signalled in the Climate Change Commission's final advice earlier this year<sup>1</sup>, and the Government's recent consultation on the first emissions reduction plan<sup>2</sup>, transitioning to a low-emissions energy system will be critical to New Zealand meeting that goal.
- 1.2 Based on current projections, the most likely means of reducing emissions from the energy sector will be electrifying as much of the transport and industrial heating sectors as possible, and meeting the increased electricity demand with material quantities of new renewable generation. Operation of existing, high-emitting fossil-fired thermal generation will have to decrease.
- 1.3 At this point in time, the most economic forms of new renewable generation are projected to be wind and solar. These are often referred to as *variable, intermittent* and/or *non-dispatchable* technologies, in that they generate electricity when the wind is blowing or sun shining, but not otherwise. They are being deployed in New Zealand at a variety of scales, from several kilowatts (kW) for rooftop solar, to hundreds of megawatts (MW) for large-scale wind farms. Solar farms in the order of thousands of MW are being planned overseas<sup>3</sup>.
- 1.4 Large increases in variable renewable generation will present new challenges to the operation of and investment in the electricity system, and to maintaining a secure, reliable and resilient electricity supply. However, new technologies also provide significant opportunities. Energy storage systems like batteries (including in electric vehicles), and controllable demand (like electric vehicle chargers), can be harnessed to provide the services to the power system that have traditionally been delivered by just a handful of existing technologies. A key shift is the move from a largely centralised system to a decentralised system, with the number of controllable devices connected to New Zealand's power system set to increase exponentially. This will provide significant diversity benefits, however it will also give rise to new coordination challenges.
- 1.5 Factors outside electricity systems are also providing new challenges to the operation of power systems worldwide. Climate change may increase the occurrence of extreme weather events, testing power system resilience, and the threats to operation from cyber security breaches increase every day.
- 1.6 The Authority's *Future security and resilience* workstream is examining how to ensure the electricity system remains stable, secure and resilient as it evolves in the coming decades. A secure and resilient power system is important to electricity consumers, to all participants in the electricity system, and to all New Zealanders more broadly.
- 1.7 Alongside this paper we are releasing a draft report on future challenges and opportunities. We want to make sure we hear from you whether we have accurately identified and prioritised the most important issues.

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<sup>1</sup> See <https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/>

<sup>2</sup> See <https://environment.govt.nz/publications/emissions-reduction-plan-discussion-document/>

<sup>3</sup> See, for example: <https://suncable.sg/>

## 2 Authority workstreams supporting the transition

- 2.1 Facilitating an efficient transition to a *low-emissions energy* system is one of the key ambitions set out in the Authority's strategy<sup>4</sup>, alongside maintaining *trust and confidence* in the reliability of the system through the transition.
- 2.2 The *Future security and resilience* workstream is one of a number of significant, transformational and interrelated Authority workstreams supporting New Zealand's transition. Others include:
- (a) Examining wholesale market operation under 100% renewables
  - (b) Updating the regulatory settings for electricity distribution networks
  - (c) Implementing real-time pricing in the electricity wholesale market
  - (d) A new Transmission Pricing Methodology
  - (e) Faster reform to efficient electricity distribution pricing
- 2.3 Each of these workstreams is described briefly in turn in the remainder of this section. This serves to clarify and provide context for the current scope and boundaries of the *Future security and resilience* workstream, set out in the following section.
- 2.4 The Authority is also undertaking several significant reviews of the electricity market currently, including:
- (a) Phase 2 of the review into the events of 9 August 2021<sup>5</sup>
  - (b) The wholesale market competition review<sup>6</sup>
  - (c) Review of the events of early 2021, driven by low hydro inflows and the tight gas market.
- 2.5 Each of these reviews will be considering issues critical to the low-emissions transition, and has the potential to give rise to a number of important workstreams.

