Before a Hearing Panel at Levin

under: the Resource Management Act 1991

in the matter of: The Proposed Horowhenua District Plan - Rural Environment

between: **Horowhenua District Council**
Local Authority

and: **Transpower New Zealand Limited**
Submitter

Statement of evidence of Steven Taylor for Transpower New Zealand Limited

Dated: 3 May 2013

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CHAPMAN TRIPP

STATEMENT OF EVIDENCE OF STEVEN TAYLOR

QUALIFICATIONS AND EXPERIENCE

1 My full name is Steven Taylor.

2 I am the Manager of the Environmental Strategy and Approvals Group at Transpower New Zealand Limited (*Transpower)*, a position I have held since 2008. The group is responsible for preparing submissions on district and regional plans and preparing the resource consent applications and notices of requirement necessary for Transpower's operational and capital activities. It also reviews and submits on consent applications lodged by others which may impact Transpower's assets.

3 I hold a Bachelor of Resource and Environmental Planning with First Class Honours. I have 17 years experience in environmental planning, having previously worked for Porirua City Council and various environmental consulting companies, providing policy and regulatory planning advice for central and local government and the private sector. I have been employed by Transpower for 9 years.

SCOPE OF EVIDENCE

4 My evidence will deal with the following:

4.1 Introduction to Transpower;

4.2 Transpower's assets within the Horowhenua District, and the role these play locally, regionally and nationally;

4.3 Transpower's programme for assisting with implementation of the National Policy Statement on Electricity Transmission (*NPSET)*, including its support for corridor management;

4.4 Why reliance on the New Zealand Code of Practice for Electrical Safe Distances 2001 (*NZECP34:2001*) alone will not protect the transmission assets; and

4.5 Conclusions.

5 In summary, my evidence:

5.1 Describes Transpower and its assets in Horowhenua District; and

5.2 Explains why Transpower supports Electricity Transmission Corridors for existing overhead lines that are not designated.

SUMMARY OF EVIDENCE

6 Transpower owns and operates the National Grid, which transmits electricity throughout New Zealand. There are five National Grid transmission lines in Horowhenua District, together with a substation and switching station. This infrastructure plays a critical role in New Zealand's electricity transmission network.

7 Transmission corridors around the transmission network operate to manage reverse sensitivity effects, ensure sensitive activities are generally not provided for near the network, protect the safety of both the transmission network and people working or living close to them, and ensure the network can be efficiently operated and maintained by providing the working and access space to do this.

8 Transpower has refined its corridor management approach over the years to ensure that it is consistent with the NPSET and accommodate the specific characteristics of each council area.

9 Transpower considers that the provisions set out in **Mr Graham Spargo's** evidence will best give effect to the requirements of the NPSET. Transpower does not support simple reliance upon NZECP34, as this will not manage sensitive activities or reverse sensitivity effects. Nor will it ensure the efficient and effective operation and maintenance of the transmission line – it is simply concerned with electrically safe separation distances.

10 Transpower has reconsidered those parts of its submission relating to the trimming and planting of trees. The Officer Report has clarified that no rule is necessary to permit the trimming of trees, and Transpower therefore no longer seeks this rule. However, Transpower continues to seek a new assessment criterion relating to tree planting near transmission lines. The Electricity (Hazards from Trees) Regulations do not manage tree *planting* – they only regulate the trimming of tree growth.

11 Transpower is aware that a balance needs to be struck between competing issues associated with the use of the electricity transmission network. Only via Resource Management Act 1991 (*RMA*) planning tools such as District Plan rules can sustainable management of both the transmission resource, and the environment it is located in, be achieved. The NPSET provides that use, development and protection of the transmission network needs to be managed in a way which enables people and communities to provide for their social, economic and cultural well-being and for their health and safety, while sustaining the potential of the Grid to meet the reasonably foreseeable needs of future generations, and while also avoiding, remedying and mitigating adverse effects of activities on the environment. It is important to note that full mitigation is not possible due to the scale, form, function and

technical constraints of the infrastructure and this is recognised in the NPSET.[1] The focus must be on overall effects-based management.

INTRODUCTION TO TRANSPOWER

Transpower's role

12 Transpower is a State Owned Enterprise that plans, builds, maintains, owns and operates New Zealand's electricity transmission network – the National Grid – which links generators to distribution companies and major industrial users. The Grid, which extends from Kaikohe in the North Island down to Tiwai in the South Island, transports electricity throughout New Zealand.

13 The National Grid comprises some 12,000 km of transmission lines and around 180 substations across the country. This is supported by a telecommunications network of some 300 telecommunication sites, which help link together the components that make up the National Grid.

14 Transpower is not a generator of electricity and has no retail sales of electricity. It can be considered to be a 'freight company' for electricity, in that it transports electrical energy from the generators to the local lines distribution companies and some major users of electricity (e.g. Carter Holt Harvey at Kinleith).

15 Transpower's main role is to ensure the reliable supply of electricity to the country. Transpower plays a fundamental part in New Zealand's economy.

16 As a State Owned Enterprise, Transpower's principal objective is to operate as a successful business.[2] It must operate within certain legislative constraints and report regularly to its shareholding Ministers. Transpower is required to deliver and operate a National Grid that meets the needs of users now and into the future.[3]

Transpower's divisions

17 There are 3 key divisions in Transpower that are responsible for maintaining, developing and operating the National Grid. The Grid Performance Division oversees the build, operation and maintenance of the Grid. The Grid Development division identifies the future (20-30 year +) needs of grid users from the perspective of both planned or potential investment in generation and expected growth in electricity demand, and develops transmission solutions to meet

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1 Policy 3.

2 State-Owned Enterprises Act 1986, s 4.

3 Statement of Corporate Intent 2012/2013, https://www.transpower.co.nz/sites/default/files/publications/resources/transpower-sci-2012-13.pdf at 5.

these needs. The third division, Grid Projects, is responsible for managing and delivering key infrastructure projects such as the North Island Grid Upgrade Project.

18 My team, the Environmental Strategy and Approvals Group, sits within Grid Development but works closely with all three of these Grid divisions. This reflects that many aspects of Grid development, maintenance, operation and project investigation and implementation involve a collaboration between environment, property and technical interests. To put it more precisely, Grid maintenance, enhancement and upgrade projects must all be viable under the RMA framework.

19 In my view, the two main issues for all three Divisions, including my team, are public and line worker safety and the long-term strategic planning, development and maintenance of the Grid. Involvement in councils' planning processes is necessary to address these issues. It is only these processes that can address matters such as reverse sensitivity, amenity values, safety, and long term planning, and thereby facilitate integrated management to achieve good long-term outcomes.

20 The National Grid is a physical resource of national significance. **Mr Spargo's** evidence describes the NPSET, which recognises that the efficient transmission of electricity via the Grid plays a vital role in the wellbeing of New Zealand, its people and the environment. The Grid needs to be operated, maintained, developed and upgraded, but this needs to be done bearing in mind its special characteristics and the adverse environmental effects it causes, as well as the adverse effects other activities cause to it. The NPSET was implemented by the Government in 2008 to manage these issues.

TRANSMISSION ASSETS WITHIN HOROWHENUA DISTRICT

21 The following National Grid transmission lines (owned and operated by Transpower) are located within the Horowhenua District:

21.1 Bunnythorpe – Haywards A (BPE-HAY A) 220kV single circuit circuit transmission line on towers;

21.2 Bunnythorpe – Haywards B (BPE-HAY B) 220kV single circuit transmission line on towers;

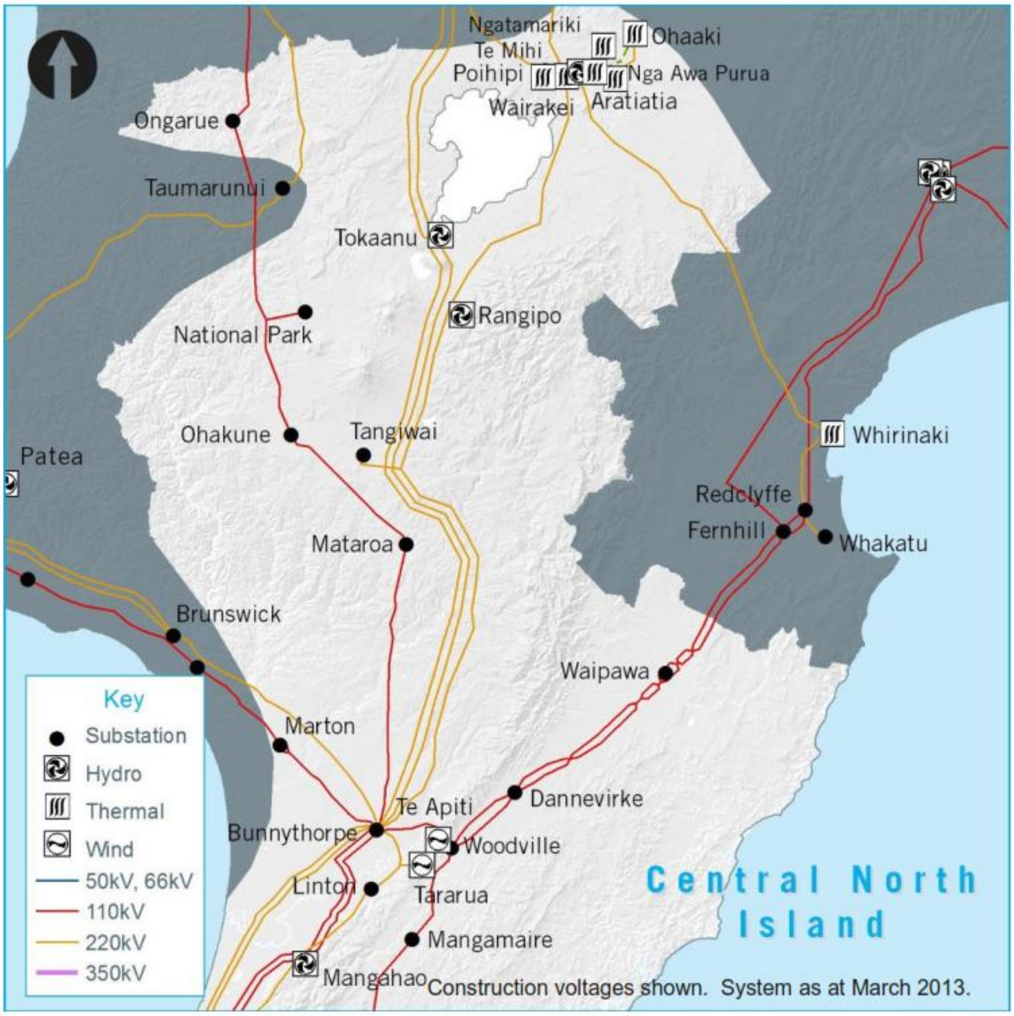
21.3 Mangahao – Paekakariki A (MHO-PKK A) 110kV single circuit transmission line on single poles;

21.4 Mangahao – Paekakariki B (MHO- PKK B) 110kV single circuit transmission line on single poles; and

21.5 Bunnythorpe – Wilton A (BPE-WIL A) 220kV double circuit transmission line on towers.

22 In addition, Transpower operates a substation at Mangahao Road and a switchyard at Te Paki Road.

23 The existing transmission network is shown below. The lines are also shown in the map in **Appendix A** to this statement.



TRANSMISSION IN THE MANAWATU-WHANGANUI REGION

24 Transmission in the Horowhenua serves a critical role in the New Zealand electricity network, by providing a vital link from remote generation locations to major load centres. Being a linear network, transmission has by necessity located in Horowhenua's rural zone. The direction of powerflow through the region, north or south, is set by generation and loads outside the region such as the status of the hydro lake generation in the South Island. The Bunnythorpe substation (amongst others) provides a vital link whether the power is flowing from the North Island to the South Island or vice versa.

25 The Central North Island Chapter of the Annual Report[4] (included in **Appendix B**) summarises the Grid development projects that Transpower anticipates will be carried out in Horowhenua over the next 15 years. The following development possibilities have been in identified in the report.

25.1 Replacement of transformers at the Mangahao Substation; as they are reaching the end of their life. The 33kV switchboard is also proposed to be moved inside at the substation; and

25.2 Replacement of conductors on the Bunnythorpe – Haywards A & B transmission lines. The two lines are over 50 years old and the conductors are nearing the end of their life. Transpower is using the opportunity to consider whether greater capacity for the lines will be needed over the next 50 years; mainly to provide for more power to flow from the North Island to South Island. The two lines will remain at 220kV following the re-conductoring.

26 The fibre optic cable connection to the Mangahao switchyard and Mangahao power station is about to be upgraded (this is not included in the Annual Report).

27 There are currently no new lines planned within the Horowhenua District. In summary, Transpower's infrastructure (including its infrastructure in Horowhenua) is a significant physical resource that must be sustainably managed and any adverse effects on it, and caused by it, must be avoided, remedied or mitigated. As **Mr Spargo** explains, the NPSET recognises that adverse effects of third parties on the network can be managed through the use of buffer corridors within which sensitive activities will generally not be provided for in plans or given resource consent.

28 In the following paragraphs I describe Transpower's support for a corridor management approach.

CORRIDOR MANAGEMENT

The reasons for transmission corridors

29 A transmission corridor around transmission lines has 4 important purposes:

29.1 The first reason is to manage reverse sensitivity effects. These occur (as **Mr Spargo** explains) when a person moves next door to, or carries out an activity next to, an existing line or structure and seeks to put constraints on the line or structure because of its effects. These effects can include noise (especially in damp weather), reduced amenity, radio

4 Paragraph 11.6.

and television interference and effects from electric and magnetic fields from the lines. All of these effects have significant cumulative potential which may lead to requests for constraints on existing lines.

29.2 The second reason is to ensure that sensitive activities such as residential development, schools, childcare and hospitals are generally not provided for near structures and lines. This is the purpose for which the NPSET requires corridors.[5]

29.3 Thirdly, as described by **Mr Youngman**, electricity transported at high voltages, (and even electricity transported at a lower 50kV voltage[6]) can cause serious, or even fatal, injuries to people who come close to them. Structures and earthworks too close to a line can affect the stability of that line, and contribute to electricity outages. The presence of these structures can also increase the need for, and thereby risk associated with mobile plant (cranes, trucks etc.) breaching safe electrical distances and coming into contact with lines.

