

# System Security Forecast 2010

## Part A

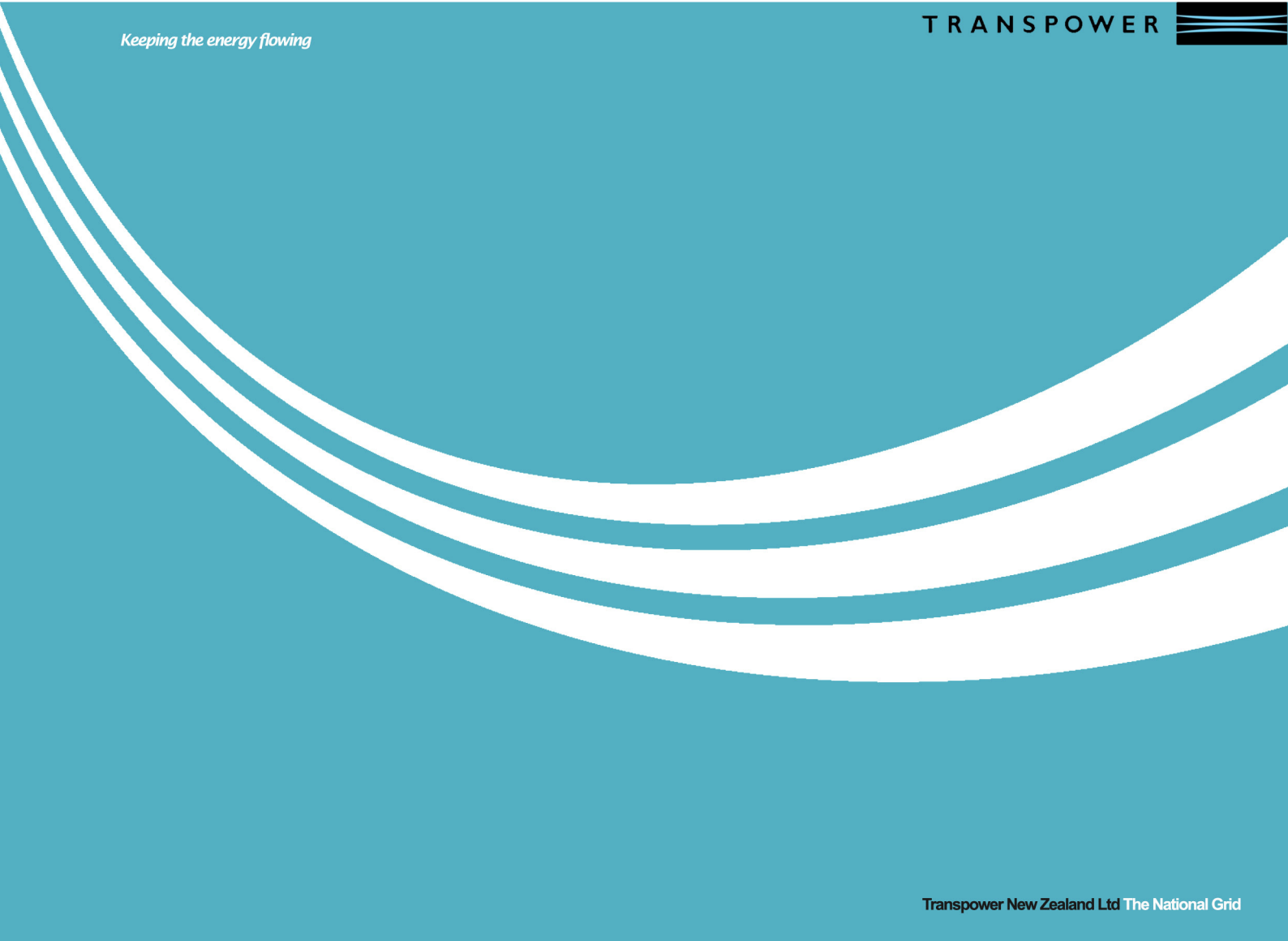
### Executive Summary



*Keeping the lights on  
24 hours a day, 7 days a week*



SYSTEM OPERATOR



*Keeping the energy flowing*

TRANSPOWER



# **I M P O R T A N T**

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## 1. FOREWORD

This is System Security Forecast (SSF) produced under the Electricity Industry Participation Code (the 'Code'). The three previous System Security Forecasts were produced in 2004, 2006 and 2008 under the Electricity Governance Rules (EGR's). The previous System Security Forecast was published on 1 December 2008 and was updated twice (in June 2009 and December 2009) to account for changes in the power system. This System Security Forecast supersedes the December 2008 System Security Forecast and the subsequent updates.