### **Future security and resilience<sup>7</sup>**

- 2.6 The multi-year *Future security and resilience* workstream is investigating challenges and opportunities to maintaining a secure, stable and resilient power system in the face of technological and other changes.
- 2.7 This project forms part of the Authority's response to the Government's Electricity Price Review<sup>8</sup> – in particular, recommendation G2, to examine the security and resilience of electricity supply.
- 2.8 As explained later in this paper, the initial focus of the *Future security and resilience* workstream is on maintaining security, stability and resilience of the power system in and close to real time. In other words, it is not assessing the power system's ability to maintain a balance of demand and supply over periods of longer than a few days (often

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<sup>4</sup> See <https://www.ea.govt.nz/about-us/strategic-planning-and-reporting/statement-of-intent/> for further information.

<sup>5</sup> See <https://www.ea.govt.nz/monitoring/enquiries-reviews-and-investigations/2021/electricity-authority-review-of-9-august-2021-event-under-the-electricity-industry-act-2010/>

<sup>6</sup> See <https://www.ea.govt.nz/monitoring/enquiries-reviews-and-investigations/2021/wholesale-market-competition-review-2/>

<sup>7</sup> See <https://www.ea.govt.nz/development/work-programme/risk-management/future-security-and-resilience-project/>

<sup>8</sup> See <https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-consultations-and-reviews/electricity-price/> for more information.

referred to as “adequacy”). This is in part due to a request from the Minister of Energy and Resources in her letter of expectations for the Authority for the 2021/22 year<sup>9</sup>, which requested that the Authority sequence this aspect of the review after Phase 1 of the New Zealand Battery Project had been completed.

2.9 There are key interrelationships between *Future security and resilience* and the following workstreams:

- (a) Examining wholesale market operation under 100% renewables (undertaken by the Authority’s Market Development Advisory Group, MDAG)
- (b) Updating the regulatory settings for electricity distribution networks.

2.10 In particular, the first of these is the primary workstream addressing spot market operation and adequacy as New Zealand transitions towards 100% renewables.

2.11 Updating the regulatory settings for electricity distribution networks is the Authority’s primary workstream addressing the future security and resilience of distribution networks in the coming decades. The Authority recently consulted on a discussion paper launching this workstream<sup>10</sup>, and received many submissions. Analysis of the feedback received will inform the direction of that work, and of any work relating to distribution networks to be undertaken under the *Future security and resilience* workstream.

2.12 Work undertaken under the *Future security and resilience* workstream will form the basis of the *Joint development programme*<sup>11</sup> between the Authority and Transpower as the system operator for the coming years.

### **Examining wholesale market operation under 100% renewables<sup>12</sup>**

2.13 Electricity markets worldwide, including New Zealand’s, have been designed on the assumption that a material proportion of generation is fuelled by fossil fuels. Fossil-fuelled thermal generation is characterised by relatively low investment costs, and high operating costs.

2.14 In contrast, renewable technologies, such as solar and wind generation, have relatively high investment costs but very low short-run costs of generation.

2.15 One of the Authority’s two standing advisory groups, MDAG, is undertaking a project investigating how the wholesale electricity market might operate (including price discovery and new investment in generation) under a 100% renewable electricity supply.

2.16 Within this context, MDAG’s project is looking at several important questions, including the following:

- (a) How the electricity spot market will promote efficient operation when a high proportion of generation capacity has low or zero short-run marginal costs of operation
- (b) How stored water will be priced and allocated across time periods, without fossil-fuelled thermal plant in the market

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<sup>9</sup> Available online at <https://www.ea.govt.nz/about-us/who-we-are/responsible-minister/>

<sup>10</sup> Available online at <https://www.ea.govt.nz/development/work-programme/evolving-tech-business/updating-regulatory-settings-for-distribution-networks/>

<sup>11</sup> See <https://www.ea.govt.nz/operations/market-operation-service-providers/system-operator/joint-development-programme/> for more details.