29.4 The fourth reason for a transmission corridor is that a relatively clear area gives line workers easier access to the line and structures for maintenance and operational requirements.

30 **Appendix C** to this evidence is a report by economist Mr Mike Copeland, which assesses the benefits and costs of Transpower's corridor management approach.

Transmission corridors in Horowhenua

31 Transpower has been seeking corridor provisions in District Plans since 1996. Transpower is continually looking for ways to improve its corridor management approach and ensure consistency with the NPSET. This continual improvement has benefited from the involvement in various resource consent applications nationally.

32 The transmission corridor width (and supporting rule framework) needs to be wide enough to ensure the following:

32.1 The integrity, operation and maintenance of the transmission lines;

32.2 Management of factors such as amenity and reverse sensitivity;

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5 Policy 11.

6 None of the lines in Horowhenua operate at this lower voltage.

32.3 People and property along the length of the lines recognise both the scale and strategic nature of the resource;

32.4 Anticipated future operational requirements; and

32.5 Sensitive activities are avoided where possible.

33 Certain activities are compatible with the efficient operation and maintenance of the electricity transmission network. The transmission corridors and planning rules proposed will allow compatible land use activities but restrain other incompatible ones. I note that the Officer's Report accepts this concept[7], for example through rule 19.6.14 and by retaining the existing policy 2.5.16 without modification. **Mr Spargo** has identified some amendments to rule 19.6.14 in order to provide more focus on land use and activities requiring management, and I support **Mr Spargo's** suggested refinements.

34 The transmission corridors that Transpower is proposing are the minimum corridors able to achieve the majority of these outcomes. The proposed corridors do not, however, fully address such matters as amenity and reverse sensitivity and consequently further consideration is necessary of urban design, integrated management and prudent avoidance. Transpower acknowledges that beyond the minimum corridor, councils may wish to impose additional controls. Councils' responsibilities are wider than Transpower's, and include obligations in relation to amenity and integrated planning (in addition to giving effect to the NPSET).

Reverse sensitivity

35 The presence of a transmission line can influence audible noise, perceived health concerns and visual amenity some distance from the line. Likewise, routine maintenance of transmission lines results in activities that affect some activities more than others. In addition to general complaints arising from the presence of a new activity, this effect can be expressed as a desire to underground existing overhead lines, and restrictions on future works, particularly where changes in visual appearance are involved. Although the distances that these effects are experienced at vary according to the type of effect, they are most noticeable in the area Transpower is suggesting as the National Grid Corridor.

36 By way of example, in 2007 Transpower undertook to increase the capacity of the existing Henderson-Otahuhu transmission line by increasing the current flowing through the lines to its rated capacity of 986MVA. This increase in capacity to that which the line is (and always has been) capable of was necessary to ensure that the electricity supply to customers north of Auckland was secure,

7 Pages 147-151.

particularly during times of forced outage. This did not involve any physical changes to the transmission lines, towers or conductors and did not change visual appearance in any way. The consent application was notified by Auckland City Council and attracted some 350 submissions. Those submitters who lived close to the line were primarily concerned about the potential health effects that any increase in current would have, but also expressed concern around likely electrical interference (primarily a fuzzy television picture). Submitters who lived further away from the transmission line, sought to have the line relocated or undergrounded. Over the course of proceedings, the Council heard evidence from submitters and expert witnesses on perceived health effects, noise, safety, (including the integrity of conductor joints), alternative transmission options, and electrical interference. Resource consent was granted by Auckland City Council, and appealed to the Environment Court at considerable cost to all involved.

Rationale for corridors sought

37 Transpower requests that the corridor provisions apply to its existing assets. If any new lines are required in the future, Transpower would designate these new lines, and secure easements from landowners, so that no corridors would be required. However, Transpower does not currently have any plans for new lines or substations in the District.

38 **Mr Youngman's** evidence discusses the rationale for the specific corridors sought by Transpower. As he explains, the main components underlying the approach are:

38.1 It is asset specific depending upon the line, support structures and voltage;

38.2 There are two parts to the corridor rules:

(a) The National Grid Corridor (or Red Zone) applies to land requiring a greater degree of regulation recognising the risks and constraints. Sensitive activities should be avoided within this area, and new buildings and earthworks should only be allowed where it can be shown that operation and maintenance of the line will not be compromised. The Corridor ensures there is sufficient physical space to carry out maintenance activities; and

(b) The corridor is complemented by subdivision rules which require that any future building platforms are located outside of the Corridor and can comply with

NZECP34:2001. In Horowhenua District, these rules were introduced by Plan Changes 20-22.[8]

38.3 In the areas with no underbuild, there is a greater ability to achieve the outcomes sought through avoidance; and

38.4 The rules will assist with NZECP34:2001 compliance, by raising awareness of this Code of Practice.

39 The lines and the network are a physical and functional entity and not just an isolated physical resource that bisects a particular plot of land, a particular zone or even a particular district. The standard corridor widths advocated by Transpower, based on asset type, overcome these issues. They recognise the broad characteristics of the assets in the District, and will also provide the benefit of greater certainty to those administering and seeking consent under the District Plan.

RELIANCE ON NZECP34:2001 ALONE NOT ENOUGH

40 Federated Farmers have suggested in submissions that compliance with NZECP34:2001 is sufficient, and a buffer corridor is not required. Transpower's view is that reliance on NZECP34:2001 alone will not fulfil the Council's obligation to give effect to the NPSET.

41 NZECP34:2001 seeks to protect persons, property, vehicles and mobile plants from harm or damage from electrical safety hazards by setting out minimum safe electrical distances. However, as discussed by **Mr Youngman**, it does not address the other electrical safety hazards and the potential effects of the line on activities in close proximity to the line. Further, it does not protect the integrity of the National Grid from the effects of other activities, it does not control subdivision, it does not distinguish sensitive activities, and thereby does not prevent the types of inappropriate development contemplated by the NPSET from occurring. In short, it does not consider the environmental effects of activities on the National Grid, nor potential environmental effects of the National Grid on activities.

42 NZECP34:2001 does not provide an opportunity for the Ministry of Business, Innovation, and Employment (or Transpower) to be involved in consenting processes. At the consenting stage, unsafe or poorly designed developments can be screened and prevented. By comparison, Transpower only becomes aware of breaches of NZECP34:2001 once developments are in place, when the cost of mitigating the associated risk is usually very high.

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[8] Rules 19.7.1(a)(i), 19.7.2(f)(viii) and 19.8.15.

43 Even development that complies with NZECP34:2001 can constrain maintenance activities on lines (which can have consequential effects on safety) and can result in increasing the number of people potentially at risk and exposed to adverse effects. It is these effects that the NPSET requires be addressed in order to achieve sustainable management. NZECP34:2001 is unable to address these effects, and it is perhaps not surprising therefore that NZECP34:2001 is not referenced in the objective or any of the policies of the NPSET. Additional controls are required in the form of District Plan rules.

44 The transmission corridors do not replace the requirement to comply with NZECP34:2001 (as this is mandatory), although they do in some respects mirror and/or complement the requirements of that Code, and will raise awareness of it. This is an important step towards ensuring that the transmission lines can be safely and efficiently managed and operated, and that electrical safe distances are met. However, simply relying on NZECP34:2001 would fail to give effect to Policy 10 of the NPSET.

45 The Officer Report[9] concludes that rules regulating earthworks near transmission lines are unnecessary because they duplicate the requirements of NZECP34:2001. Transpower disagrees and considers these rules necessary and reasonable. They will promote integrated management of earthworks, buildings and activities near lines (rather than leaving aspects of these to be managed via disparate methods). Transpower's proposed rules would allow normal farming activities, while ensuring the environmental effects of earthworks (including quarries) are taken into account. The Proposed Plan already contains earthworks rules for particular Landscape Domains or near heritage structures.[10] The rules proposed by Transpower will be consistent with this.

RULES RELATING TO TREES

Tree Trimming

46 Transpower's submission sought a permitted activity condition to provide for trimming, felling and removal of vegetation and non-notable trees. As **Mr Youngman's** evidence explains, trees can create a hazard when they are too close to transmission lines.

47 The Officer Report has clarified[11] that the only rule in the Proposed Plan which restricts the trimming or felling of trees is Rule 19.6.27, which applies only to notable trees listed in Schedule 3. These listed notable trees do not appear to be near Transpower's lines in

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9 Pages 150-151.

10 See, for example, rules 19.1(t), 19.4.10(a)(v), 19.4.11(a)(ii), 19.5.3(a) and 19.6.12.

11 Page 115.

the Horowhenua District, and on that basis, Transpower is now comfortable that no new permitted activity rule is required. Transpower understands that the trimming or removal of any non-notable tree would be a permitted activity because it is not otherwise regulated in the Proposed Plan (in accordance with section 9 of the RMA).

Tree planting

48 Transpower also submitted in relation to the tree planting assessment criteria in the Proposed Plan,[12] seeking that the effects on the electricity transmission network of any tree planting within the transmission corridor be a new assessment criterion.

49 The Reporting Officer[13] disagreed with Transpower's submission, on the basis that the Electricity (Hazards From Trees) Regulations 2003 manages trees within the transmission corridor.

50 Transpower disagrees with the Reporting Officer, and continues to seek the new assessment criterion. The assessment criteria already require the consideration of effects on utilities, including the shading and ice on the roads and the maintenance of level crossing sight lines. These safety considerations are of the same nature as those which Transpower seeks to be considered through its proposed amendments. Furthermore, reliance on the Electricity (Hazards From Trees) Regulations 2003 is akin to the "ambulance at the bottom of the cliff" approach – it requires the trimming of trees which grow too close to lines, but it does not prevent those trees being planted in the first place. The amendment to the Proposed Plan suggested by Transpower would promote a proactive and integrated approach to the management of land, avoiding the need to take remedial steps in the future.

CONCLUSIONS

51 The electricity transmission network is critical to Horowhenua District's social and economic wellbeing and the NPSET requires that to be recognised in the District Plan. Transpower needs to be able to operate and maintain its transmission infrastructure in order to enable Horowhenua's community to have a sustainable, secure, safe and efficient supply of electricity to homes, workplaces, schools, neighbourhoods and elsewhere.

52 Transpower supports the District Plan provisions recommended in the Officer's Report (with the amendments suggested by **Mr Spargo**) because they will guide future development of the District in a way which takes into account both the transmission

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12 Assessment Criteria 25.2.4.

13 Page 194.

infrastructure and other natural and physical resources. Transpower considers that the Proposed Plan strikes the appropriate balance.

Steven Taylor
3 May 2013

APPENDIX A – MAP OF TRANSMISSION ASSETS

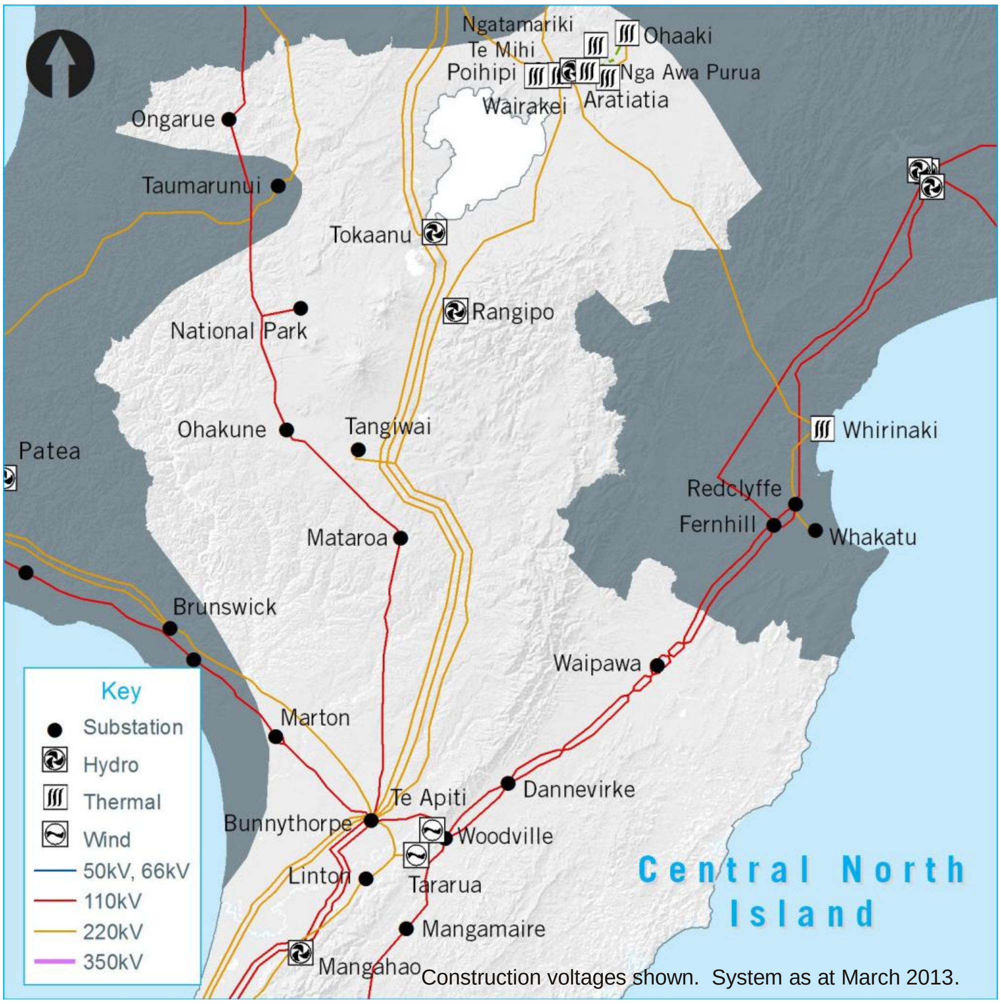
APPENDIX B – CENTRAL NORTH ISLAND REGION CHAPTER OF THE TRANSPOWER 2012 ANNUAL REPORT

11 Central North Island Regional Plan

11.1 Regional overview

This chapter details the Central North Island regional transmission plan. We base this regional plan on an assessment of available data, and welcome feedback to improve its value to all stakeholders.

