Medium Term Load Forecast Trial Results

Report for TESLA

23 February 2015

TRANSPOWER

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1	2 March 2015	
1.1	28 April 2017	Typo in MAPE formula corrected

	Position	Date
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1. INTRODUCTION

As System Operator, Transpower is responsible for real-time security and scheduling and dispatch of the power system 24 hours a day, 7 days a week. A key input into undertaking this role is accurate load forecasting over the medium term horizon (30 minutes to 14 days). This is known as the Medium Term Load Forecast or MTLF.

There is an expectation that increasing distributed generation and demand response will make forecasting more challenging.

Transpower has also developed and trialled its Demand Response programme for transmission deferral. Effective and economic use of Demand Response for this purpose also requires an accurate load forecast.

For these reasons, Transpower sought to explore what is possible in terms of improving its MTLF accuracy, and in 2011 embarked on a project to ascertain the quantum and economics of possible improvements to its existing MTLF model.

In 2012 Transpower held a trial to identify a better load forecast than its existing one. Participants in the trial were selected through a competitive tender. Of the 14 companies that responded to Transpower's initial approach to the market, Transpower selected five companies to take part as participants in the trial. Selection was based on responses to technical and commercial load forecast requirements, as well as each respondent's experience in load forecasting for utilities[1]. Transpower's own MTLF model was included as a 'sixth participant' in the trial.

This report summarises and discusses the trial results.

Following the trial, TESLA Asia Pacific Ltd (TESLA) was selected as the preferred vendor, on the basis of its demonstrated performance in the trial, assessment against Transpower's functional and non-functional requirements, and cost-benefit analysis.

In 2016, Energy Market Services (a commercial business group within Transpower NZ Ltd.) entered into a joint venture with TESLA to supply TESLA forecasts on a subscription basis to our market participants.

This version of the report has been prepared to document the performance of the selected preferred vendor TESLA. It has been modified to remove all cost and pricing information, and to protect the identity of other participants.

[1] By "experience" Transpower specifically means that the company has existing load forecast models and an existing client base for whom they provide load forecast services. Transpower was not seeking companies to develop load forecast models afresh, but instead companies who had an established track record in electricity load forecasting.

2. USES AND REQUIREMENTS OF THE MTLF

The MTLF is used in a number of areas, which include:

- real-time energy and security coordination by the System Operator
- the price schedules provided to the electricity market ahead of real-time, which help inform participants' offer and bid strategies
- outage planning
- calling of Transpower Demand Response.

The key requirements of the MTLF to satisfy these uses can be summarised as to provide:

- accurate forecast load for each half-hour (trading period) for the next 14 days, updated half-hourly
- forecast load for each of the approximately 180 conforming grid exit points (GXPs), plus aggregates of zones, islands, and national
- particular accuracy of forecast at demand peaks and the period between the morning and evening peak of the load profile.

The primary reasons for seeking improvements to the MTLF are to:

- improve information used by the System Operator in deciding whether to call Transpower Demand Response, and thereby improve its efficiency through lower costs of using it and better security outcomes
- improve information used in energy and security co-ordination by the System Operator, and thereby continuously improve assessment of energy and potential security issues ahead of time
- improve the load forecast input to a number of schedules used by market participants and the System Operator, to enable more efficient dispatch, and through improving the load forecast input to price schedules, provide better information to market participants
- consider and incorporate new demand side initiatives, including demand side bidding and forecasting (DSBF) and dispatchable demand, to feedback the impact of resultant demand response into the load forecast.

3. PERFORMANCE ASSESSMENT

Before embarking on the trial, Transpower needed to determine a method of assessing the relative performance of trial participants, relative to each other and to Transpower's existing MTLF model.

For this purpose, load forecast error is the difference between the MTLF and the actual metered load per trading period. Performance is measured by the Mean Absolute Percentage Error (MAPE):

MAPE = ABS (Actual Load – Forecast Load) / Actual Load

In order to compare overall performance, Transpower developed a general performance index (GPI) by weighting different spatial resolutions and horizons, based on their perceived utility to users of the forecasts and resultant schedules, such as the co-ordination centres, outage planes and market participants.[2]

4. TRIAL RESULTS

The trial was conducted live, over the internet, from 1 March to 31 August 2012.