The preparation of this System Security Forecast has taken into account both the stated existing capabilities of the power system and new investment in transmission and generation that is extremely likely to go ahead. The System Security Forecast has not taken into consideration proposals for transmission and generation investment for which the timing and capability of the investment is yet to be confirmed.

The System Security Forecast indicates forecast demand that may not be able to be met in some specific geographical areas of the power system over the next 3 years. This is a consequence of only considering investment in transmission and generation that is most likely to go ahead. Additional generation and transmission assets will be required to meet forecast demand in future years.

It is expected that information in this SSF, along with other system adequacy publications under Part 12 of the 'Code', will help inform participants of the generation investment required to ensure the continued secure operation of the power system in future years. Transpower, as Grid Owner, will work through the regulatory processes to progress transmission upgrades. Collectively, future investment in generation and transmission should remove or alleviate many of the power system issues presented in this System Security Forecast.

All Transpower publications are available on Transpower's website [www.transpower.co.nz](http://www.transpower.co.nz). We welcome your feedback on the content, coverage and quality of the information to ensure that future editions are as useful and relevant as possible.



Dr Patrick Strange  
Chief Executive



## 2. ABOUT TRANSPOWER

Transpower New Zealand Ltd owns and operates New Zealand's high-voltage electricity transmission network - the *National Grid* – linking generators to distribution companies and major industrial users.

Electricity is an instant connection from source to switch. It can't be stored, so *Transpower* must ensure its lines deliver continuous volumes of electricity to wherever it's required throughout New Zealand. As *System Operator*, Transpower keeps the right amount of energy flowing, 24 hours a day, 7 days a week.

Transpower is a State-Owned Enterprise. The National Grid is Your Grid. Transpower is owned by the people of New Zealand and we are continually striving to ensure we meet the expectations of New Zealanders that they will have a safe, secure and continuous supply of electricity. Our country, our communities, our jobs, our houses, our families and our futures depend on it.

What we do impacts on every New Zealander. Transpower is enabling individual lifestyles, supporting local communities, connecting renewable sources of energy, and growing the national economy.

Within the New Zealand electricity industry, Transpower plays a central role and provides essential support services for the electricity market. Transpower works in collaboration with electricity generation and lines companies to ensure a bright future for all New Zealanders.

**More information on Transpower New Zealand Limited is available on its web site**

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## 3. EXECUTIVE SUMMARY AND SECURITY OVERVIEW

### 3.1 INTRODUCTION

The System Security Forecast (SSF) is a forecast of the System Operator's ability to meet the principal performance obligations over the next decade.

The Policy Statement sets out the policies and the means that are considered appropriate for the System Operator to observe in complying with the principal performance obligations. The SSF has been prepared using the Policy Statement as the framework for analysis.

The SSF uses the language of the Policy Statement to describe power system capability issues. For example, the Policy Statement provides that the System Operator will plan to meet certain quality targets and limits during, and following, the occurrence of a contingent event. An example of those targets is that no asset should exceed its stated capability.

This terminology may be new to readers unfamiliar with the Policy Statement but the interpretation is straightforward. Asset owners make statements to the System Operator regarding the capability of their assets (e.g. the rating of the asset, what voltage range the asset is capable of operating within). During and following a contingent event, the System Operator plans to ensure that no asset will exceed the capabilities stated by its owner (i.e. that no asset is left in an "overloaded" state after a credible event).

This SSF contains detailed analysis of shorter term capability (i.e. the next three years) to address the need of industry participants. This is inline with the processes developed under Part 12 of the 'Code' on transmission investment which have produced a number of public documents. These include the Electricity Commission's Statement of Opportunities and Transpower's Annual Planning Report. Collectively these reflect medium and long term power system capability issues, and the options for investment to enhance power system capability.



### 3.2 THE PRINCIPAL PERFORMANCE OBLIGATIONS

The principal performance obligations (PPOs) of the System Operator are:

- Part 7, clause 7.2 (1a) – Avoid Cascade Failure

Act as a reasonable and prudent System Operator with the objective of dispatching assets made available in a manner that avoids the cascade failure of assets. A cascade failure of assets results in the loss of demand may lead to frequency or voltage excursions and supply and demand imbalances.