Figure 11-1: Central North Island region



The Central North Island region includes a mix of grid exit points, from the large load at Palmerston North and environs (supplied from Bunnythorpe and Linton) to numerous medium to small loads. There is also a large industrial load at Tangiwai.

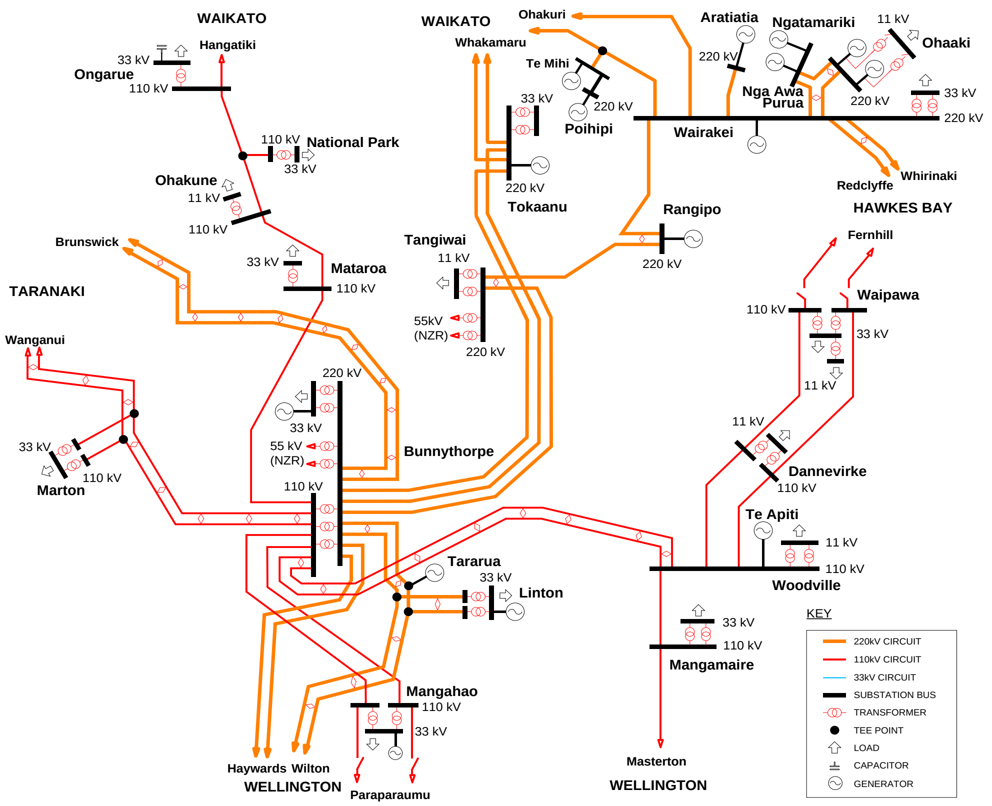
We have assessed the Central North Island region's transmission needs over the next 15 years while considering longer-term development opportunities. Specifically, the transmission network needs to be flexible to respond to a range of future service and technology possibilities, taking into consideration:

- the existing transmission network
- forecast demand
- forecast generation
- equipment replacement based on condition assessment, and
- possible technological development.

11.2 Central North Island transmission system

This section highlights the state of the Central North Island regional transmission network. The existing transmission network is set out geographically in Figure 11-1 and schematically in Figure 11-2.

Figure 11-2: Central North Island transmission schematic



11.2.1 Transmission into the region

The Central North Island region comprises 220 kV and 110 kV transmission circuits with interconnecting transformers located at Bunnythorpe. The direction of power flow through the region, north or south, is set by generation and loads outside the region.

All the 220 kV circuits form part of the grid backbone. The 110 kV transmission network is mainly supplied through the 220/110 kV interconnecting transformers at Bunnythorpe, plus low capacity connections to other regions.

The Central North Island region is a main corridor for 220 kV transmission circuits through the North Island. The 220 kV transmission system connects Bunnythorpe from the south, and Wairakei and Tokaanu from the North.

There is an approved project to replace the 220 kV single circuit Wairakei–Poihipi–Whakamaru line connecting to the Waikato region with a double-circuit line.

Most of the Central North Island's generation capacity is connected to the 220 kV and is significantly in excess of the local demand. Surplus generation is exported over the National Grid to other demand centres.

11.2.2 Transmission within the region

The 110 kV transmission system within the Central North Island region mainly consists of low-capacity circuits. The transmission system may impose constraints under certain operating conditions. Operational measures taken to ensure the 110 kV circuits operate within their thermal capacity are:

- normally splitting the 110 kV system at:
  - Waipawa, for the Fernhill–Waipawa circuits, and
  - Mangahao and Paraparaumu, for the Mangahao–Paraparaumu circuits.
- managing generation output to avoid overloading of the 110 kV:
  - Bunnythorpe–Woodville circuits
  - circuits between Bunnythorpe and Arapuni (Waikato region), and
  - circuits between Bunnythorpe and Stratford (Taranaki region).

Special protection schemes are also used to automatically reconfigure the grid or reduce generation to ensure the circuits operate within their thermal capacity. Schemes that are normally in service are at Tokaanu and Woodville.

11.2.3 Longer-term development path

Longer-term development plans are being formed as part of the Lower North Island investigation.

The transmission development in this region will largely depend on the magnitude and location of future generation, and the commissioning of new generation in the region may bring forward the need for transmission investment. Possible upgrades include duplexing the existing 220 kV lines, and rebuilding some of the 110 kV lines for 220 kV operation.

11.3 Central North Island demand

The after diversity maximum demand (ADMD) for the Central North Island region is forecast to grow on average by 1.1% annually over the next 15 years, from 333 MW in 2013 to 390 MW by 2028. This is lower than the national average demand growth of 1.5% annually.

Figure 11-3 shows a comparison of the 2012 and 2013 APR forecast 15-year maximum demand (after diversity[97]) for the Central North Island region. The forecasts are derived using historical data, and modified to account for customer information, where appropriate. The power factor at each grid exit point is also derived from historical data. See Chapter 4 for more information about demand forecasting.

[97] The after diversity maximum demand (ADMD) for the region will be less than the sum of the individual grid exit point peak demands, as it takes into account the fact that the peak demand does not occur simultaneously at all the grid exit points in the region.

Figure 11-3: Central North Island region after diversity maximum demand forecast

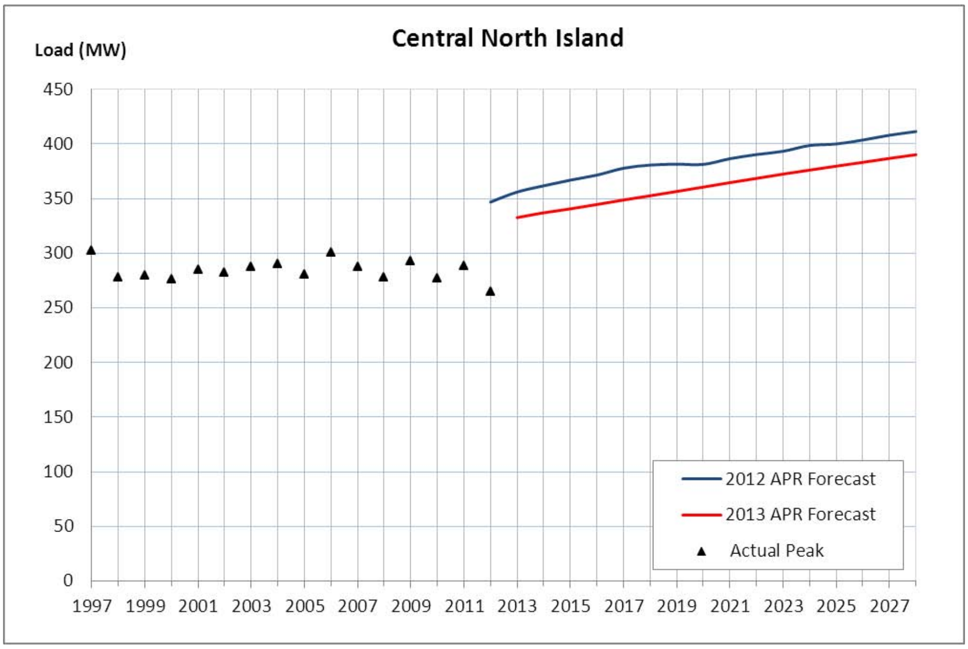


Table 11-1 lists forecasts peak demand (prudent growth) for each grid exit point for the forecast period, as required for the Grid Reliability Report.

Table 11-1: Forecast annual peak demand (MW) at Central North Island grid exit points to 2028

Grid exit point	Power factor	Peak demand (MW)										
		Next 5 years						5-15 years out				
		2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Bunnythorpe 33 kV	0.97	119	122	124	127	129	132	137	143	148	153	159
Bunnythorpe – NZR	0.79	8	8	8	8	8	8	8	8	8	8	8
Dannevirke	0.97	15	16	16	16	16	16	17	17	18	18	19
Linton	0.99	72	74	75	77	78	80	83	87	90	93	96
Mangamaire	0.97	12	12	13	13	13	13	14	14	14	15	15
Mangahao	0.95	44	44	45	46	46	47	48	50	51	53	54
Marton	0.97	17	17	18	18	18	18	18	19	19	20	20
Mataroa	0.98	8	8	8	9	9	9	9	9	10	10	10
National Park	0.98	8	8	8	9	9	9	9	9	10	10	10
Ohaaki	0.94	6	6	6	6	6	6	6	7	7	7	7
Ohakune[1]	0.98	11	9	10	10	10	10	11	11	12	12	13
Ongarue	0.98	11	11	11	11	11	11	11	12	12	12	12
Tokaanu	0.99	10	10	11	11	11	11	11	12	12	12	13
Tangiwai 11 kV[1]	0.98	44	47	47	48	48	49	50	51	52	53	54
Tangiwai NZR	0.81	10	10	10	10	10	10	10	10	10	10	10
Woodville	0.98	4	4	4	4	4	5	5	5	5	5	5
Waipawa	0.96	22	23	23	23	24	24	25	26	26	27	28
Wairakei	0.90	50	51	51	52	53	54	55	57	59	60	62

1. The customer advised a 2 MW load shift from Ohakune to the Tangiwai 11 kV bus planned for 2014.

11.4 Central North Island generation

The Central North Island region's generation capacity is 1,334 MW, increasing to 1,448 MW after the commissioning of Te Mihi geothermal power plants. This generation contributes a significant portion of the total North Island generation and exceeds local demand. Surplus generation is exported over the National Grid to other demand centres.

Table 11-2 lists the generation forecast for each grid injection point for the forecast period, as required for the Grid Reliability Report. This includes all known and committed generation stations including those embedded within the relevant local lines company's network (Powerco, The Lines Company, Scanpower, Centralines, or Electra).[98]

Table 11-2: Forecast annual generation capacity (MW) at Central North Island grid injection points to 2028 (including existing and committed generation)

Grid injection point (location if embedded)	Generation capacity (MW)										
	Next 5 years						5-15 years out				
	2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Aratiatia	78	78	78	78	78	78	78	78	78	78	78
Bunnythorpe (Tararua Wind Stage 2)	36	36	36	36	36	36	36	36	36	36	36
Linton (Tararua Wind Stage 1)	32	32	32	32	32	32	32	32	32	32	32
Linton (Totara Road)	1	1	1	1	1	1	1	1	1	1	1
Mangahao	42	42	42	42	42	42	42	42	42	42	42
Nga Awa Purua	140	140	140	140	140	140	140	140	140	140	140
Nga Awa Purua – Ngatamariki	82	82	82	82	82	82	82	82	82	82	82
Ohaaki	46	46	46	46	46	46	46	46	46	46	46
Ongarue (Mokauiti, Kuratau and Wairere Falls)	13	13	13	13	13	13	13	13	13	13	13
Poihipi	51	51	51	51	51	51	51	51	51	51	51
Rangipo	120	120	120	120	120	120	120	120	120	120	120
Tararua Wind Central – Tararua Stage 3	93	93	93	93	93	93	93	93	93	93	93
Tararua Wind Central (Te Rere Hau)	49	49	49	49	49	49	49	49	49	49	49
Te Mihi	166	166	166	166	166	166	166	166	166	166	166
Tokaanu	240	240	240	240	240	240	240	240	240	240	240
Wairakei	161	109	109	109	109	109	109	109	109	109	109
Wairakei (Hinemaiaia)	7	7	7	7	7	7	7	7	7	7	7
Wairakei (Rotokawa)	35	35	35	35	35	35	35	35	35	35	35
Wairakei (Te Huka)	23	23	23	23	23	23	23	23	23	23	23
Woodville – Te Apiti	90	90	90	90	90	90	90	90	90	90	90

11.5 Central North Island significant maintenance work

Our capital project and maintenance works are integrated to enable system issues to be resolved if possible when assets are replaced or refurbished. Table 11-3 lists the

98 Only generators with a capacity greater than 1 MW are listed. Generation capacity is rounded to the nearest megawatt.

significant maintenance-related work[99] proposed for the Central North Island region for the next 15 years that may significantly impact related system issues or connected parties.

Table 11-3: Proposed significant maintenance work

Description	Tentative year	Related system issues
Bunnythorpe interconnecting transformers expected end-of-life	2014-2016	Options for the replacement transformers are under investigation. See Section 11.8.1 for more information.
Bunnythorpe 33 kV outdoor to indoor conversion	2013-2014	The forecast load at Bunnythorpe will exceed the transformers' capacity from 2013. See Section 11.8.4 for more information.
Linton 33 kV outdoor to indoor conversion and supply transformer replacement	2017-2019 2013-2014	The forecast load at Linton will exceed the transformers' capacity from 2018. See Section 11.8.5 for more information.
Mangahao supply transformers expected end-of-life, and 33 kV outdoor to indoor conversion	2020-2022 2014-2016	Managing Mangahao generation can reduce the transformer's loading. See Section 11.8.6 for more information.
Marton supply transformers expected end-of-life	2023-2026	The forecast load will exceed the transformers' capacity from 2023. See Section 11.8.8 for more information.
Mataroa supply transformer expected end-of-life	2017-2019	No n-1 security at Mataroa. See Section 11.8.10 for more information.
National Park supply transformer expected end-of-life	2013-2015	No n-1 security at National Park. See Section 11.8.11 for more information.
Ohakune supply transformer expected end-of-life	2013-2015	The discussion on options to increase the supply security and transformer capacity is underway. See Section 11.8.12 for more information.
Ongarue 33 kV supply transformer expected end-of-life, and Ongarue 33 kV outdoor to indoor conversion	2025-2026 2017-2019	No n-1 security at Ongarue. See Section 11.8.13 for more information.
Wairakei supply transformers expected end-of-life	2024-2026	No system issues are identified within the forecast period.