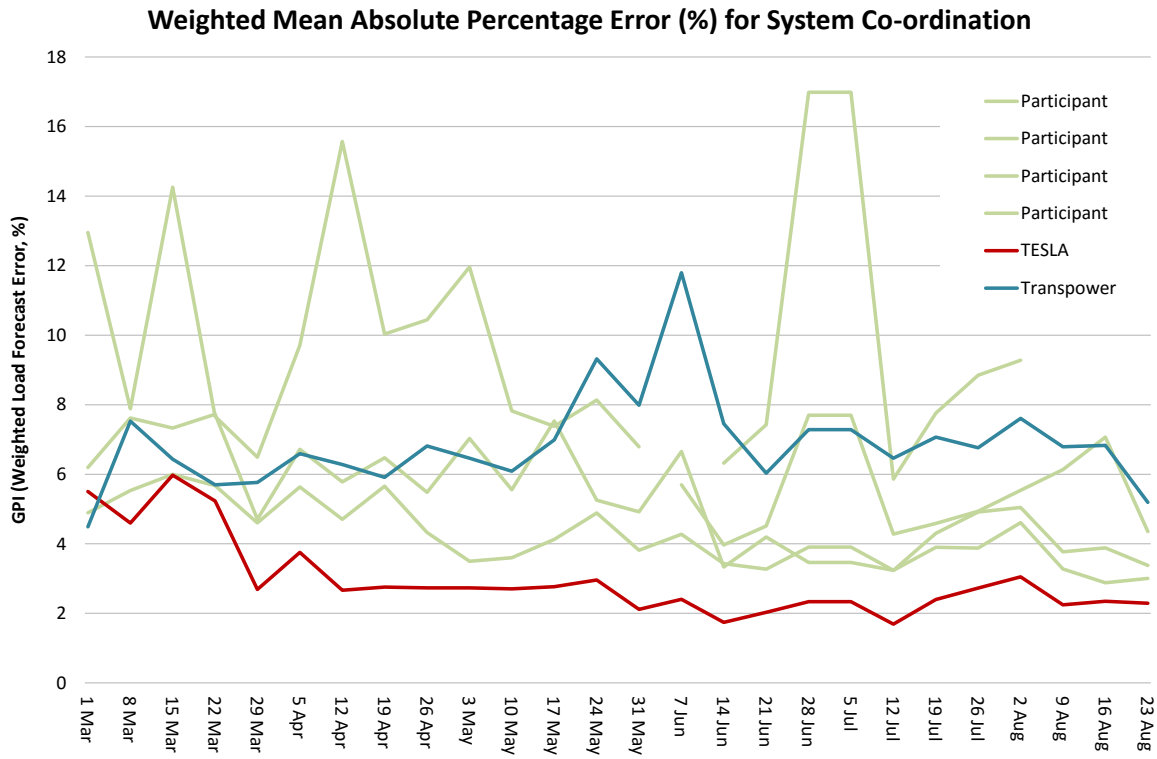
A selection of performance results are presented below for various combinations of location, horizon and measure.

TESLA's and Transpower existing MTLF's performance are identified specifically, and other participants' performance indicated. One of the other participants only participated in the last half of the trial.

[2] More information about the trial and the general performance index is given in the paper Miller, A. J. V., Edwards, C., and Goodwin, D, "*Searching for a medium-term load forecast model: trials and tribulations*", Electricity Engineers' Association Conference and Trade Exhibition, June 2013.