- Part 7, clause 7.2 (1b) - Frequency

Act as a reasonable and prudent System Operator to maintain frequency during normal conditions and excursions to the targets set out in the 'Code' in order to manage frequency time error.

- Part 7, clause 7.2 (1c) - Maintain Other Standards

The System Operator will, at the reasonable request of any participant, identify the cause of the problem where the following standards are not being met at any point of connection to the grid, and take any action available to the System Operator under the 'Code' to resolve the problem. The standards referred to by this rule relate to the following:

- Harmonic levels (New Zealand Electrical Code of Practice - NZECP 36:1996)
- Voltage flicker levels (Australian Standard - AS2279.4:1991)
- Voltage imbalance of less than 1%

The System Operator manages the dispatch of assets made available to avoid cascade failure by applying power system capability limits to the operation of the power system. In cases where demand exceeds power system capability, the System Operator can still ensure the operation of the power system remains within power system capability by demand shedding prior to any event occurring. The *avoid cascade failure* and the *frequency* PPOs can always be met by ensuring that demand does not exceed the capability of the assets made available.

The System Operator can not guarantee that sufficient assets are made available by asset owners to meet demand now and in the future. At places where power system capability is not sufficient to meet demand, asset owners will need to invest in new assets, increase the capability of existing assets or make available assets that were not intended to be made available at that time to avoid the need to shed demand.

The System Security Forecast therefore considers the power system capability limits of the present power system (taking into account committed investments) and when forecast demand might exceed those limits.



### 3.3 REPORT STRUCTURE AND SUMMARY

The report is divided into five sections.

#### 3.3.1 PART B: APPROACH AND ASSUMPTIONS

##### 3.3.1.1 *Approach*

In this section, the core methodology and approach for the rest of the report is detailed.

##### 3.3.1.2 *Assumptions*

The assumptions used in the analysis are set out in this section.

#### 3.3.2 PART C: POWER SYSTEM SECURITY ANALYSIS

This section provides an analysis of North and South Island system adequacy and power system capability over the three year forecast period using the information in the 'approach and assumptions' section. It includes an analysis of the capability limits requiring operational management.

The North Island analysis considers Operational Issues for Supply into each of the eight power system regions in the North Island plus the HVDC link.

The South Island analysis considers Operational Issues for Supply into each of the four power system regions in the South Island.

#### 3.3.3 PART D: MANAGEMENT OF FREQUENCY

This section provides an analysis of the System Operator's ability to meet aspects of the principal performance obligations related to frequency over the three year forecast period.

#### 3.3.4 PART E: DRY YEAR OPERATIONAL ISSUES

This section provides information on power system constraints and mitigation measures in maximising power transfer from the North Island via the HVDC to help meeting South Island demand during a dry year.



### 3.4 KEY ASSUMPTIONS

The System Security Forecast makes assumptions about power system conditions now and in the future. The key assumptions are around:

#### 3.4.1.1 Demand

Two forecast demand periods are considered.

Short Term (one to three year forecast):

- The demand projections are based on historic trends. Expected and prudent forecasts are used.

#### 3.4.1.2 Generation

The studies assume all existing generating stations and those considered to be "committed investments" at 2 July 2010 will operate over the three year assessment period. Considerable amounts of new generation (including wind generation) have been proposed but have not reached the stage where the new generation can be considered committed. Power system capability limits assessed in the SSF will be significantly affected should these proposals go ahead.

#### 3.4.1.3 Power system configuration and asset capability

The base 'power system configuration' and 'asset capability' assumed in the analysis is that as at 2 July 2010 along with investment proposals that pass the committed investments test.

#### 3.4.1.4 System Operator's Policy Statement

The Policy Statement sets out the policies and the means that are considered appropriate for operating the power system. The Policy Statement provides the framework for the analysis carried out in the preparation of this System Security Forecast.

#### 3.4.1.5 Analysis

The performance of the power system during and following contingent events (as defined in the Policy Statement) is assessed and compared against the target quality conditions and limits. Power system load limits beyond which the target quality conditions and limits can be met are determined.



### 3.5 NEW ZEALAND SYSTEM SECURITY OVERVIEW

Power system analysis is undertaken to identify security issues and summarise the operational management measures that may need to be applied over the period from January 2011 to Dec 2013.