<sup>12</sup> See <https://www.ea.govt.nz/development/advisory-technical-groups/mdag/mdag-price-discovery-project/>

- (c) How the wholesale market will enable efficient investment when supply is dominated by generation with low short-run marginal costs
  - (d) How to ensure efficient pricing in extended periods of supply scarcity, such as dry years.
- 2.17 MDAG is currently developing a problem definition paper and intends to publish this for feedback in late 2021 or early 2022.

### **Updating the regulatory settings for electricity distribution networks<sup>13</sup>**

- 2.18 This work programme aims to ensure the regulatory settings in the electricity distribution sector support the transition to a low-emissions energy system while promoting competition, reliability and efficiency for consumers' long-term benefit.
- 2.19 The work programme has a particular focus on increasing competition and consumer participation in flexibility markets on distribution networks, i.e. the markets for buying and selling services from controllable distributed energy resources (DER). The work builds on several years of investigation in this area by the Authority's Innovation and Participation Advisory Group (IPAG). Globally, and in New Zealand, the quantity of DER connected to the power system is set to increase significantly in coming decades. It is important that the full value and benefits of these resources are realised not just for those that own and operate the DER, but also for those consumers who do not and cannot own DER.
- 2.20 The desired outcome is for sector participants to have the ability, information and incentives to make efficient investments in both network and non-network solutions – for instance investing in DER capable of providing network-supporting services, rather than upgrading distribution networks. Where non-network solutions are more efficient, the desired outcome is for these services to be procured through a competitive framework.
- 2.21 More efficient investments can lower prices for consumers – as noted above, not just for those consumers who own DER, but for those who do not. More investment in DER, including in renewable generation, batteries and demand response, will support the shift to lower emissions by decreasing peak demand (or, at least, constraining growth in peak demand). Competition in this area can lead to consumers having more choice of both supplier and type of service, and will help drive costs down.
- 2.22 A cost benefit analysis commissioned by the Authority and undertaken by Sapere Research Group<sup>14</sup> estimated that, if the full benefits of DER were to be realised, the net benefit from 2021 to 2050 is expected to be \$7 billion in net present value. Of this, \$2.8 billion accrues to consumers while \$4 billion will go to the owners and operators of the DER.
- 2.23 The Authority is currently analysing feedback on a discussion paper and developing its next steps in this work programme.

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<sup>13</sup> See <https://www.ea.govt.nz/development/work-programme/evolving-tech-business/updating-regulatory-settings-for-distribution-networks/>

<sup>14</sup> Available online at <https://www.ea.govt.nz/development/work-programme/evolving-tech-business/updating-regulatory-settings-for-distribution-networks/>

## Implementing real-time pricing in the electricity wholesale market<sup>15</sup>

- 2.24 As well as providing much-needed flexibility to distributors, DER, including demand-side flexibility (such as EV chargers and hot-water heating), battery storage systems and distributed generation – also have significant potential to balance fluctuations in nationwide supply from large-scale, variable generation like wind and solar.
- 2.25 Harnessing DER will be an efficient method for managing this generation variability, but it will require coordination in real-time. If this responsiveness is uncoordinated, demand and supply will not be balanced as effectively as possible.
- 2.26 Making the most of the potential flexibility available will rely on electricity market participants, and the owners and operators of DER, seeing clear price signals in real time they can respond to with confidence.
- 2.27 The real-time pricing (RTP) project will promote the efficient integration of increased levels of variable generation into the power system in two ways:
- (a) **Settlement pricing based on real-time dispatch pricing:** this will mean that owners and operators of DER can act on published pricing in real time, knowing that the price will be directly related to the final settlement price.
  - (b) **Introduction of Dispatch Notification participation:** Dispatch Notification is a new, low-cost method for DER (including demand response) to signal their price responsiveness in the market. This will allow response to pricing by DER to be co-ordinated with other market resources. This will lead to more efficient and stable pricing outcomes, and greater participation by DER in the wholesale price-discovery process.
- 2.28 The design and policy decisions for RTP have already been made. RTP is set to begin operation in New Zealand in late 2022, with the Dispatch Notification product launched early in 2023.