11.6 Future Central North Island projects and transmission configuration

Table 11-4 lists projects to be carried out in the Central North Island region within the next 15 years.

Figure 11-4 shows the possible configuration of Central North Island transmission in 2028, with new assets, upgraded assets, and assets undergoing significant maintenance within the forecast period.

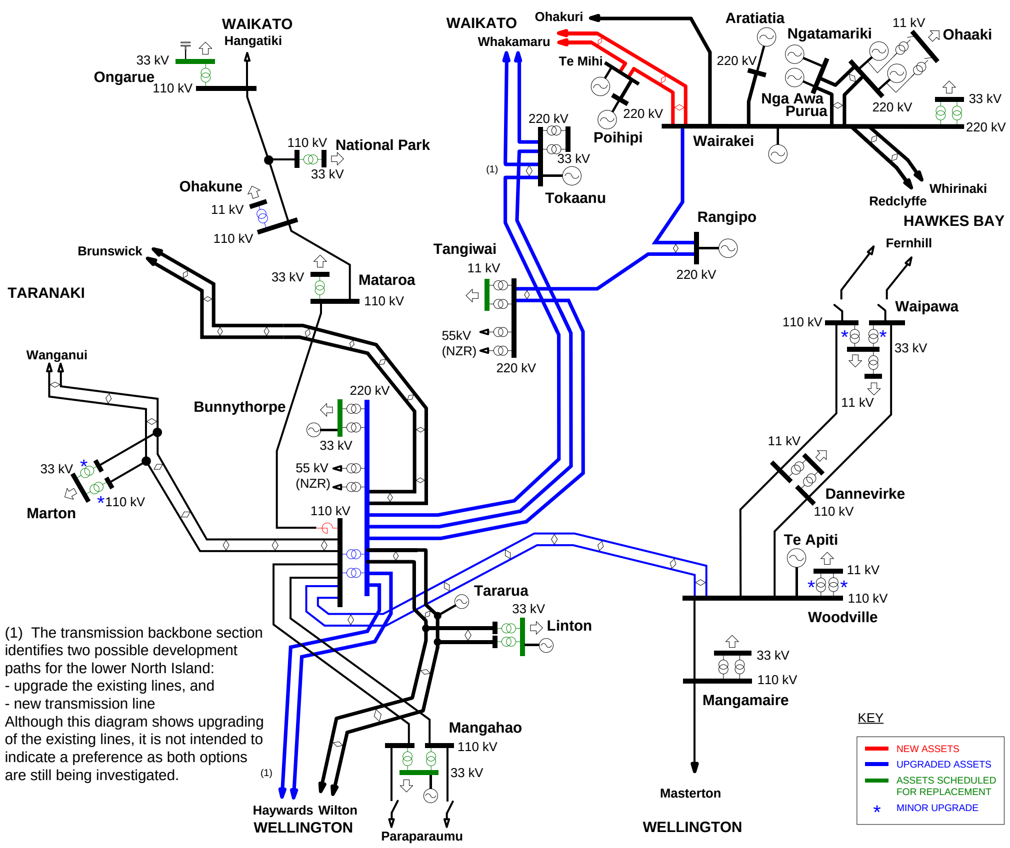
Table 11-4: Projects in the Central North Island region up to 2028

Circuits/site	Projects	Status
Bunnythorpe	Replace existing interconnecting transformers with two 150 MVA units. Convert 33 kV outdoor switchgear to an indoor switchboard. Rearrange the 220 kV bus configuration.	Possible Proposed Possible
Bunnythorpe–Haywards	Bunnythorpe–Haywards–A and B reconductoring.	Preferred
Bunnythorpe–Mataroa	Install a series reactor.	Possible
Bunnythorpe–Woodville	Upgrade the special protection scheme or reconductor the Bunnythorpe–Woodville circuit or convert the circuit's operating voltage.	Possible

[99] This may include replacement of the asset due to its condition assessment.

Circuits/site	Projects	Status
Linton	Convert the 33 kV outdoor switchgear to an indoor switchboard. Replace the supply transformer.	Proposed Proposed
Mangahao	Replace supply transformers. Convert the 33 kV outdoor switchgear to an indoor switchboard.	Proposed Proposed
Marton	Resolve the supply transformers' metering and protection limits. Replace the supply transformers.	Possible Proposed
Mataroa	Replace the supply transformer.	Proposed
National Park	Replace the supply transformer.	Proposed
Ohakune	Replace the supply transformer with a higher rated unit.	Possible
Ongarue	Replace the supply transformer. Convert the 33 kV outdoor switchgear to an indoor switchboard.	Proposed Proposed
Tangiwai	Replace the 11 kV switchgear.	Proposed
Haywards–Bunnythorpe–Tokaanu–Whakamaru	Increase the transmission circuit capacities.	Possible
Waipawa	Resolve the supply transformers' metering and protection limits.	Possible
Wairakei	Replace the supply transformers.	Proposed
Wairakei–Whakamaru	Build a new 220 kV double circuit transmission line and dismantle the existing 220 kV Wairakei–Whakamaru–B single circuit transmission line.	Committed
Woodville	Resolve the supply transformers' metering equipment limit.	Possible

Figure 11-4: Possible Central North Island transmission configuration in 2028



11.7 Changes since the 2012 Annual Planning Report

Table 11-5 lists the specific issues that are either new or no longer relevant within the forecast period when compared to last year's report.

Table 11-5: Changes since 2012

Issues	Change
Marton low voltage	New issue.
Mataroa and National Park low voltage	New issue.
Waipawa low voltage	New issue.
Woodville supply transformer capacity	New issue.

11.8 Central North Island transmission capability

Table 11-6 summarises issues involving the Central North Island region for the next 15 years. For more information about a particular issue, refer to the listed section number.

Table 11-6: Central North Island region transmission issues

Section number	Issue
Regional	
11.8.1	Bunnythorpe interconnecting transformer capacity
11.8.2	Bunnythorpe–Mataroa 110 kV transmission capacity
11.8.3	Bunnythorpe–Woodville 110 kV transmission capacity
Site by grid exit point	
11.8.4	Bunnythorpe supply transformer capacity
11.8.5	Linton supply transformer capacity
11.8.6	Mangahao supply transformer capacity
11.8.7	Marton low voltage
11.8.8	Marton supply transformer capacity
11.8.9	Mataroa and National Park low voltage
11.8.10	Mataroa supply transformer security
11.8.11	National Park transmission and supply transformer security
11.8.12	Ohakune supply security and capacity
11.8.13	Ongarue supply transformer security
11.8.14	Tokaanu supply transformer security
11.8.15	Waipawa low voltage
11.8.16	Waipawa supply transformer capacity and security
11.8.17	Woodville supply transformer capacity
Bus security	
11.9.1	Transmission bus security
11.9.2	Central North Island region low voltage

11.8.1 Bunnythorpe interconnecting transformer capacity

Project reference:	BPE-POW_TFR-EHMT-01
Project status/type:	Possible, Base Capex
Indicative timing:	2014-2016

Indicative cost band:	B

Issue

There are three interconnecting transformers at Bunnythorpe, each rated at 50 MVA, providing:

- a total nominal installed capacity of 150 MVA, and
- n-1 capacity of 116/125 MVA (summer/winter).

Loading on the Bunnythorpe interconnecting transformers may exceed their n-1 capacity for high Central North Island and Wellington loads, coupled with low local generation in Wellington.

Solution

This issue can be managed using operational measures by constraining:

- Mangahao generation on
- HVDC transfer to high north flow, or
- Central North Island regional load down.

The Bunnythorpe interconnecting transformers have an expected end-of-life within the forecast period. One option is to replace these with two 150 MVA transformers.

11.8.2 Bunnythorpe–Mataroa 110 kV transmission capacity

Project reference:	BPE_MTR–TRAN-EHMT-01
Project status/type:	Possible, Base Capex. This project is part of the lower North Island transmission capacity investigation.
Indicative timing:	To be advised
Indicative cost band:	A

Issue

The Bunnythorpe–Mataroa single circuit is rated at 57/70 MVA (summer/winter). This circuit can overload for some generation dispatch patterns such as high HVDC north power flow, high wind generation in the lower North Island, low Arapuni generation, and an outage of a 220 kV Huntly–Stratford, Stratford–Taumarunui, Bunnythorpe–Tokaanu, Tokaanu–Whakamaru or Rangipo–Wairakei circuit.

Solution

This issue can be managed operationally by limiting the HVDC north power flow, and/or increasing Arapuni generation, and/or opening the Arapuni–Ongarue circuit (leaving Ongarue, National Park, Ohakune, and Mataroa on n security).

A short-term option is automatically opening the circuit when it overloads.

Longer-term options are to reduce the power flow along the Bunnythorpe–Mataroa circuit by installing a series reactor, or increase the circuit's rating by reconductoring.

11.8.3 Bunnythorpe–Woodville 110 kV transmission capacity

Project reference:	BPE_WDV-TRAN-EHMT-01
Project status/type:	Possible, Base Capex. This project is part of the lower North Island transmission capacity investigation,
Indicative timing:	Special protection scheme upgrade: to be advised Circuit reconductoring or convert circuit's operating voltage: 2015-2020
Indicative cost band:	Special protection scheme upgrade: A Circuit reconductoring or convert circuit's operating voltage: to be advised

Issue

The Bunnythorpe–Woodville circuits are rated at 57/70 MVA (summer/winter). The loading on these circuits depends on the HVDC transfer direction and level, Te Apiti generation levels and the load in Wellington, Wairarapa, Dannevirke, and Waipawa. The circuits may overload for an outage of:

- one circuit overloading the remaining circuit during high south flow, or
- some 220 kV circuits between Bunnythorpe and Haywards, overloading the Bunnythorpe–Woodville circuits.

A special protection scheme at Woodville will prevent overloading for a Bunnythorpe–Woodville outage by:

- detecting an outage of a Bunnythorpe–Woodville 110 kV circuit causing overloading of the remaining Bunnythorpe–Woodville circuit
- opening the Mangamaire–Woodville circuit at Woodville to prevent through transmission, and
- removing Te Apiti generation if the overload on Bunnythorpe–Woodville remains.

Solution

The existing special protection scheme will resolve the issue caused by an outage of a Bunnythorpe–Woodville 110 kV circuit.

The overloading for a 220 kV circuit outage between Bunnythorpe and Haywards can be managed operationally by:

- restricting HVDC south power flow, and/or
- restricting Te Apiti generation, or
- opening either the 110 kV Mangamaire–Woodville circuit or the Mangamaire–Masterton circuit, leaving Mangamaire on n security.

Longer-term options, which do not require operational measures include:

- upgrading the existing special protection scheme to operate for a 220 kV circuit outage (also requiring a bus protection upgrade at Woodville)
- reconductoring the 110 kV Bunnythorpe–Woodville circuits with a higher rated conductor, or
- converting the Bunnythorpe–Woodville circuits to 220 kV operation.

11.8.4 Bunnythorpe supply transformer capacity

Project status/type:	This issue is for information only

Issue

Two 220/33 kV transformers supply Bunnythorpe's load, providing:

- a total nominal installed capacity of 166 MVA, and
- n-1 capacity of 100/100 MVA[100] (summer/winter).

The peak load at Bunnythorpe is forecast to exceed the transformers' n-1 winter capacity by approximately 14 MW in 2013, increasing to approximately 53 MW in 2028 (see Table 11-7). Tararua wind generation (Stage 2) is connected to the Bunnythorpe 33 kV bus, and the forecast assumes minimum generation of 7 MW coincident with the peak load.

[100] The transformers' capacity is limited by cable ratings; with this limit resolved, the n-1 capacity will be 101/106 MVA (summer/winter).

Table 11-7: Bunnythorpe supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						5-15 years out				
		2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Bunnythorpe	0.97	14	16	19	21	24	26	31	37	42	48	53

Solution

Increasing the transformers' cable limit will not solve the overload issue. In the short term, Powerco can transfer load within the distribution system to Linton following a contingency. We are discussing longer-term options with Powerco, which include:

- load transfer to Linton (see Section 11.8.5), and
- a third supply transformer at Bunnythorpe.

We have also discussed with Powerco conversion of the Bunnythorpe 33 kV outdoor switchyard to an indoor switchboard. Future investment will be customer driven.

11.8.5 Linton supply transformer capacity

Project status/type:	This issue is for information only

Issue

Two 220/33 kV transformers (rated at 60 MVA and 100 MVA) supply Linton's load, providing:

- a total nominal installed capacity of 160 MVA, and
- n-1 capacity of 77/81 MVA (summer/winter).

The peak load at Linton is forecast to exceed the transformers' n-1 winter capacity by approximately 1 MW in 2020, increasing to approximately 14 MW in 2028 (see Table 11-8). Tararua wind generation (Stage 1) is connected to the Linton 33 kV bus, and the forecast assumes minimum generation of 7 MW coincident with the peak load.

Table 11-8: Linton supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						5-15 years out				
		2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Linton	0.99	0	0	0	0	0	0	1	4	7	11	14

Solution

Linton normally has two 100 MVA transformers, but one failed and has been temporarily replaced with a 60 MVA transformer. We will discuss options with Powerco, which include:

- retaining the 60 MVA transformer permanently, and using operational measures to manage the overload, and
- replacing the 60 MVA transformer if load is transferred from Bunnythorpe (see Section 11.8.4).

We will also discuss with Powerco converting the Linton 33 kV outdoor switchyard to an indoor switchboard. Future investment will be customer driven.