#### 3.5.1 MAJOR POWER SYSTEM CAPABILITY LIMITS

An overview of the areas of the power system where there is significant short term operational management is provided in this section. There are two large areas in the New Zealand power system where ongoing operational management of power system issues are currently required:

- Upper North Island. This area comprises the Auckland and North Isthmus regions. The issues are concerned with power transfer into the Upper North Island. The System Operator works with the Upper North Island Working Groups to manage summer and winter power system security issues
- Upper South Island. This area comprises the Canterbury, West Coast, and Top of South Island regions. The issues are concerned with power transfer into the Upper South Island from the Waitaki region

The following table shows indicative power system capability limits, operational measures and risk exposure for the Upper North Island and Upper South Island areas.

| Causing Factor   | Power System Limit Group | Power System Issue | Indicative Limit   | Operational Measures                              | Risk Exposure  |
|--|--------------------------|--------------------|--|---|--|
| <i>Loss of Otahuhu B generating unit</i>                             | Upper North Island       | Voltage Stability  | Upper North Island load limits to:<br><br><b>Present Grid Configuration</b><br>1928/2126 MW in summer/winter (pf 0.94/0.96)<br><br><b>Post Grid Upgrade1</b><br>2400/2657 MW in summer / winter (pf 0.94/0.96) | Load management, contracted voltage support plant | Prudent demand forecasts do not exceed power system capability         |
| <i>Outage of Otahuhu B generating unit and loss of Huntly unit 5</i> | Upper North Island       | Voltage Stability  | Upper North Island load limits to:<br><br><b>Present Grid Configuration</b><br>1739/1930 MW in summer/winter (pf 0.94/0.96)<br><br><b>Post Grid Upgrade</b><br>2197/2447 MW in summer/winter (pf 0.94/0.96)    | Load management, contracted voltage support plant | Prudent demand forecasts do not exceed power system capability         |
| <i>Loss of the Ashburton-Timaru-Twizel-1 or 2 220 kV circuit</i>     | Upper South Island       | Voltage Stability  | Upper South Island load limits to:<br><br>1160/1066 MW high / low gen (pf 0.94)  | Load management                                   | Summer: Prudent demand forecasts do not exceed power system capability |

1 Refer to the committed upgrade list in Upper North Island report, section 5.1.7 and 6.1.7.



The System Operator is also aware of a number of proposed investments that do not meet the committed investment tests but will alleviate the need for operational management or increase power system capability limits beyond forecast demand for the ten year period.

### 3.5.2 SIGNIFICANT POWER SYSTEM CAPABILITY LIMITS

This section presents an overview of the significant power system issues /capability limits applying over the period of three years from 2011 to 2013. A detailed discussion of power system limits is in the Security Analysis sections of Part C, a geographical and a schematic map of New Zealand's High Voltage Power System are provided in the Appendix, Part F. The following table sets out a summary of significant power system capability limits in the medium term.

| Causing Factor  | Power System Issue  | Power System Limit Group                                    | Operational Measures   | Comment  |
|---|---|---|--|--|
| <i>The loss of the Henderson-Southdown-1 220 kV circuit</i>   | Henderson-Otahuhu-1 220 kV circuit exceeds stated capability  | Top of the North Island                                     | Special protection scheme  | Power system capability limit on the Top of the North Island load is required  |
|   | Voltage instability   |   | Load management  |  |
| <i>The loss of the one of the 220 kV circuits between Redclyffe and Wairakei</i>                                | Grid voltages fall below advised asset capability<br>Redclyffe interconnecting transformers exceed stated capacity<br>Regional voltage collapse   | Hawkes Bay regional load                                    | Load management<br>Security constraints  | Enhancements in power system capability through investment or the employment of operational measures will be required to avoid demand curtailment at certain times when insufficient generation at Tuai and Whirinaki is available |
| <i>Steady state loading of Hawera-Stratford circuit</i><br><i>Loss of other circuits in the Taranaki region</i> | Circuits exceeding stated capability  | Power transfer from the Taranaki region                     | Short term ratings<br>Grid Owner offering the Hawera Automatic Bus Splitting Scheme and the Hawera reactor | The new circuit in October 2012 will alleviate this issue.   |
| <i>Loss of a Tokaanu-Whakamaru 220 kV circuit</i>   | Bunnythorpe-Mataroa 110 kV circuit exceed stated capability   | North power transfer from Bunnythorpe                       | Short term ratings   | Power system capability limits are required on transfer  |
| <i>Loss of the Dobson-Reefton-Inangahua-1 110 kV circuit</i>  | Voltage falls below advised asset capability  | West Coast (South Island) load                              | Load Management<br>Dispatch of local generation  | Power system capability limit on West Coast load is required. The limit depends on the amount of local generation output<br><br>Power system capability limit increases after the completion of West Coast grid Upgrade project.   |
| <i>Loss of a Clyde-Twizel 220 kV circuit</i>  | Dynamic Stability<br>Naseby-Roxburgh-1 220 kV circuit exceeds stated capability<br>Livingstone-Waitaki-1 220 kV circuit exceeds stated capability | Southland load and north/south transfer from/into Southland | Load management, generation availability   |  |