## A new Transmission Pricing Methodology<sup>16</sup>

- 2.29 This workstream is developing a new approach to paying for investments in the national electricity transmission grid: a benefit-based approach. Under this approach, those who benefit from transmission investments will pay for them.
- 2.30 If the current proposal is implemented, benefit-based charges will replace the main charges under the existing transmission pricing methodology (TPM) – the regional coincident peak demand (RCPD) and the high voltage direct current (HVDC) charges.
- 2.31 The Authority considers that the new approach to paying for transmission assets will deliver significant benefits to consumers and give electricity consumers and generators much-improved signals of the costs and benefits of using the transmission grid. Overly-high transmission charges for using electricity at times when consumers most want it will be removed, and the new approach will stop rewarding parties that shift costs on to other consumers for no overall benefit.

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<sup>15</sup> See <https://www.ea.govt.nz/development/work-programme/pricing-cost-allocation/spot-market-settlement-on-real-time-pricing/>

<sup>16</sup> See <https://www.ea.govt.nz/development/work-programme/pricing-cost-allocation/transmission-pricing-review/>



- 2.32 The proposed new TPM will also promote the right investment at the right time in renewable generation, transmission and electrification of industrial processes and transport.
- 2.33 Efficient investment and use decisions by generators, distributors and consumers will result in electricity prices over the long term being lower than they would otherwise be. Lower electricity prices will support the electrification of transport and process heat, whilst supporting a transition to meet New Zealand’s low-emissions challenge at least cost to consumers. The proposed new TPM will ensure a level playing field for batteries (and other storage) so that they are not at a competitive disadvantage compared to other generation. The proposed new TPM will help to address the first-mover disadvantage issue for new transmission connection investments (a potential barrier to renewables/electrification).
- 2.34 The Authority is currently consulting on the proposed new TPM.

### **Faster reform to efficient electricity distribution pricing<sup>17</sup>**

- 2.35 This programme of work both supports the electricity sector and drives faster reform to efficient electricity distribution pricing.
- 2.36 Distribution pricing matters; the distribution component makes up approximately 27% of the average electricity bill. More efficient distribution pricing will result in consumer benefits, enhancing affordability and supporting the transition to a low-emissions energy system.
- 2.37 The benefits of pricing reform are substantial across all consumers – residential, commercial and industrial – as efficient distribution pricing plays a critical role in reducing network upgrade and expansion costs, and ensuring distributors also consider network alternatives. It also results in more choice and flexibility for consumers and enables consumers to make better technology investment decisions.
- 2.38 Efficient investment and use decisions by both distributors and consumers will result in lower prices over the long term. As noted above, lower prices will support the electrification of transport and process heat.
- 2.39 As the proposed new TPM is likely to remove the peak pricing signal in transmission pricing, efficient distribution pricing becomes more urgent. Also, as electricity load increases, from process heat and uptake of EVs, some networks will face congestion, again meaning efficient pricing becomes more urgent.
- 2.40 The Authority recently consulted on refreshed guidance for distributors. This workstream also links closely to the Authority’s *Updating the regulatory settings for the distribution sector* work programme.

## **3 The future security and resilience workstream**

- 3.1 As set out above, the *Future security and resilience* workstream is focused on how to ensure that New Zealand’s electricity system remains stable, secure and resilient in the coming decades. Alongside affordability and sustainability, reliability (which encompasses security and resilience) is a key component of the energy trilemma.
- 3.2 Electricity systems worldwide, including New Zealand’s, have been designed on the assumption that a material proportion of generation is fuelled by fossil fuels. Achieving

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<sup>17</sup> See <https://www.ea.govt.nz/development/work-programme/pricing-cost-allocation/distribution-pricing-review/>



New Zealand's climate goals will likely require a material increase in variable renewable generation, presenting new challenges to the operation of and investment in the electricity market, and to maintaining a secure, reliable and resilient electricity supply.