11.8.6 Mangahao supply transformer capacity

Project status/type:	This issue is for information only

Issue

Two 110/33 kV transformers supply Mangahao's load, providing:

- a total nominal installed capacity of 60 MVA, and
- n-1 capacity of 37/39 MVA (summer/winter).

The peak load at Mangahao is forecast to exceed the transformers' n-1 winter capacity by approximately 9 MW in 2013, increasing to approximately 20 MW in 2028 (see Table 11-9). The Mangahao generation station is connected to the 33 kV bus, and the forecast assumes that Mangahao is not generating during peak load periods.

Table 11-9: Mangahao supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						5-15 years out				
		2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Mangahao	0.95	9	10	11	11	12	13	14	16	17	19	20

Solution

If Mangahao generates at 20 MW or more, this issue could be delayed beyond the forecast period. The supply transformer overload is managed operationally as Mangahao generation is usually available during peak load periods.

We will also convert the Mangahao 33 kV outdoor switchgear to an indoor switchboard within the next five years. In addition, both Mangahao supply transformers will approach their expected end-of-life within the next 5-10 years. We will discuss with Electra and Todd Energy the timing and options for these works. Future investment will be customer driven.

11.8.7 Marton low voltage

Project status/type:	This issue is for information only

Issue

The supply bus voltage at Marton is forecast to fall below 0.95 pu following an outage of a:

- Bunnythorpe–Marton–Wanganui circuit, or
- Bunnythorpe 110 kV bus section.

Marton has supply transformers with off-load tap changers.

Solution

This issue can be managed operationally by managing Taranaki generation and HVDC transfer during peak load periods.

11.8.8 Marton supply transformer capacity

Project reference:	MTN-POW_TFR-EHMT-01
Project status/type:	Possible, Base Capex
Indicative timing:	2023
Indicative cost band:	A

Two 110/33 kV transformers (rated at 20 MVA and 30 MVA) supply Marton's 33 kV load, providing:

- a total nominal installed capacity of 50 MVA, and

- n-1 capacity of 20/20 MVA[101] (summer/winter).

The peak load at Marton is forecast to exceed the transformers' n-1 winter capacity by approximately 1 MW from 2023 (see Table 11-10).

Table 11-10: Marton supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						5-15 years out				
		2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Marton	0.97	0	0	0	0	0	0	0	0	1	1	1

Solution

Resolving the metering equipment limit will solve the transformers' n-1 capacity issue within the forecast period.

In addition, both Marton supply transformers will approach their expected end-of-life within the forecast period. We will discuss with Powerco the rating and timing for the replacement transformers. Future investment will be customer driven.

11.8.9 Mataroa and National Park low voltage

Project status/type:	This issue is for information only

Issue

Supply bus voltages at Mataroa and National Park are forecast to fall below 0.95 pu following an outage of a:

- Bunnythorpe–Mataroa–1 circuit, or
- Bunnythorpe 110 kV bus section.

Both grid exit points have supply transformers with off-load tap changers.

Solution

This issue can be managed operationally by constraining on generation at Arapuni.

11.8.10 Mataroa supply transformer security

Project status/type:	This issue is for information only

Issue

The load at Mataroa is supplied by a single 110/33 kV, 30 MVA supply transformer comprising three single-phase units, resulting in no n-1 security.

Solution

A spare on-site unit may be able to provide backup following a unit failure, with replacement taking 8-14 hours. However, this is an uncontracted spare, which may not be available when needed. Powerco considers the lack of n-1 security can be resolved operationally for the forecast period.

The Mataroa supply transformer is approaching its expected end-of-life within the next five years. We will discuss with Powerco the future supply options at Mataroa. Future investment will be customer driven.

[101] The transformers' capacity is limited by metering equipment, followed by an LV bushing limit (24 MWA) and a protection limit (25 MVA); with these limits resolved, the n-1 capacity will be 26/27 MVA (summer/winter).

11.8.11 National Park transmission and supply transformer security

Project status/type:	This issue is for information only

Issue

The load at National Park is supplied through a single 110 kV transmission circuit and a single 110/33 kV, 10 MVA supply transformer comprising three single-phase units, resulting in no n-1 security.

Solution

A spare on-site unit provides backup following a unit failure, with replacement taking 8-14 hours. Some load can also be backfeed through The Lines Company distribution system and they consider the lack of n-1 security can be resolved operationally for the forecast period.

The National Park supply transformer is also approaching its expected end-of-life within the next five years. We are discussing future supply options with The Lines Company to increase supply security. Future investment will be customer driven.

11.8.12 Ohakune supply security and capacity

Project reference:	OKN-POW_TFR-DEV-01
Project status/type:	Possible, customer-specific
Indicative timing:	2016, subject to agreement with The Lines Company
Indicative cost band:	A

Issue

The load at Ohakune is supplied by a single 110/11 kV, 10 MVA supply transformer comprising three single-phase units (currently with one on-site spare). This means Ohakune has no n-1 security, although the spare on-site unit provides backup following a unit failure (with replacement taking 8-14 hours).

The peak load at Ohakune is forecast to exceed the transformer's continuous capacity by approximately 2 MW in 2013. The overload will decrease when load is shifted to Tangiwai, increasing again to approximately 3 MW in 2028 (see Table 11-11).

Table 11-11: Ohakune supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						5-15 years out				
		2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Ohakune	0.98	2	0	0	1	1	1	2	2	2	3	3

Solution

The local lines companies, Powerco and The Lines Company, have not requested a higher security level at Ohakune. We are discussing long-term options, which include:

- using operational measures to constrain load within the transformer's rating
- the customer using diesel generation to remain within the transformer's rating, and
- installing a higher rated transformer.

In addition, the Ohakune supply transformer is approaching its expected end-of-life within the next five years. We will discuss the timing for the replacement transformer with the local lines companies. Future investment will be customer driven.

11.8.13 Ongarue supply transformer security

Project status/type:	This issue is for information only

Issue

The load at Ongarue is supplied by a single 110/33 kV, 20 MVA supply transformer comprising three single-phase units, resulting in no n-1 security.

Solution

Most load can be backfed through The Lines Company's distribution system. The Lines Company considers the lack of n-1 security can be resolved operationally for the forecast period.

We will also convert the Ongarue 33 kV outdoor switchgear to an indoor switchboard within the next 5-10 years. Also the Ongarue supply transformer will approach its expected end-of-life towards the end of the forecast period. We will discuss with The Lines Company the timing of the switchgear conversion work and transformer replacement options. Future investment will be customer driven.

11.8.14 Tokaanu supply transformer security

Project status/type:	This issue is for information only

Issue

The load at Tokaanu is supplied by a single 220/33 kV, 20 MVA supply transformer, with a second transformer that can be manually switched into service when required. This means that Tokaanu does not have seamless n-1 security. Tripping the on-load transformer will result in a loss of supply until the other transformer is manually switched into service.

Solution

The Lines Company considers the lack of n-1 security can be resolved operationally for the forecast period. Future investment will be customer driven.

11.8.15 Waipawa low voltage

Project status/type:	This issue is for information only

Issue

Waipawa is normally supplied at 110 kV from Bunnythorpe via Dannevirke. The supply bus voltages at Waipawa are forecast to fall below 0.95 pu following an outage of a Waipawa–Dannevirke–Woodville circuit. In addition, this outage causes a step voltage change greater than 5%.

The Waipawa supply transformers and Bunnythorpe interconnecting transformers have off-load tap changers, so these transformers cannot be used to manage the voltage.

Solution

Replacing the Bunnythorpe interconnecting transformer with 150 MVA transformers with on-load tap changers (see Section11.8.1) will improve, but not eliminate the low voltage issue.

The Waipawa 110 kV disconnectors have recently been replaced with motorised disconnectors. Therefore, if low voltage occurs, the load can be quickly transferred from the Central North Island to the Hawkes Bay region.

In the longer-term, the 110/33 kV supply transformers can be replaced with transformers that have on-load tap changers. Future investment will be customer driven.

11.8.16 Waipawa supply transformer capacity and security

Project reference:	WPW-POW_TFR-EHMT-01
Project status/type:	Possible, Base Capex
Indicative timing:	2017
Indicative cost band:	A

Issue

Waipawa has loads at 33 kV and 11 kV. Two 110/33 kV transformers (rated at 20 MVA and 30 MVA) supply Waipawa's load, providing:

- a total nominal installed capacity of 50 MVA, and
- n-1 capacity of 26/26 MVA[102] (summer/winter).

The peak load at Waipawa is forecast to exceed the transformers' n-1 winter capacity by approximately 1 MW in 2017, increasing to approximately 5 MW in 2028 (see Table 11-12).

Table 11-12: Waipawa supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						5-15 years out				
		2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Waipawa	0.96	0	0	0	0	1	1	2	2	3	4	5

A single 33/11 kV, 10 MVA transformer supplies Waipawa's 11 kV load, resulting in no n-1 security.

Solution

Resolving the 110/33 kV transformers' metering and protection limits will delay the transformers' capacity issue for a few years. We will discuss with Centralines the future supply options for Waipawa.

Centralines considers the lack of n-1 security for Waipawa's 11 kV load can be resolved operationally within the forecast period. Future investment will be customer driven.

11.8.17 Woodville supply transformer capacity

Project reference:	WDV-POW_TFR-EHMT-01
Project status/type:	Possible, Base Capex
Indicative timing:	2023
Indicative cost band:	A

Two 110/11 kV transformers supply Woodville's 11 kV load, providing:

- a total nominal installed capacity of 20 MVA, and
- n-1 capacity of 5/5 MVA[103] (summer/winter).

[102] The transformers' capacity is limited by a metering limit, followed by protection and transformer bushing (27 MVA) limits; with these limits resolved, the n-1 capacity will be 29/30 MVA (summer/winter).

The peak load at Woodville is forecast to exceed the transformers' n-1 winter capacity by approximately 1 MW from 2023 (see Table 11-13).

Table 11-13: Woodville supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						5-15 years out				
		2013	2014	2015	2016	2017	2018	2020	2022	2024	2026	2028
Woodville	0.98	0	0	0	0	0	0	0	0	1	1	1

Solution

Resolving the metering equipment limit will solve the transformers' n-1 capacity issue within the forecast period.

11.9 Central North Island bus supply security

The 2013 APR has been expanded to include issues arising from the outage of a single bus section rated at 50 kV and above for the next 15 years.

Bus outages disconnect more than one power system component (for example, other circuits, transformers, reactive support or generators). Therefore, bus outages may cause greater issues than a single circuit or transformer outage (although the risk of a bus fault is low, being less common than a circuit or transformer outage).

11.9.1 Transmission bus security

Table 11-14 lists bus outages that cause voltage issues or a total loss of supply. Generators are included only if a bus outage disconnects the whole generation station or causes a widespread system impact. Supply bus outages, typically 11 kV and 33 kV, are not listed.

Table 11-14: Transmission bus outages

Transmission bus outage	Loss of supply	Generation disconnection	Transmission issue	Further information
Aratiatia 220 kV		Aratiatia		
Bunnythorpe 110 kV			Bunnythorpe–Woodville overloading	See note 1
Bunnythorpe 220 kV			Bunnythorpe–Woodville overloading	See Note 2
			Regional low voltage	11.9.2
Mangamaire 110 kV	Mangamaire			
Mataroa 110 kV	Mataroa			
Nga Awa Purua 220 kV		Nga Awa Purua		See note 3
		Ngatamariki		See note 3
Ohakune 110 kV	Ohakune			
Ongarue 110 kV	Ongarue			
Rangipo 220 kV		Rangipo		
Tokaanu 220 kV	Tokaanu			
Wanganui 110 kV	Marton			See note 4
Woodville 110 kV	Dannevirke			See note 5

[103] The transformers' capacity is limited by metering equipment; with this limit resolved, the n-1 capacity will be 13/14 MVA (summer/winter).

Transmission bus outage	Loss of supply	Generation disconnection	Transmission issue	Further information
	Waipawa			See note 5
	Woodville			
		Te Apiti		
Wairakei 220 kV		Aratiatia		See note 6
		Wairakei		See note 7

1. An outage of a Bunnythorpe 110 kV bus section will also disconnect a Bunnythorpe–Woodville circuit, which may overload the remaining circuit. A special protection scheme at Woodville will operate to remove the overload (see Section 11.8.3). The bus outage may also cause the supply bus voltage at Waipawa to fall below 0.95 pu. See Section 11.8.15 for options to address the low voltage at Waipawa.
2. An outage of a Bunnythorpe 220 kV bus section disconnects circuits to Haywards. This may cause both Bunnythorpe–Woodville circuits to overload, which is not prevented by the special protection scheme at Woodville (see Section 11.8.3).
3. Nga Awa Purua has a single bus, with a single connection to Ngatamariki. A bus outage at Nga Awa Purua will disconnect all generation at Nga Awa Purua and Ngatamariki.
4. Marton is supplied from the Bunnythorpe–Marton–Wanganui circuits. Because there is no bus zone protection at Wanganui (in the Taranaki region), a fault on the Wanganui 110 kV bus will disconnect both circuits, causing a loss of supply at Marton.
5. Dannevirke and Waipawa are normally supplied via the Waipawa–Dannevirke–Woodville circuits as a spur from Woodville. An outage of the Woodville 110 kV bus disconnects both circuits, causing a loss of supply.
6. Aratiatia is connected to Wairakei through a single circuit. A Wairakei bus outage that disconnects this circuit disconnects the Aratiatia generation station.
7. Following the commissioning of the Wairakei–Whakamaru–C line. A Wairakei bus outage will disconnect the Wairakei generation station.

The customers (Mighty River Power, Scanpower, Powerco, The Lines Company, or Centralines) have not requested a higher security level. If increased bus security is required, the options typically include bus reconfiguration and/or additional bus circuit breakers. Future investment is likely to be customer driven.