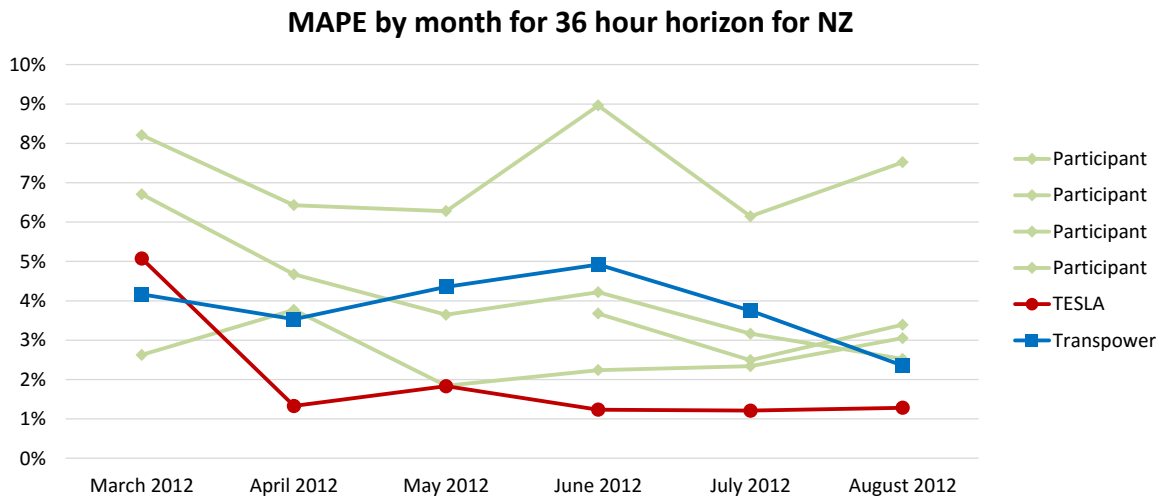
4.1 OVERALL PERFORMANCE

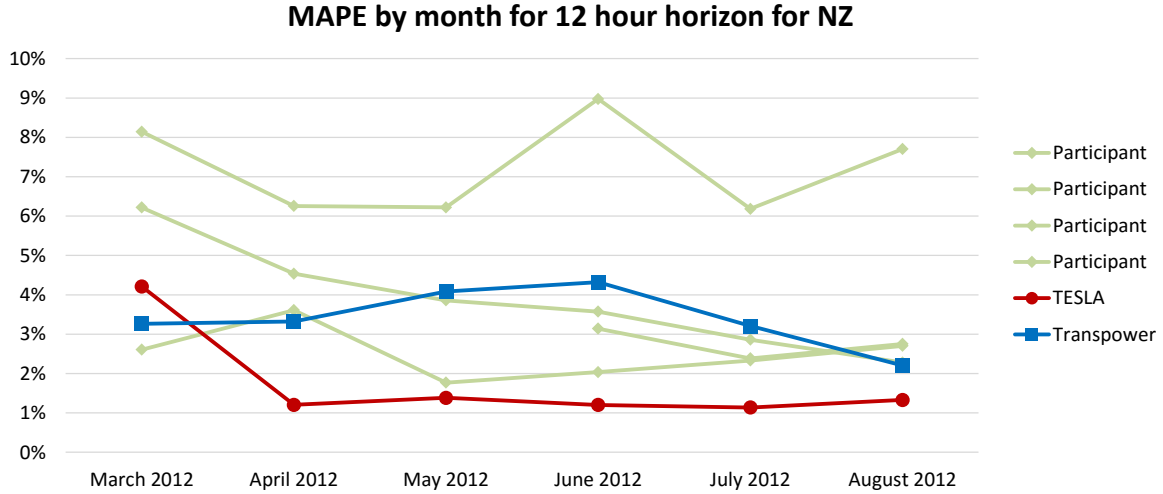
The following graph demonstrates overall performance as measured by the weekly general performance index (GPI) for the co-ordination centres for the trial period in 2012:

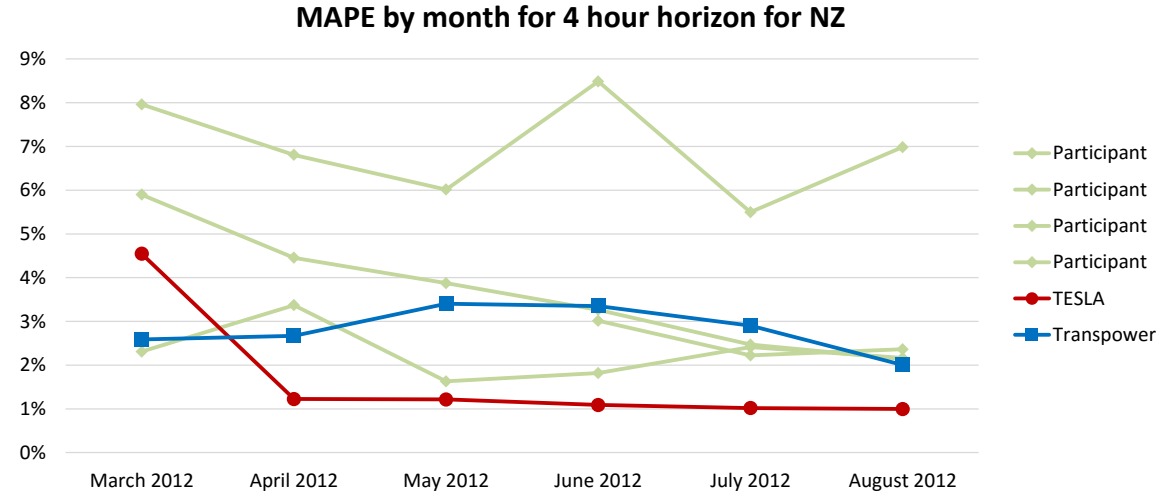


4.2 NATIONAL RESULTS

The following three graphs demonstrate performance at the national level for three different horizons:

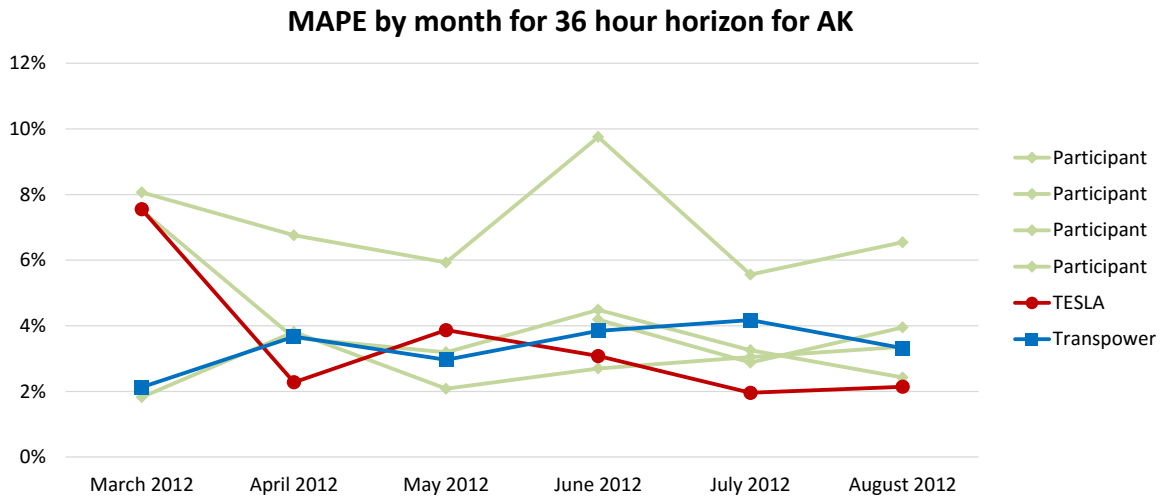


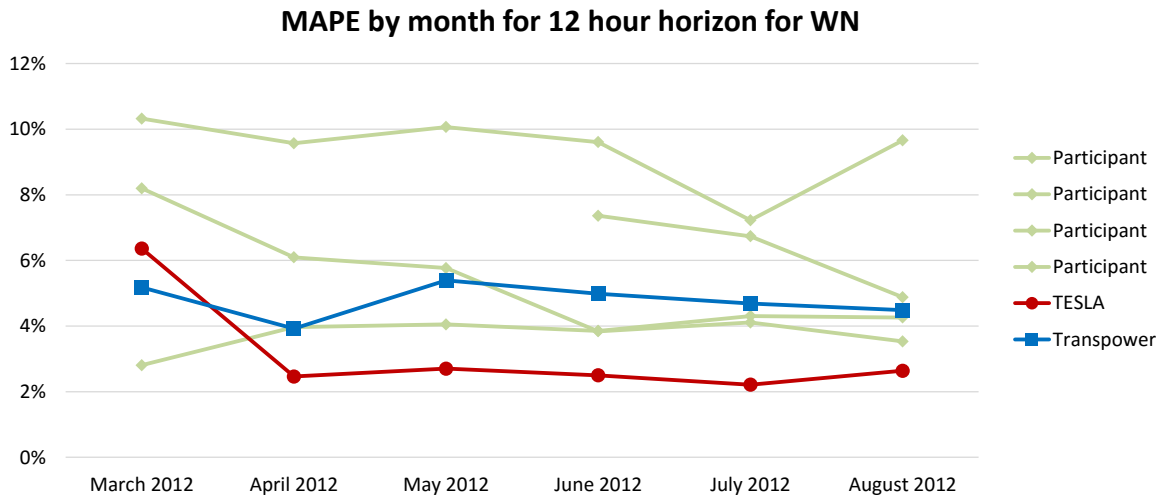


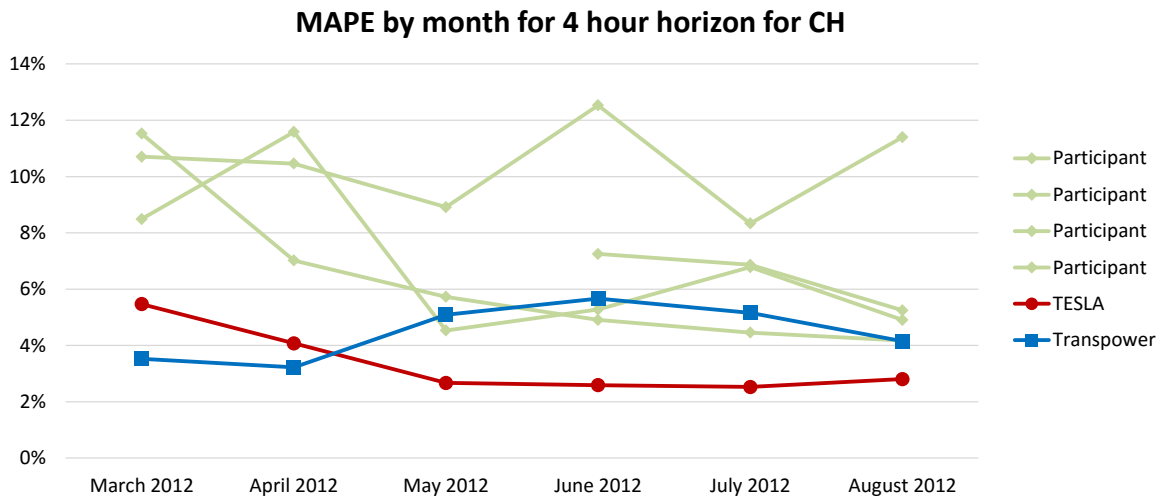


4.3 LOAD CENTRES (EXAMPLES)

The following three graphs demonstrate performance for three different load centres (Auckland, Wellington and Christchurch), and three different horizons:

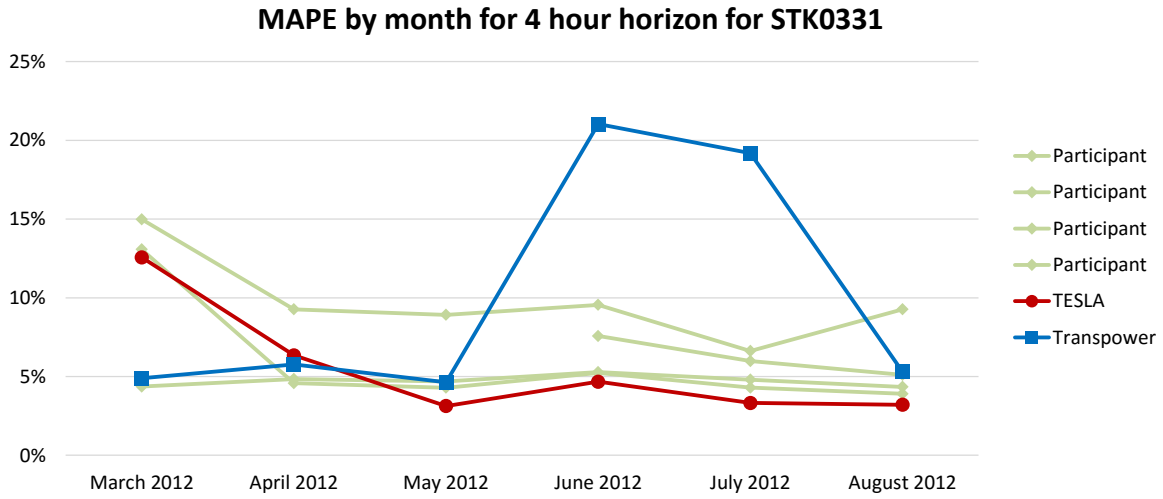


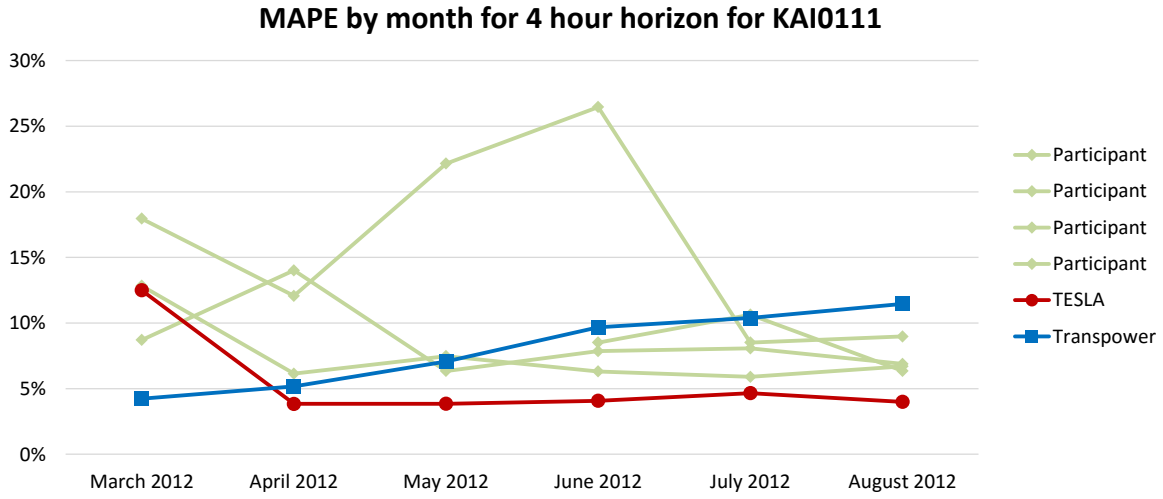


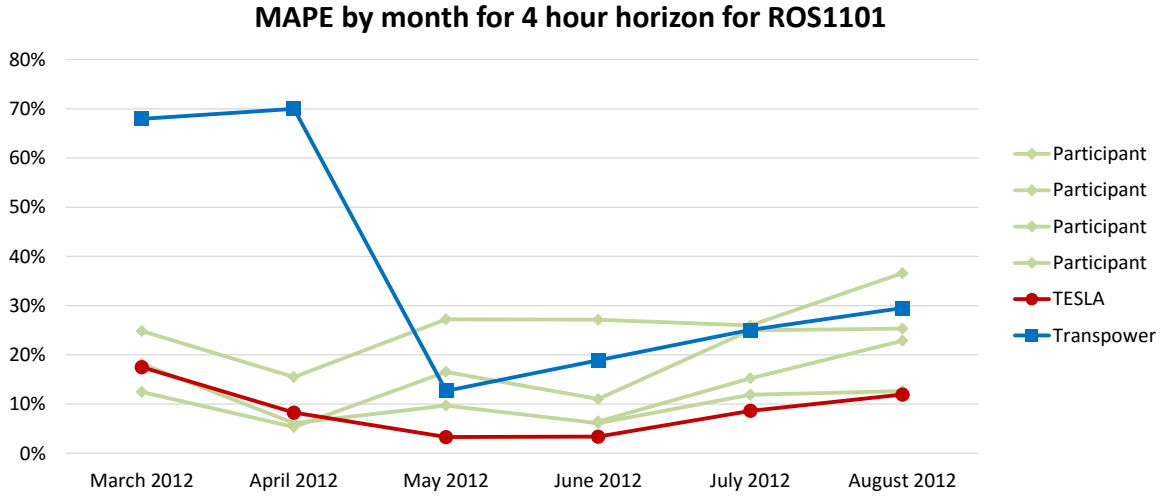


4.4 LOCATIONS (EXAMPLES)

The following three graphs demonstrate performance for three different load grid exit points (GXPs) at Stoke, Kaiapoi and Mt Roskill, at a common horizon. These GXPs were chosen as representative of typical results observed.