- 3.3 However, the move towards 100% renewables, and the uptake of new technology, present opportunities for other technologies to provide the services that are typically supplied predominantly by hydro generation and supported by fossil fuels, particularly when insufficient hydro is available.

### **We are working with the system operator to identify opportunities and challenges**

- 3.4 As part of this workstream, the Authority has commissioned advice from Transpower as the system operator. This work will take place in three phases as set out below.

#### **Phase one – identifying challenges and opportunities**

- 3.5 **Phase one** includes producing an initial report on future security and resilience challenges and opportunities based on current understanding. The phase one draft report is appended to this discussion paper in Appendix A.
- 3.6 We will be undertaking a round of sector workshops in late November and early December to engage on, and refine, the content of the phase one report. As set out below, we invite interested parties to attend the workshops. After receiving and analysing this feedback, the report will be finalised in early 2022.

#### **Phase two – developing a prioritised roadmap for delivery**

- 3.7 **Phase two** of the project will build on sector contributions from phase one and include the development and publication of a detailed 10-year roadmap of investigations and related technical and regulatory work needed to transform the electricity system over the next ten years.
- 3.8 This roadmap is scheduled to be published in early 2022 and will again be the subject of a round of engagement with industry. This phase is expected to conclude by the middle of 2022.

#### **Phase three – delivery of the roadmap**

- 3.9 From April 2022 onwards, **phase three** will start by publishing a prioritised plan for monitoring and addressing the challenges and opportunities identified through phase two.
- 3.10 This final phase will include delivery of a multi-year programme of studies and solutions to address the challenges and opportunities identified.
- 3.11 It is important to note that the focus of phases one and two is on prioritising and sequencing future work. No decisions are being made at this point on any solutions for addressing the challenges and opportunities identified.
- 3.12 Each of the subsequent initiatives addressing challenges and opportunities identified in phase one, and especially those considering amendments to the Code, would be subject to the Authority's usual consultation processes.

## **The initial focus of this workstream is on the transmission network**

- 3.13 The initial focus of the *Future security and resilience* workstream is on identifying challenges and opportunities across the broader transmission network. This includes issues such as system strength, and wholesale ancillary services, that impact New Zealand's electricity network at a multi-regional or national level.
- 3.14 As discussed above, issues relating the future security and resilience of distribution networks are being addressed primarily through the *Updating the regulatory settings for electricity distribution networks* programme of work.
- 3.15 The two areas clearly overlap. For example, DER can provide services to the distribution networks on which they're located, but also to the broader system (for example through ancillary services, such as instantaneous reserve or frequency keeping). Effective aggregation and coordination of many smaller resources is an important factor in realising this opportunity.
- 3.16 Boundaries between the Authority's workstreams must be drawn somewhere, and monitored accordingly. We will ensure consistency and cohesiveness between the multiple Authority workstreams addressing the transition.

## **We can learn from existing scenarios for New Zealand**

- 3.17 In recent years, many different scenarios have been developed and published to assess the potential future evolution of New Zealand's electricity system.
- 3.18 Most of these scenarios, however, do not explicitly examine the real-time operation of the power system, or what the future challenges and opportunities are in doing so. They are more broadly focussed on how total energy demand might evolve over time (for example through electrification), and how this demand may be met (for example, through new renewables). In other words, these scenarios are more focussed on adequacy.
- 3.19 Prior to the commencement of the work with the system operator, and MDAG's workstream on 100% renewables, the Authority commissioned Sapere Research Group (Sapere) to undertake a survey of recent scenarios for the evolution of New Zealand's electricity system, and to draw out what these scenarios could be signalling in relation to risks to future security and resilience.
- 3.20 Sapere's report is attached as Appendix B. It highlights that increasingly, detail matters – the timing, location and type of new demand and generation added to the system, and the timing of load removed from the system, have a significant impact on the system's security and resilience.
- 3.21 Their report also highlights a gap in existing scenario modelling, which is to demonstrate the impact a more flexible demand side could have on the evolution and operation of the power system. While there will not be any new modelling undertaken in phases one or two of *Future security and resilience*, this suggests a key area for consideration in future work. MDAG is exploring the impacts of increased demand-side flexibility on wholesale market outcomes in its work examining the operation of a 100% renewable electricity system.