11.9.2 Central North Island region low voltage

Project reference:	BPE_BUSC–EHMT-01
Project status/type:	Possible, Base Capex
Indicative timing:	To be advised
Indicative cost band:	To be advised

Issue

Many of the supply transformers and the Bunnythorpe interconnecting transformers have off-load tap changers, so cannot be used to manage voltage. During periods of high Wellington load and low local generation, the supply bus voltages in the region are forecast to fall below 0.95 pu following an outage of the Bunnythorpe 220 kV bus section that disconnects the:

- 220 kV Bunnythorpe–Brunswick–1 circuit
- 220 kV Bunnythorpe–Haywards–2 circuit
- 220 kV Bunnythorpe–Linton–1 circuit
- 220 kV Bunnythorpe–Tokaanu–2 circuit
- 220/110 kV Bunnythorpe–T3 interconnecting transformer, and
- 220/33 kV Bunnythorpe–T10 supply transformer.

The low supply bus voltages may occur at Waipawa, Marton and/or Wanganui (in the Taranaki region), depending on system conditions.

In addition, the step voltage change for this outage will exceed 5% at some grid exit points.

Solution

Replacing the Bunnythorpe interconnecting transformer with 150 MVA transformers with on-load tap changers (see Section 11.8.1) will improve the supply bus voltages, but will also lower 220 kV voltages, which in turn restricts power transfer between Bunnythorpe and Wellington.

Rearranging the bus connections at Bunnythorpe and/or installing a fourth 220 kV bus coupler will provide n-1 bus security.

11.10 Other regional items of interest

There are no other items of interest identified to date beyond those in Section 11.8 and Section 11.9. See Section 11.11 for specific generation scenarios, proposals and opportunities relevant to this region.

11.11 Central North Island generation scenarios, proposals and opportunities

This section details relevant regional issues for selected generation proposals under investigation by developers and in the public domain, or other generation opportunities. The impact of committed generation projects on the grid backbone is dealt with separately in Chapter 6.

The maximum generation that can be connected depends on several factors and usually falls within a range. Generation developers should consult with us at an early stage of their investigations to discuss connection issues.

11.11.1 Impact of generation scenarios on regional plan

The generation scenarios (see Chapter 5) represent a series of possible future generation outcomes. This section presents only those scenarios relevant to <u>this region</u> for the next 15 years.

All of the generation scenarios anticipate substantial new geothermal generation in the next 5-10 years in the Wairakei ring area. See Section 11.11.2 for information about the opportunities for generation in the area.

Generation scenarios 1 to 4 anticipate substantial new wind generation connected at or near Linton. See section 11.11.4 for information about the opportunities for generation in the area.

Generation scenarios 1, 2 and 4 anticipate renewable generation connected in the central plateau region between Tangiwai and Rangipo. See Chapter 6, Section 6.4.5 for information about the opportunities for generation in the area.

None of the generation scenarios anticipates generation connected to the Central North Island 110 kV network but do anticipate generation in the 110 kV networks of the Wellington, Waikato and Taranaki regions. This generation may reduce the loading on the Bunnythorpe interconnecting transformers depending on the load and generation patterns.

11.11.2 Additional geothermal generation

There are a number of recently or soon-to-be commissioned geothermal generation developments in the region connecting into or near the Wairakei Ring. We are replacing the existing Wairakei–Poihipi–Whakamaru–1 circuit with a new overhead double-circuit line between Wairakei and Whakamaru. This will increase the power flow capacity through the Wairakei Ring (see Chapter 6, Section 6.4.3, for more information).

11.11.3 Tauhara geothermal station

Tauhara will connect into a 220 kV circuit from Wairakei to the Hawkes Bay region. Maungaharuru wind generation station, and Hawke's Bay wind stations) in the Hawkes Bay region will also connect to the same circuit (see Chapter 13, Section 13.11.3), which has enough capacity for the two generation connections.

There is potential for further geothermal generation development in the Tauhara area, as well as further wind and hydro generation development in the Hawkes Bay area. This additional potential generation will require Tauhara to be connected to both 220 kV circuits from Wairakei to the Hawkes Bay region, and a thermal upgrade of the circuits between Wairakei and Tauhara.

11.11.4 Additional wind generation connection to the 220 kV circuits between Bunnythorpe and Wellington

There are several investigations and proposals for wind station connections to the 220 kV double-circuit line between Bunnythorpe, Linton, and Wellington, which could occur at Linton or at new connection points along the line.

This is a high-capacity line and the effect of some additional generation on transmission capacity between Bunnythorpe and Wellington will be a small net percentage increase or decrease in transfer capacity, depending on the direction of power flow. A total of approximately 830 MW maximum generation injection into both the Bunnythorpe–Tararua Wind Central–Linton and Bunnythorpe–Linton 220 kV circuits will not cause system issues.

The wind generation resource under investigation is so large, however, that it is unlikely to be economical to connect it all to these 220 kV circuits because of transmission constraints.

11.11.5 Additional generation connected to the 110 kV buses

There are several possible wind generation sites close to the 110 kV transmission circuits that run from Mangamaire to Woodville, Dannevirke, and Waipawa. The capacity on the existing 110 kV Masterton–Mangamaire–Woodville and Bunnythorpe–Woodville circuits enables the connection of approximately 80 MW of additional generation, depending on where the generation is connected. Higher levels of generation may require occasional generation constraints or incremental and/or major system upgrades (including new lines).

11.11.6 Puketoi ranges

There are several prospective wind generation sites in the Puketoi ranges, with a combined capacity of many hundreds of megawatts. The closest network is the 110 kV transmission network (see Section 11.11.5), which is not nearby. If wind generation is developed in this area, then a single new transmission line may possibly connect all this wind generation to the National Grid at Bunnythorpe.

Generation from the Puketoi ranges can also connect along the 220 kV double-circuit line from Bunnythorpe to Wellington. However, care is required to ensure that the total generation from the Puketoi ranges, plus other generation along the 220 kV Bunnythorpe–Wellington line, does not become too high (see Section 11.11.4). It is also possible that some of the 110 kV lines may be rationalised as part of this work.

APPENDIX C – REPORT BY MR MIKE COPELAND

ASSESSMENT OF THE ECONOMIC BENEFITS AND COSTS OF USING TRANSPOWER'S CORRIDOR MANAGEMENT APPROACH TO GIVE EFFECT TO POLICIES 10 AND 11 OF THE NATIONAL POLICY STATEMENT ON ELECTRICITY TRANSMISSION IN DISTRICT AND CITY PLANS

Prepared for

Transpower New Zealand Limited

By

Michael Copeland

Brown, Copeland & Co Ltd

4 February, 2013

INTRODUCTION

Background

1 Territorial authorities (*TAs*) throughout New Zealand are required to give effect to the National Policy Statement on Electricity Transmission 2008 (*NPSET*) in their district and city plans as they come up for review or by way of a specific plan change.

2 The objective of the NPSET is:

> *To recognise the national significance of the electricity network by facilitating the operation, maintenance and upgrade of the existing transmission network and the establishment of new transmission resources to meet the needs of present and future generations, while:*
>
> - *managing the adverse environmental effects of the network; and*
> - *managing the adverse effects of other activities on the network.*

3 Including provisions within district and city plans giving effect to the NPSET ensures that, in recognising the national and local economic and social significance of the electricity transmission network, the existing transmission assets within a district or city can be operated, maintained, replaced and upgraded efficiently. This provides a range of economic benefits at a national, regional and local (district or city) level. However such provisions in district and city plans may also give rise to economic costs.

4 Transpower New Zealand Limited (*Transpower*), as the owner and operator of the transmission system (or "National Grid"), is clearly an interested party when TAs give effect to the NPSET in district or city plan reviews or in proposed plan changes. Nationwide, Transpower is advocating for a corridor management (or "buffer" corridor) approach (*CMA*) to give effect to policies 10 and 11 of the NPSET. The key components of this approach are:

4.1 An 'inner corridor' ('red zone', 'transmission yard' or 'transmission setback') of either:

(a) 10-12 metres[1] either side of the centreline of a transmission line; or

(b) 12 metres around support structures.

[1] The size of the corridor relates to the asset type (including structure type and voltage).

4.2 For existing urban areas in this inner corridor, new buildings and structures and extensions to existing buildings and structures associated with residential and "sensitive" commercial and industrial activity – i.e. those activities which would lead to a number of people being located for long periods within the inner corridor - are generally not considered to be compatible with transmission activities and therefore require resource consent. However, existing buildings and structures are generally not affected and "non-sensitive" new activities would be accommodated via a permitted activity rule. Fences, small sheds and extensions to small sheds are considered to be "non-sensitive" and would be permitted;

4.3 For existing rural areas in this inner corridor, new milking sheds on dairy farms and other large buildings would require resource consent. Other agricultural and horticultural activities would be covered by permitted activity rules;

4.4 A further 'outer corridor' (or 'green zone') of 4-25 metres[2] either side of the inner zone within which all new buildings and structures are classified as "permitted activities" and do not require a resource consent. Outside of the district and city plans, these activities would need to comply with the New Zealand Electrical Code of Practice (NZECP34-2001).[3] Transpower is seeking an advice note be placed in plans in relation to compliance with NZECP-2001;

4.5 The assessment of subdivisions within the transmission corridor to ensure that their design and potential impact on transmission activities is avoided, remedied or mitigated, including by identifying a building platform outside of the 'inner corridor'; and

4.6 The control of earthworks, in particular around support structures, but also those earthworks that may affect the clearance distances between lines and the ground.

5 As noted, Transpower's CMA does not require the removal or modification of existing buildings and structures, subdivisions or earth formations but seeks to control future development in urban

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2 The size of the corridor relates to the asset type (including structure type and voltage).

3 NZECP34:2001 is a mandatory code of practice under the Electricity Act 1992 and which sets minimum safe distances from transmission lines to protect persons and property (including vehicles and mobile plant) from harm or damage from electrical hazards. The Code establishes clearance distances from transmission lines to buildings and structures, the ground, and other lines. It also restricts how close building, structures and excavations can occur to transmission poles and towers. The Code became mandatory in 2001, but an earlier version has been in existence for some time.

and rural/greenfields areas which may compromise the operation, maintenance, replacement or minor upgrading of its transmission network.

6 Also even within Transpower's proposed inner corridor, certain types of activities are classified as permitted activities and do not require a resource consent. These include buildings and structures less than 10 square metres and 2.5 metres in height where associated with sensitive activities, fences under 2.5 metres high, recreation, farming activities (for example, cropping, harvesting, grazing, ploughing, track maintenance and most farm buildings), mobile plant,[4] car parking and utilities including roads. Vegetation is also not restricted by the rules Transpower seeks, but it must comply with the Electricity (Hazards from Trees) Regulations 2003, under the Electricity Act 1992.

7 With respect to rural land, Transpower has had discussions with Federated Farmers of New Zealand and Horticulture New Zealand. It has been agreed that the majority of farming activities are non-sensitive, with the exception of milking sheds. Most low horticultural structures will also be permitted.

8 Some District and City Plans, prior to changes being made to give effect to the NPSET, already have included in them restrictions on activities under or near to transmission lines and other transmission facilities. In some instances, what Transpower is proposing is more permissive than the provisions contained in these operative plans.

9 The rules Transpower seeks in its CMA do not cover the authorisation of new transmission lines and facilities. For these, Transpower will obtain RMA approvals. It will still be required to negotiate access arrangements and compensation payments with affected land owners. Where there is no satisfactory outcome to these negotiations the provisions of the Public Works Act would continue to apply and this requires land owners to be paid compensation, including provision for injurious effects on associated business activities.

10 Transpower's CMA does not assign additional property rights to Transpower. The provisions in District and City Plans which Transpower is seeking will not influence existing or future access arrangements between Transpower and affected land owners.

Report Objective

11 This report examines, in a general sense, the nature and extent of the economic benefits and costs of Transpower's suggested solution to policies 10 and 11 of the NPSET (Transpower's CMA), recognising

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[4] Where covered by a district or city plan.

that the significance of the benefits and costs will vary from one district or city to another. This is because:

11.1 Whilst Transpower is seeking to apply a consistent CMA nationwide, there will be variations in the detail of provisions contained within each district or city council's proposed plan revisions or plan changes;

11.2 Some districts and cities within their operative district or city plans already have provisions restricting activities within transmission corridors, whilst others do not. For those districts or cities with existing provisions, the level of constraint on economic activities varies from one plan to the next;

11.3 The width of the transmission corridors sought by Transpower vary according to asset type. The asset types vary from one district or city to the next, as will the length of transmission corridors and the footprints of other transmission facilities within each district and city;

11.4 Each district and city will have a different mix of economic activity within the transmission corridors and that will be potentially affected by what Transpower proposes. For example, in some districts, rural activities will be those predominantly affected, but in other districts and cities, urban activities will be predominantly affected.

12 The intention is that this report will be of assistance in identifying and assessing economic benefits and costs of proposed provisions in district and city plans giving effect to the NPSET.

Report Format

13 This report is divided into 5 parts (in addition to this introductory section). These cover:

13.1 An executive summary;

13.2 A consideration of the relevance and interpretation of economic benefits and costs under the Resource Management Act 1991 (RMA);

13.3 The economic benefits of Transpower's proposed transmission CMA;

13.4 The economic costs of Transpower's proposed transmission CMA; and

13.5 Some overall conclusions.

SUMMARY OF REPORT

14 TAs throughout New Zealand are required to "give effect" to the NPSET.

15 The supply of electricity via Transpower's transmission system (the National Grid) is essential to the economic and social wellbeing of all New Zealand residents and businesses.

16 Transpower's transmission CMA recognises the national, regional and local economic and social significance of the National Grid and seeks to ensure it can be operated, maintained, upgraded and developed efficiently.

17 Transpower's transmission CMA does not cover the authorisation of new transmission lines or substations, although the significance of new infrastructure is recognised in the NPSET. Transpower will continue to be required to negotiate access arrangements for new lines with land owners as at present. Existing access arrangements are not affected by Transpower's transmission CMA.

18 Plan Changes giving effect to the CMA will provide a number of economic benefits including:

18.1 Reduced costs for inspection, operation, maintenance, replacement and upgrading of the National Grid;

18.2 Reduced electricity supply outages;

18.3 Improved safety to persons and property; and

18.4 Reduced process costs for Transpower.

19 The undergrounding of the transmission network is only in very limited circumstances a realistic alternative to overhead transmission lines. It is substantially more expensive, much less reliable because of the time taken to repair faults and still requires land use restrictions to enable access for emergency repairs and periodic maintenance. Land use activities will need to be restricted near underground cables, in order to protect them and allow access for maintenance and emergencies. Therefore undergrounding is not a realistic alternative to Transpower's transmission CMA.