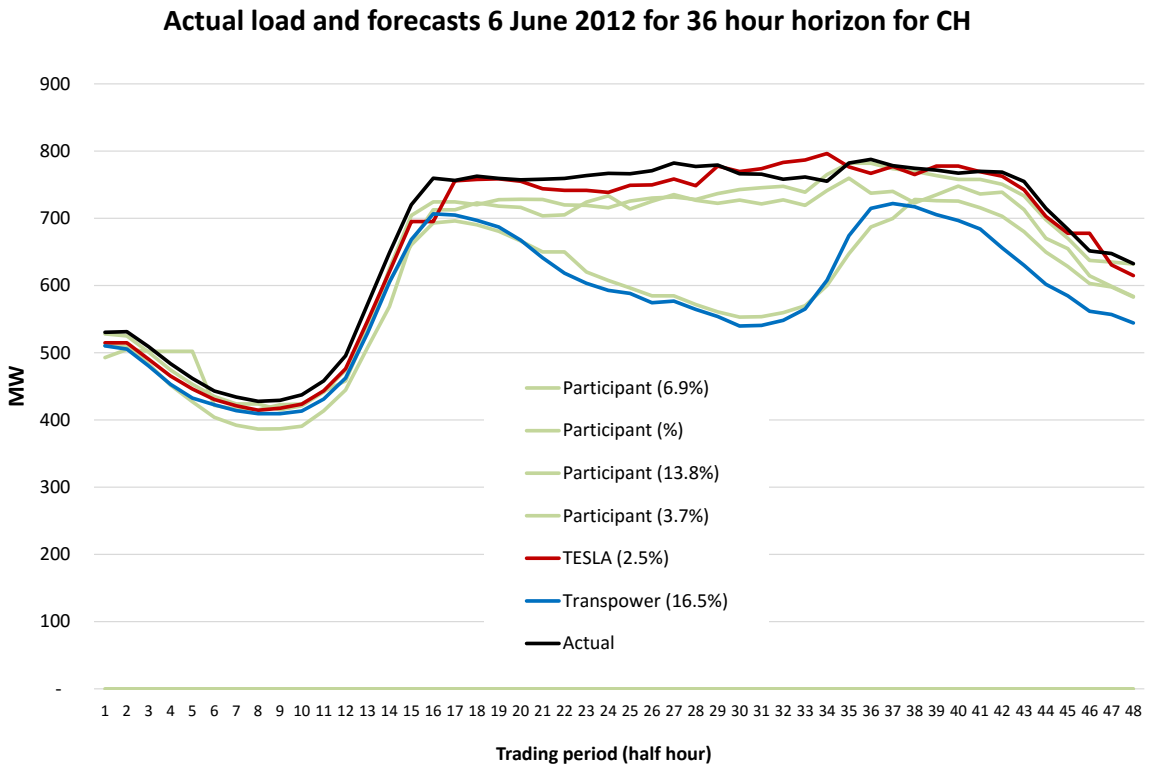


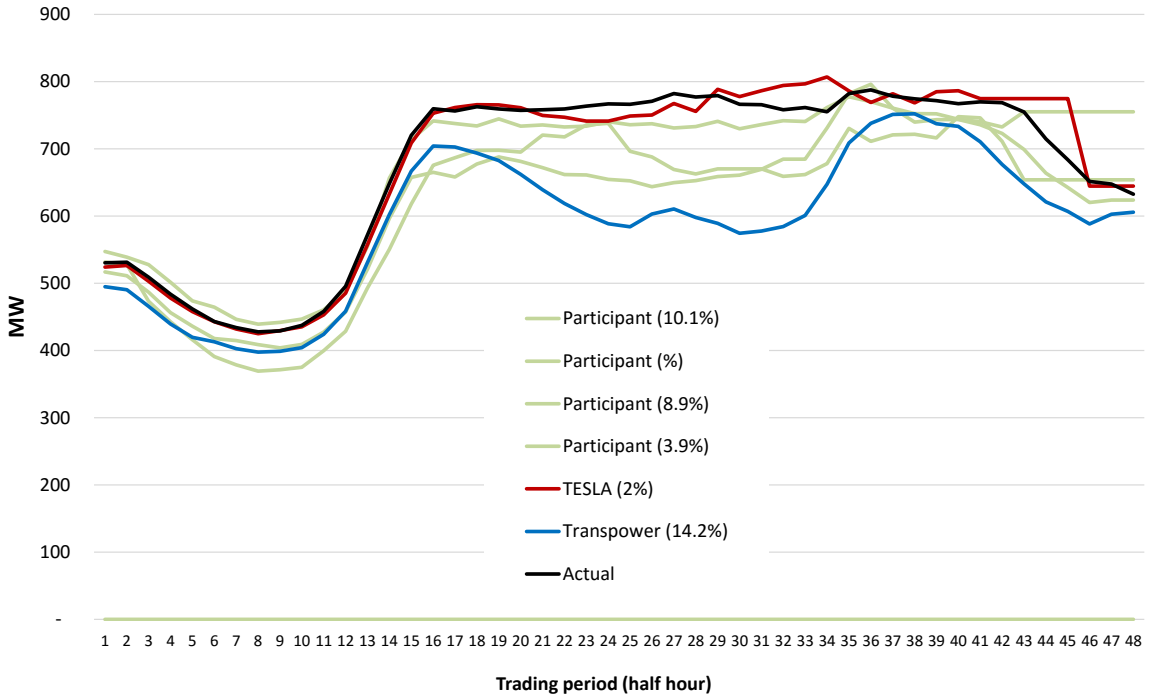




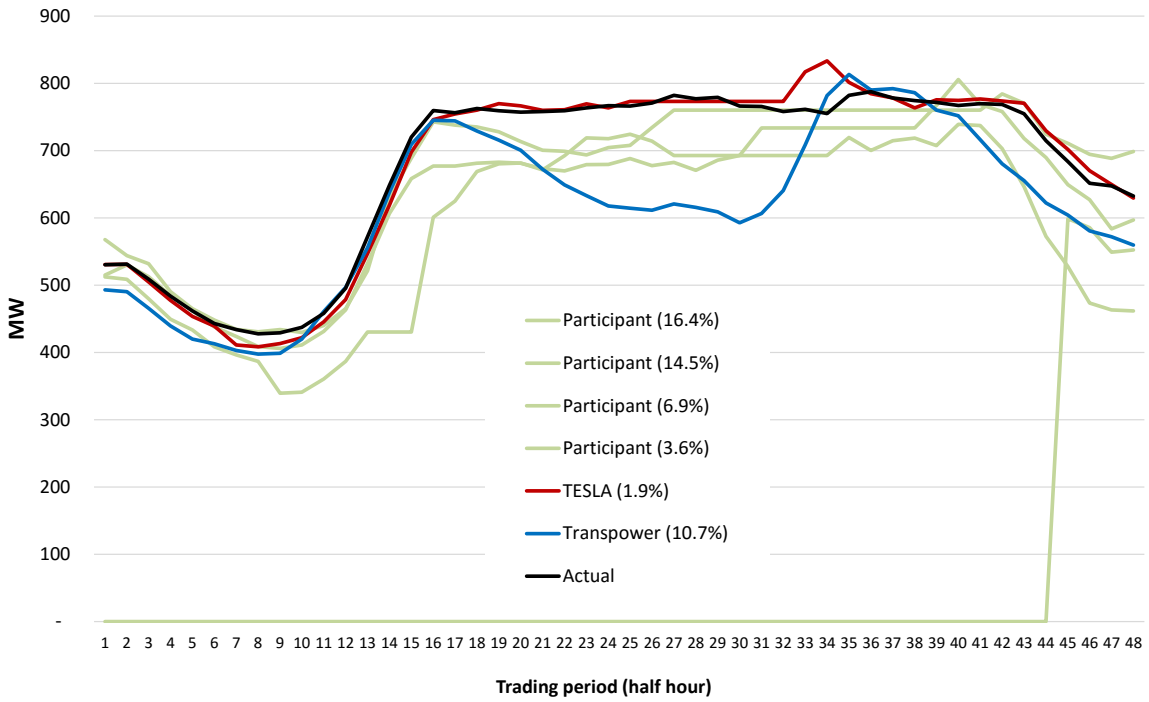