## **We can also learn from overseas**

- 3.22 The significant shifts in the New Zealand power system highlighted in the first section of this discussion paper are also occurring in many overseas jurisdictions, to a greater or

lesser extent. While New Zealand's power system is unique in many respects, we can learn from overseas experience and projection.

- 3.23 A key part of the phase 1 draft report has been the investigation of challenges and opportunities in other relevant jurisdictions. It is important to highlight not just those issues that may occur in New Zealand, but also to be clear on issues that may not manifest here. As noted in the Sapere report, the context matters.

## 4 We are seeking your views on the opportunities and challenges

- 4.1 Release of the Phase 1 draft report is the first key milestone in the *Future security and resilience* workstream.
- 4.2 Importantly, the report appended to this discussion paper is a draft. The report will not be finalised until we have heard and taken account of stakeholder feedback.
- 4.3 As discussed above, the report is focussed on challenges and opportunities in relation to maintaining security, stability and resilience at the transmission system level. This is an area in which Transpower has significant expertise, and has undertaken numerous studies in the past.
- 4.4 Areas outside of their expertise, for example in relation to distribution networks, are being investigated and addressed primarily in other Authority workstreams. We will engage other expertise to assess these issues, as required.
- 4.5 In order to mitigate the risk of the report being too focussed on Transpower's experience or perspective, Transpower engaged an independent expert reviewer from Sapere Research Group. We have also worked closely with Transpower through the development of the draft report, and provided feedback on earlier drafts, supported by our own independent experts.

### We will be gathering feedback via workshops

- 4.6 It is critically important that the industry has a shared understanding of future challenges and opportunities, and understands how the prioritisation for addressing these has been established. Further, testing the draft report publicly and gathering feedback are some of the key controls we are employing to address the risk of any challenges or opportunities being missed or mischaracterised.
- 4.7 We will be undertaking a number of workshops to gather feedback, with the details of these posted on our website<sup>18</sup>. The workshops will be interactive, giving participants the opportunity to discuss the range of issues presented in the report, and their relative prioritisation, and to raise any they think have been excluded.
- 4.8 You may register for one of the feedback workshops by emailing [fsr@ea.govt.nz](mailto:fsr@ea.govt.nz).
- 4.9 You are also welcome to provide written feedback, although this is not required at this point. Written feedback can be provided via email to [fsr@ea.govt.nz](mailto:fsr@ea.govt.nz), no later than **5pm on Tuesday 14 December 2021**. Please note that we intend to publish all feedback we receive, as per standard Authority practice, unless expressly requested not to do so.

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<sup>18</sup> Details are available at <https://www.ea.govt.nz/development/work-programme/risk-management/future-security-and-resilience-project/>

## 5 Next steps in the process

- 5.1 As noted above, the Phase 1 report appended as Appendix A is draft, and we are gathering feedback on it before it is finalised. It is our intention to finalise and publish this paper, along with a summary of feedback received, by the end of February 2022.
- 5.2 In parallel, the Authority and system operator are progressing phase two of the review – the development of a roadmap of activities for addressing the challenges and opportunities identified in phase one. We intend to publish the draft roadmap, and gather feedback again through workshops, in February and March 2022.
- 5.3 The finalised roadmap, and a summary of feedback received, will be published by the middle of 2022.
- 5.4 Phase 3 of *Future security and resilience*, the implementation of the activities in the roadmap will commence in the following financial year, from July 2022. The activities in the roadmap will be prioritised for delivery alongside and amongst the rest of the Authority's activity over the coming years.

# Appendix A Phase 1 draft report prepared by the system operator

## Appendix B Survey of future scenarios compiled by Sapere Research Group