20 Transpower's proposed transmission CMA will lead to economic costs to the extent landowners' flexibility of land use is restricted. However in assessing any such costs it is any loss of profits compared to the next best compatible alternative use that needs to be identified, not losses in revenue. There may also be "spill over" costs for the broader community to the extent there is a reduction in the overall level of economic activity, but not where economic

activity in one location is only transferred elsewhere within the local economy.

21 Potential economic costs arising from Transpower's transmission CMA will be limited in that:

21.1 Non-sensitive activities will generally still be permitted throughout the proposed transmission corridor areas. In urban areas these include commercial and industrial activities not involving persons being located for long periods within the inner corridor, site fences, small sheds, yards, parking, storage areas and landscaping. In rural areas non-sensitive activities include most agricultural and horticultural activities and buildings except milking sheds;

21.2 Only new development and alterations that expand the footprint or height of existing sensitive development will be restricted within the inner corridors;

21.3 Even within the inner corridors proposed by Transpower, consent for any land use, including sensitive land uses, can be applied for and may be granted; and

21.4 The Electricity Act and a number of operative district and city plans already have provisions, which restrict development under or near the National Grid. These limit the incremental economic costs of Transpower's proposed transmission CMA.

22 The specific provisions and the incidence of economic benefits and costs of Transpower's proposals to give effect to the NPSET in district and city plans will vary from one district or city to another. However having regard to the economic benefits and the limits on the extent of economic costs identified in this report, it is likely that Transpower's transmission CMA is consistent with economic wellbeing and the efficient and effective use of resources from a district (or city), regional and national viewpoint.

ECONOMICS AND THE RMA

Section 32 Analysis

23 Section 32(3) of the RMA requires councils in considering proposed changes to their district or city plans to examine:

(a) *The extent to which each objective is the most appropriate way to achieve the purpose of this Act; and*

(b) *Whether, having regard to their efficiency and effectiveness, the policies, rules, or other methods are the most appropriate for achieving the objectives.*

24. This examination is required to take into account the benefits and costs of proposed plan changes (section 32(4)(a)). Benefits and costs can be monetary or non-monetary (section 2). This report's identification of the economic benefits and costs and discussion of their likely significance is therefore relevant to a local authority's evaluation under section 32.

Community Economic Wellbeing

24 Economic considerations are intertwined with the concept of the sustainable management of natural and physical resources, which is embodied in the RMA. In particular, Part 2 section 5(2) refers to enabling "*people and communities to provide for their … economic ... well being*" as part of the meaning of "*sustainable management*", the promotion of which is the purpose of the RMA.

25 As well as indicating the relevance of economic effects in considerations under the RMA, section 5 also refers to *"people **and communities**"* (emphasis added), which highlights that, in assessing the effects of proposed changes to district or city plans, it is the impacts on the wider community and not just particular individuals or organisations, that must be taken into account. This is underpinned by the definition of *"environment"* which also extends to include people and communities. Economic effects include those having low probability but high impact.

Economic Efficiency

26 Part 2 section 7(b) of the RMA directs that, in achieving the purpose of the Act, all persons *"shall have particular regard to ... the efficient use and development of natural and physical resources"* which includes the concept of economic efficiency.[5] Economic efficiency can be defined as:

> *the effectiveness of resource allocation in the economy as a whole such that outputs of goods and services fully reflect consumer preferences for these goods and services as well as individual goods and services being produced at minimum cost through appropriate mixes of factor inputs.*[6]

27 More generally, economic efficiency can be considered in terms of:

27.1 Maximising the value of outputs divided by the cost of inputs;

27.2 Maximising the value of outputs for a given cost of inputs;

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5 See, for example, in *Marlborough Ridge Ltd v Marlborough District Council* [1998] NZRMA 73 at [86], the Court noted that all aspects of efficiency are "*economic*" by definition because economics is about the use of resources generally.

6 Pass, Christopher and Lowes, Bryan, 1993, *Collins Dictionary of Economics* (2nd edition), Harper Collins, page 148.

27.3 Minimising the cost of inputs for a given value of outputs; and

27.4 Minimising waste.

Viewpoint for Economic Assessment

28 An essential first step in carrying out an evaluation of the positive and negative economic effects of a proposal under the RMA is to define the appropriate viewpoint that is to be adopted. This helps to define which economic effects are relevant to the analysis. Typically a district or wider regional viewpoint is adopted and sometimes a national viewpoint might be considered appropriate.

29 For considering the economic effects of Transpower's transmission CMA to give effect to policies 10 and 11 of the NPSET in district or city plans, the district or city is the relevant community of interest, because the economic effects of the proposed plan provisions will largely (but not solely) impact on the residents and businesses in that district or city.

30 However, Transpower's transmission network assets within a district or city are part of the National Grid network throughout New Zealand and therefore their efficient operation, maintenance, development and upgrade is important to residents and businesses elsewhere in New Zealand, but particularly in adjacent and nearby districts. This implies a regional viewpoint is also relevant.

31 In addition, there are a number of reasons why a national viewpoint is also relevant:

31.1 Transmission system failures or delays in transmission capacity improvements can have cost implications for electricity consumers elsewhere on the network because of the elongated and cross-boundary characteristics of the National Grid;

31.2 Increased costs for Transpower are eventually passed on to all electricity consumers throughout the country because of Transpower's national average cost pricing model[7] and Transpower being subject to price control regulations under the Commerce Act;[8]

31.3 Transpower is a state owned enterprise (SOE) and therefore owned by all New Zealand residents and businesses;

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[7] See National Policy Statement on Electricity Transmission, Evaluation under Section 32 of the Resource Management Act; Ministry for the Environment; March 2008; (Section 3.1.2).

[8] See under Regulated Industries, Commerce Commission website (www.comcom.govt.nz/).

31.4 It is the "inter-connectedness" of the National Grid that has led to the preparation of the NPSET and the requirement that district and city plans give effect to the NPSET's provisions.

ECONOMIC SIGNIFICANCE OF ELECTRICITY SUPPLY AND THE NATIONAL GRID

National Electricity Supply[9]

32 The supply of electricity is essential to the economic and social wellbeing of all New Zealand residents and businesses. It provides essential services such as light and heating to homes as well as meeting some emergency needs. Most businesses are reliant on electricity for aspects of their operation and therefore the supply of electricity is essential for employment and economic prosperity at the national, regional and district or city levels.

33 Transpower is the SOE that has two main functions with respect to the operation and development of New Zealand's electricity system. Firstly, it is the owner and the operator of the high voltage electricity transmission system (the National Grid). In this capacity Transpower plans, builds, maintains, upgrades and operates the National Grid. Secondly, it provides co-ordination and security functions for the electricity system (the System Operator).

34 The National Grid is the physical link between generators, local lines businesses and 'direct connect' customers. It consists of approximately 11,800 kilometres of high voltage alternating current (HVAC) transmission lines and the high voltage direct current (HVDC) link which crosses Cook Strait by submarine cables, linking the South Island and North Island electricity systems. The National Grid also has 182 substations.[10]

35 The NPSET Evaluation under Section 32 of the RMA states:[11]

> *"Demand for electricity is increasing with population growth, rising incomes and new technology powered by electricity. The combination of growing demand and the need to provide electricity in environmentally sustainable ways gives increased importance to the improvement, upgrade and extension of the New Zealand electricity transmission network, or national grid."*

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9 Data and information in this section from Transpower New Zealand Limited Simplified Disclosure Prospectus; 17 August, 2012; and Transpower New Zealand Limited 2012 Financial Accounts.

10 Submission by Transpower New Zealand Limited on Whangarei District Council Proposed Plan Change 123A.

11 National Policy Statement on Electricity Transmission, Evaluation under Section 32 of the Resource Management Act; Ministry for the Environment; March 2008; (Executive Summary, page 10).

36 New Zealand's transmission network is regarded as narrow and longitudinal, with areas of demand (load) commonly some distance from the areas of significant generation. Consequently, the transmission network is essential in complementing generation to bring the power to where it is needed. Without the National Grid power stations would need to be built within or nearby areas of demand. This would prove to be extremely costly, resulting in significantly higher electricity prices and a reduction in New Zealand's economic competitiveness.

37 A particular feature of the National Grid, and a key benefit for a sustainable New Zealand, is its ability to provide New Zealanders with access to renewable generation. Typically, the remote areas of generation connected by the National Grid are renewable (e.g. hydro in the Lower South Island, wind in the Lower North Island, and hydro and geothermal in the Central North Island). This enables lower cost sources of electricity generation to be utilised and enables economies of scale in generation to be realised. It also lowers New Zealand's carbon emission liabilities.

38 Many of New Zealand's larger population centres are located in the North Island, while a significant amount of hydro generation is located in the South Island. Power flow tends to be from south to north during normal rainfall years, delivering power from the hydro generation in the South Island to the North Island through the HVDC link, which also balances demand between the islands.

39 Most of New Zealand's population is located in regions where local generation is well short of the local demand – for example Northland, Auckland, Bay of Plenty, Hawke's Bay, Wellington, Marlborough, Nelson and the West Coast. Even those regions which produce surplus power have major population centres distant from the sources of electricity supply (e.g. Hamilton in Waikato, Christchurch in Canterbury, Dunedin in Otago and Invercargill in Southland). Therefore most of the country's power requirements must be transported some distance to the points of demand for residential and commercial use. Without the National Grid, electricity prices for most consumers would be considerably higher.

40 Nearly two million New Zealand households and businesses purchase more than $6 billion of electricity annually. Of these, approximately:

40.1 1.7 million or 86% are residential consumers;

40.2 160,000 or 8% are commercial consumers;

40.3 75,000 or 4% are rural[12] consumers;

40.4 40,000 or 2% are industrial consumers.

About 34% of the total electricity consumed in New Zealand is purchased by residential consumers, 36% by industrial consumers, 25% by commercial consumers and 5% by rural consumers.[13]

41 Growth in national electricity demand is expected to average 1.7% per annum over the next 15 years.[14]

42 The value of Transpower's property, plant and equipment is listed in its 2011/12 financial accounts as $2,721 million, whilst capital work in progress in 2011/12 was valued at $1,288.6 million.

43 Transpower has a significant investment programme underway building new capacity and refurbishing and replacing existing assets. Current (August 2012) projections are for Transpower to spend between $4 billion and $5 billion over the next 10 years, with more than half of this (approximately $2.7 billion) spent in the next 5 years. Some of this work will involve Transpower building new transmission lines and facilities. Transpower's transmission corridor management approach will not facilitate investment in these new transmission lines and facilities. However, Transpower's proposed investment programme also includes replacement of existing lines and equipment and increasing the capacity of parts of the existing network, and this work will be facilitated by the protection of transmission corridors for existing lines and other transmission facilities.

44 Transpower recovers its transmission costs via line company charges. For domestic consumers, transmission charges represent around 8% of their total electricity bills or about 2.25 cents per kwh[15] and around 20% of their line charges. For larger consumers, transmission is a very much more significant component of line charges and a number of the country's major electricity consumers are supplied directly by the transmission system – e.g. the Tiwai Point aluminium smelter, the Kinleith Mill, and Glenbrook Steel.

45 Large consumers within each region, district or city include hospitals, ports, retail and business centres, agricultural product

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12 Agricultural, forestry and fishing.

13 Electricity Authority: http://www.ea.govt.nz/consumer/industry-overview/

14 Source: Annual Planning Report Incorporating the Grid Reliability Report and the Grid Economic Investment Report; Transpower New Zealand Limited; March 2012.

15 Based on data from Quarterly Survey of Domestic Electricity Prices, Ministry of Economic Development website 28 September, 2012.

processing plants and other industrial plants. Whilst the National Grid is important for all businesses and households, they are especially significant for these large consumers, who provide essential services and are the key drivers of employment, incomes and economic activity at the local, regional and national level.

46 The national, regional and district or city level economic benefits of the National Grid are significant, and Transpower's transmission CMA, designed to enable the efficient inspection, operation, maintenance, development and upgrade of the National Grid, will assist with the continuation of those benefits.

ECONOMIC BENEFITS OF TRANSPOWER'S TRANSMISSION CORRIDOR MANAGEMENT APPROACH

47 The key economic benefits of Transpower's transmission CMA are:

47.1 Reduced inspection, operation, maintenance, replacement and upgrade costs;

47.2 Reduced outages;

47.3 Improved safety to persons and property; and

47.4 Reduced process costs for Transpower.

Reduced inspection, operation, maintenance, replacement and upgrade costs

48 Nationwide Transpower spends around a significant amount each year on inspection and maintenance of its transmission lines. It also has additional capital expenditure costs for the replacement and upgrading of the existing transmission network. Such costs are recovered via line charges included in the electricity bills for residential and business customers.

49 Transpower's transmission CMA will help to prevent such costs from increasing. Inappropriate development within transmission corridors will add to costs by making inspection, operation, maintenance, development and upgrade work more difficult and therefore more expensive. These cost increases will eventually be passed through to residential and business electricity consumers via higher line charges.

Reduced outages

50 Under-building of transmission lines is a major risk to maintaining electricity supply from the National Grid. The more development and activity allowed within the corridors, the greater the frequency and risk of outage incidents and the severity of their costs.

51 Transpower's records show that "third-party incidents" (i.e. those relating to development or activities by parties other than Transpower or electricity consumers) resulted in supply interruptions equating to 311 MWh of electricity non-supply, nationally, over the period 1996 to 2006.[16]

52 For residential consumers, outages as a result of transmission failures are likely to be sufficiently brief to cause only minor inconvenience. However for business customers with high electricity reliance or consumption the costs can be more significant – either in terms of lost production or the requirement to invest in expensive back-up sources of electricity supply.