| Causing Factor   | Power System Issue   | Power System Limit Group               | Operational Measures   | Comment   |
|--|--|--|--|---|
| <i>Loss of an Invercargill-Roxburgh 220 kV circuit</i> | Invercargill-Roxburgh 220 kV circuit exceeds stated capability   | Southland load                         | Load management, generation availability, special protection schemes, short term ratings | Power system capability limit on Southland load is required                         |
| <i>Wellington Regional load</i>                        | Voltage instability for loss of Haywards -Linton 220 kV circuit  | Limits on HVDC south transfer          | Security constraint  | HVDC south transfer will be constrained at times of low Wellington regional load    |
| <i>Wellington Regional load</i>                        | Bunnythorpe - Woodville circuit exceeds stated capability following loss of Bunnythorpe-Haywards-3 circuit | Limits on HVDC south transfer          | Security constraint<br>Grid reconfiguration<br>Load management                           | HVDC south transfer will be constrained at times of high Wellington regional load   |
| <i>Loss of a Brunswick-Stratford 220 kV circuit</i>    | Remaining Brunswick-Stratford 220 kV circuits exceed stated capability                                     | Limits on HVDC south transfer          | Security constraints<br>Short term ratings   | Power system capability limits on transfer from Stratford to Brunswick are required |
| <i>HVDC line conductor thermal</i>                     | Exceed stated capability   | capacity Limits on HVDC south transfer | Security constraints   | HVDC south transfer limited to 666 MW   |
| <i>Equipment rating</i>                                | Exceed stated capability   | Limits on HVDC north transfer          | Security constraints   | HVDC north transfer limited to 900 MW   |

### 3.5.2.1 Other issues

There are a number of cases where local demand will exceed power system capability limits requiring operational measures to avoid demand shedding, or where the loss of a single asset will cause loss of supply to a grid exit point:

- power system capability limits can be required during the outages of interconnecting transformers to avoid other parallel interconnecting transformers exceeding stated capability
- there may be loss of supply during maintenance outages of lines at selected supply points where supply transformers are teed off transmission lines, for example at National Park, Mataroa, and Ohakune
- outages to maintain grid assets can reduce security of supply to some grid exit points during the outage and a loss of supply may occur if another asset is lost during maintenance (e.g. the outage of one circuit of a double circuit spur connecting a grid exit point and the loss of the other will result a loss of supply at the grid exit point)

## 3.6 MANAGING FREQUENCY

One of the principal performance obligations concerns the management of power system frequency. The policies and means used by the System Operator to meet this principal performance obligations are set out in the Policy Statement. The System Operator procures ancillary services (frequency regulating reserves, instantaneous reserves and over-frequency reserves) to comply with the frequency principal performance obligations.



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The System Operator uses the framework set out in the ancillary services Procurement Plan to procure frequency regulating reserves, instantaneous reserves and over-frequency reserves. Ancillary services providers are contracted to provide these reserves.

This forecast focuses on the adequacy of these processes and means to manage frequency over the next three years. The approach is largely qualitative. A simplified analysis is used to support a forecast of the System Operator's ability to meet the frequency principal performance obligations. This analysis assesses whether there is sufficient generation capacity to meet future energy and reserves requirements. The analysis indicates, under the assumptions made in this System Security Forecast, there is sufficient surplus generation capacity (assuming that all available plant is offered) to provide instantaneous reserves over the next three years.

Based on the assumptions and analysis in Part C, the System Operator has no reason to believe that the policies and means set out in the Policy Statement for managing frequency will not be adequate over the three year period.

### 3.6.1 CONCLUSIONS

The System Operator believes that it can continue to meet the principal performance obligations over the next three years. However, meeting the principal performance obligations will require demand shedding at times unless there is further investment in generation and transmission. The System Operator expects the SSF and other industry planning reports will provide valuable information to decision makers in the investment process with the outcome that sufficient generation and transmission are built to ensure the PPOs can be met without recourse to regular demand shedding.