53 By way of example, for the approximate 2 month period between 18 March and 23 May 2006 there were 5 outages to transmission supply to Westpower's customers on the West Coast of the South Island. A survey by Westpower established that these 5 outages led to estimated losses totalling $352,000 for 32 out of 34 businesses surveyed. In addition, survey respondents had spent an additional $736,000 on back-up equipment to protect against losses from future outages.[17]

54 More significant transmission outages have occurred in Auckland. In 1998 the failure of Mercury Energy's 110 kV transmission cables lead to power supply to downtown Auckland being cut with an estimated long term economic cost equivalent to 0.1 to 0.3 per cent of New Zealand's Gross Domestic Product.

55 In 2009 electricity was cut to about 280,000 people in Northland and parts of Auckland when a forklift hit one of two transmission circuits whilst the other was out for maintenance. This outage caused New Zealand's only oil refinery at Marsden point to temporarily close.[18]

56 These transmission outages were not as a consequence of under-building of transmission lines, although, the 2009 outage may have been able to be avoided through design.[19] These outages give an indication of the significant costs that are incurred especially by industrial consumers when electricity supply outages occur.

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16 Source: Appendix I of *Further Guidance on Risks of Development Near High Voltage Transmission Lines*. From Ministry for Environment website: http://www.mfe.govt.nz/publications/rma/nps-electricity-transmission-further-guidance-jan2010/appendix1.html.

17 Dollar amounts in 2006 price terms. Source: Report on Survey Results into Economic Effect of Westpower Customer Power Outages between 18 March and 23 May 2006; Westpower Limited; July/August 2006.

18 See Auckland Council website – Natural hazards and emergencies; infrastructure failure.

19 Transpower's subdivision rules seek to address such issues through the design and layout.

Production runs must sometimes be halted, sales may be lost, raw materials and other inputs may be wasted and staff may need to be stood down for a period of time.

57 A transmission system outage may also cause an increase in the price of electricity. Depending on the location of the fault and the affected equipment, more pressure is placed on the remaining in-service parts of the transmission system. A reduction in the level of transmission equipment available to the electricity market could result in binding transmission constraints and, consequently, increased electricity prices.

58 Transpower faces increased costs in responding to outages both in its capacity as the owner and operator of the National Grid and in its capacity as the System Operator. It needs to respond to the fault to ensure the security of scheduling and dispatch is not compromised. Time is also taken to reassess the security of planned outage and commissioning work in light of the fault. Afterwards, Transpower, as the System Operator, reviews the circumstances surrounding events that have had a material impact on its operations to determine appropriate process improvements and other actions to reduce the likelihood and impact of a recurrence.[20]

59 Again all of Transpower's costs associated with transmission outages are eventually passed through to electricity consumers.

Improved safety to persons and property

60 Development near high-voltage transmission lines creates low probability, high consequence risks. Without the implementation of an adequate transmission management corridor, there is an increase in the probability and consequences of risks from:

60.1 Arcing, flashovers, earthing issues, and coming into direct contact with lines (e.g., TV aerials or water overflow pipes inducing current under the lines);

60.2 Acts of God (e.g., a conductor (line) may fall after a storm event, which could have significant effects if it occurred in a residential area);

60.3 Loss of power supply (e.g., an event in October 2009 where third party activity involving mobile plant carrying shipping containers came into contact with the Henderson-Otahuhu A 220kV line in Auckland resulting in the loss of supply to approximately 280,000 consumers);

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[20] See: *Further Guidance on Risks of Development near high voltage transmission lines*. From Ministry for Environment website: http://www.mfe.govt.nz/publications/rma/nps-electricity-transmission-further-guidance-jan2010/appendix1.html

60.4 Contact with lines, resulting in an operational fault or outage; and

60.5 Death or injury to line workers from more hazardous work places.[21]

61 The increases in the probability and consequences of these risks have both economic and non-economic dimensions. Greater risks to personal safety have potential costs from losses in wages, reduced output and private and public sector health costs. Greater risks to property have potential costs in terms of losses in wages, reduced output and replacement costs.

Reduced process costs for Transpower

62 Without provisions in district or city plans such as those being sought under the transmission CMA, Transpower will be faced with significant additional costs in relation to under-building and encroachment issues (particularly for high density residential development). These cover legal, consultant and staff costs relating to:

62.1 Reviewing and responding to notified consents, negotiating conditions and appealing decisions under the RMA. While these tasks will still be required with the transmission CMA in place, they are likely to be more efficiently performed as the effects on the National Grid will have been considered at the application stage;

62.2 More complex liaising and coordinating with property owners for access for machinery and staff to properties for transmission system inspection, repair, maintenance, replacement and upgrading activities;

62.3 Involvement in stop-work procedures under the RMA and non-compliance with NZECP34 under the Electricity Act;

62.4 Increased inspection costs and field officer costs because of greater risks of encroachment or other threats to transmission system operation; and

62.5 Increased risk of reverse sensitivity issues (e.g., more people living nearby, which leads to complaints about the operation of the grid, such as objections to resource consents,

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[21] See: *Further Guidance on Risks of Development Near High Voltage Transmission Lines*. From Ministry for Environment website: http://www.mfe.govt.nz/publications/rma/nps-electricity-transmission-further-guidance-jan2010/appendix1.html

requirements for electric and magnetic field (EMF) readings, or health and safety assessments).[22]

Undergrounding of transmission lines

63 The undergrounding of transmission lines is sometimes suggested as an alternative to Transpower's transmission corridor management approach. Whilst underground transmission cables have been used in New Zealand, this is for only a very small part of the National Grid. Undergrounding is substantially more expensive - up to 15 times the cost of overhead transmission lines depending upon capacity.[23]

64 Also underground cables are less reliable than overhead lines due to fault repairs taking a significantly greater time. For example, when the Auckland CBD blackout occurred in 1998 after four 110 kV underground cables failed in quick succession, the CBD was left without electricity for almost three weeks. Supply was eventually restored, not by repair of the faulty under ground cables, but by construction of a temporary overhead line.[24]

65 Finally, underground transmission cables still require restrictions on land use above and adjacent to the cable to enable access for vehicles and other plant and equipment to undertake repairs and periodic maintenance work.

ECONOMIC COSTS OF TRANSPOWER'S TRANSMISSION CORRIDOR MANAGEMENT APPROACH

66 Transpower's transmission CMA seeks to incorporate the objective and policies 10 and 11 of the NPSET into district and city plans with the purpose of providing economic (and other) benefits not just for Transpower, but also the general community made up of the residents and businesses of the district or city as a whole. However provisions in district and city plans giving effect to the transmission CMA may lead to costs for some individual landowners with property within the transmission corridors. In certain instances this could have additional "spill over" costs for the wider community.

67 This section of the report discusses the nature of these costs for affected individual landowners and the wider community and

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22 Source: Appendix I of *Further Guidance on Risks of Development Near High Voltage Transmission Lines*. From Ministry for Environment website: http://www.mfe.govt.nz/publications/rma/nps-electricity-transmission-further-guidance-jan2010/appendix1.html

23 Source: Statement of Evidence of Hugh Robert Kelsey Wildash re Applications for Resource Consent and Notices of Requirement by Transpower New Zealand Limited for the North Island Grid Update Project; 31 January, 2008.

24 Source: Statement of Evidence of Hugh Robert Kelsey Wildash in rebuttal re Applications for Resource Consent and Notices of Requirement by Transpower New Zealand Limited for the North Island Grid Update Project; 7 April, 2008.

identifies a range of factors which are likely to limit the significance of such costs as a consequence of Transpower's transmission CMA.

Economic costs from land use restrictions

68 Restrictions on land use arising from Transpower's proposed transmission corridor management approach will give rise to economic costs to the extent that landowners' flexibility of land use is affected. The significance of such costs will vary from one affected land owner to another. It should not be automatically assumed that because a particular activity cannot take place within transmission corridors the landowner is denied the opportunity of that particular activity. It may be possible to still locate new buildings and structures on the land holding outside of the transmission corridor and, if this is the case, it is only any additional costs associated with this alternative arrangement of activities that are economic costs of the transmission corridor management approach.[25]

69 Even where Transpower's transmission corridor management approach prevents a landowner from engaging in a particular activity, any loss of profits needs to be measured relative to the next best alternative compatible use of the land. For example, where vacant land within an inner transmission corridor is not permitted to be developed for commercial offices, the land could perhaps be used for car parking. The loss of profits in this example is the difference in return from these two activities and not the loss of profits as measured by the projected return from the commercial office development compared to the returns from the land remaining vacant.

70 From a broader "community" perspective displaced economic activity, as a consequence of provisions in a district or city plan protecting a transmission corridor, only leads to an economic cost if it is lost to the district or city. Transfers of economic activity (e.g. a new retail centre) from one landowner to another within the district or city, is not lost from a district or city perspective. Only to the extent the relocated economic activity is less efficient in its alternative location is there a cost from a community perspective. It is this loss in efficiency, not the value of the activity displaced, that needs to be assessed.

71 Also in assessing the significance of economic costs from restricting activities within transmission corridors it is necessary to focus on losses in profitability and not losses in revenue. Losses in revenue (or losses in the value of output or production) are overstatements

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[25] In certain situations it may be possible for Transpower and landowners to co-ordinate their respective requirements such that no relocation or loss of activity occurs. For example in the case of some horticultural land, routine maintenance work on transmission lines can be timed after harvesting of crops and before replanting commences.

of losses in economic wellbeing or economic efficiency. The production of goods and services requires inputs of labour, raw materials and other resources. It is only the loss in profits (or net economic benefits), which provides a measure of the reduction in economic wellbeing or economic efficiency as a consequence of provisions in district or city plans restricting activities within transmission corridors.

72 Reductions in revenue (or output or production), where it leads to a reduction in overall economic activity (e.g. expenditure, employment and incomes) within a local, regional or national economy may have associated with it reductions in economic welfare or economic wellbeing. These relate to for example reductions in economies of scale or increases in unemployment of resources (including labour). However such "spill over" effects depend upon the type of activity involved (e.g. constraints for use of rural residential lifestyle land on the edges of urban areas are unlikely to generate such effects). Also these effects will not arise where reductions in economic activity in one location are transferred elsewhere, rather than lost from the local, regional or national economy.

73 In assessing the significance of land use constraints as a consequence of Transpower's transmission CMA, any reductions in land values are a reflection of, and not in addition to, any reductions in profits. The change in property value effect does not materialise unless and until an owner sells the property. At this point there is a wealth loss to the seller, but no ongoing reduction in business profitability to be borne by the seller. The purchaser of the property gains by potentially having to pay a lesser price for the property but incurs the costs of the ongoing reduced profitability. From a community perspective the loss in land value "nets out". To include both the reduced profitability and the loss in land value would involve "double-counting" of the costs.

74 Any additional costs for land owners in terms of reductions in profitability (or property value reductions) need to be assessed in the context of the benefits in terms of more efficient provision of transmission services. Some of these benefits are in the form of cost savings to Transpower - e.g. reduced inspection, operation, maintenance, development and upgrade costs; some of the savings from reduced outages; some of the improved safety benefits; and reduced process costs for Transpower. Other benefits accrue directly to local residents and businesses - e.g. some of the savings from reduced outages; and some of the improved safety benefits. However even the benefits in the form of cost savings to Transpower are eventually passed through to local residents and businesses in the form of lower line charges.

75 At the national level, the summary of the costs and benefits of the NPSET's Section 32 report[26] shows benefits to Transpower alone of $10.0 million (and there are additional benefits to consumers, Government and others), and more than 3.5 times the additional costs to land owners of $2.7 million (and these additional costs also include additional consenting costs for land owners).

Factors limiting significance of economic costs

76 A number of safeguards are built into what Transpower is proposing to limit economic costs for affected land owners. These include:

76.1 The approach generally provides for non-sensitive permitted activities throughout the transmission corridor. In urban areas, these would include many commercial and industrial activities as well as site fences, small sheds, yards, parking, storage areas and landscaping. In rural areas, these would include the majority of rural buildings, paddocks, fencing (as high as deer fences) and landscaping.

76.2 The CMA relates to new development and alterations that expand the footprint or height of existing development within the transmission line corridors and buffer zones around transmission facilities (primarily for sensitive activities, and activities with a large footprint). The new provisions do not require the removal or reduction in footprint or height of existing development; and

76.3 The CMA proposed does not prohibit outright new development within transmission line corridors. Most rural activities would be permitted. Within the inner corridor (or red zone), new buildings and structures for sensitive activities require a non-complying activity consent. Within the outer corridor, only subdivision is affected – to ensure that the building platform is located outside of the inner corridor. In other words, consent can be granted to new development within the corridor where in particular circumstances: (i) the benefits of restricting new development within the corridor are not significant, and/or (ii) there are significant costs in restricting new sensitive development within the corridor.

77 In addition, a number of operative district and city plans already require consent for new development within transmission line corridors. For these districts and cities the provisions resulting from Transpower's proposed approach may not be significantly more onerous (and in some instances may be less onerous) than existing requirements.

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[26] National Policy Statement on Electricity Transmission, Evaluation under Section 32 of the RMA 1991; Ministry for the Environment, March 2008 (Table 16, page 58).

78 Also irrespective of any provisions contained in existing or future district or city plans, compliance with NZECP34:2001 is mandatory under the Electricity Act. This requires all buildings and structures to meet minimum electrical safety clearance distances from transmission lines and other transmission facilities. It is only the incremental economic costs from restrictions, over and above those imposed by NZECP34:2001 (and any contained in operative district or city plans), that are a consequence of the changes proposed by Transpower's transmission CMA.

CONCLUSIONS

79 Having regard to:

79.1 The economic significance of electricity supply and transmission services at the national, regional and district or city levels;

79.2 The economic benefits of Transpower's proposed transmission CMA in the form of reduced inspection, operation, maintenance, replacement and upgrade costs; reduced outages, improved safety; and reduced process costs for Transpower;

79.3 The various factors identified in this report which limited the extent of additional economic costs resulting from Transpower's proposed transmission corridor management; and

79.4 Transpower's proposed transmission CMA not facilitating new transmission line corridors or new sites for other transmission facilities;

Transpower's proposed approach is likely to be consistent with enabling "*communities to provide for their … economic ... well being*", and having regard to *"the efficient use and development of natural and physical resources"*. This is not to deny that in some circumstances it will impose costs on some individual landowners.