4.5 SIGNIFICANT WEATHER EVENT

The following four graphs demonstrate performance for the single day of the 6 June 2012 snowstorm in Christchurch, for different horizons:

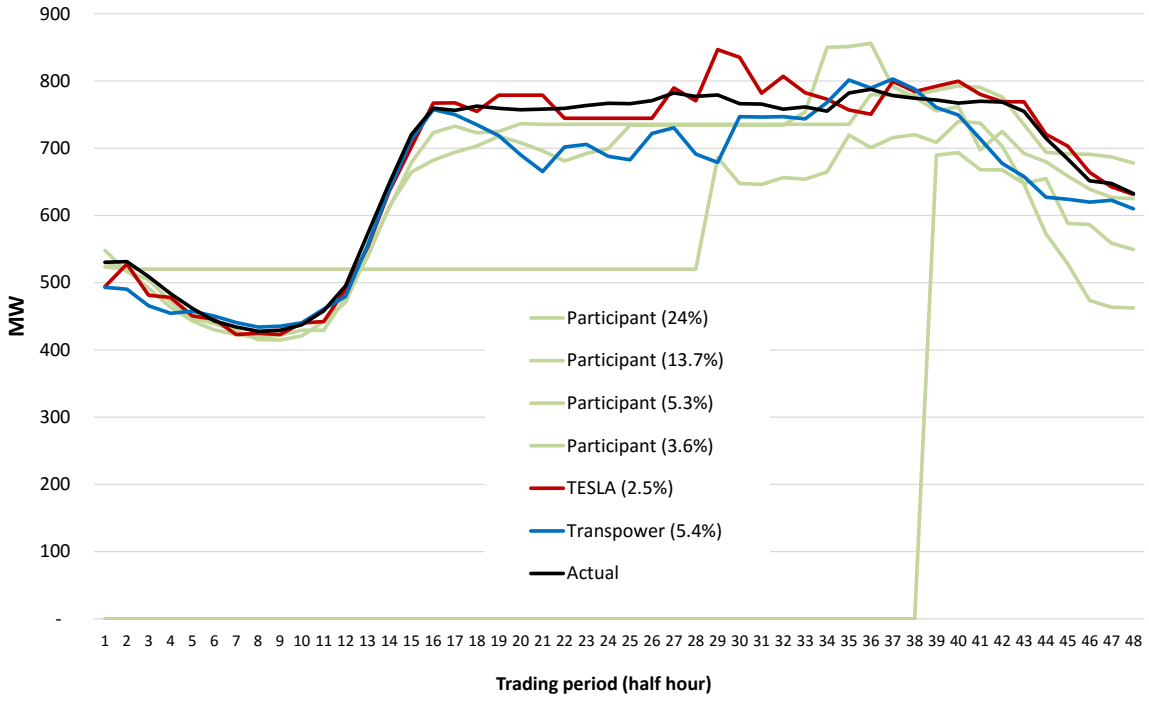




Actual load and forecasts 6 June 2012 for 4 hour horizon for CH

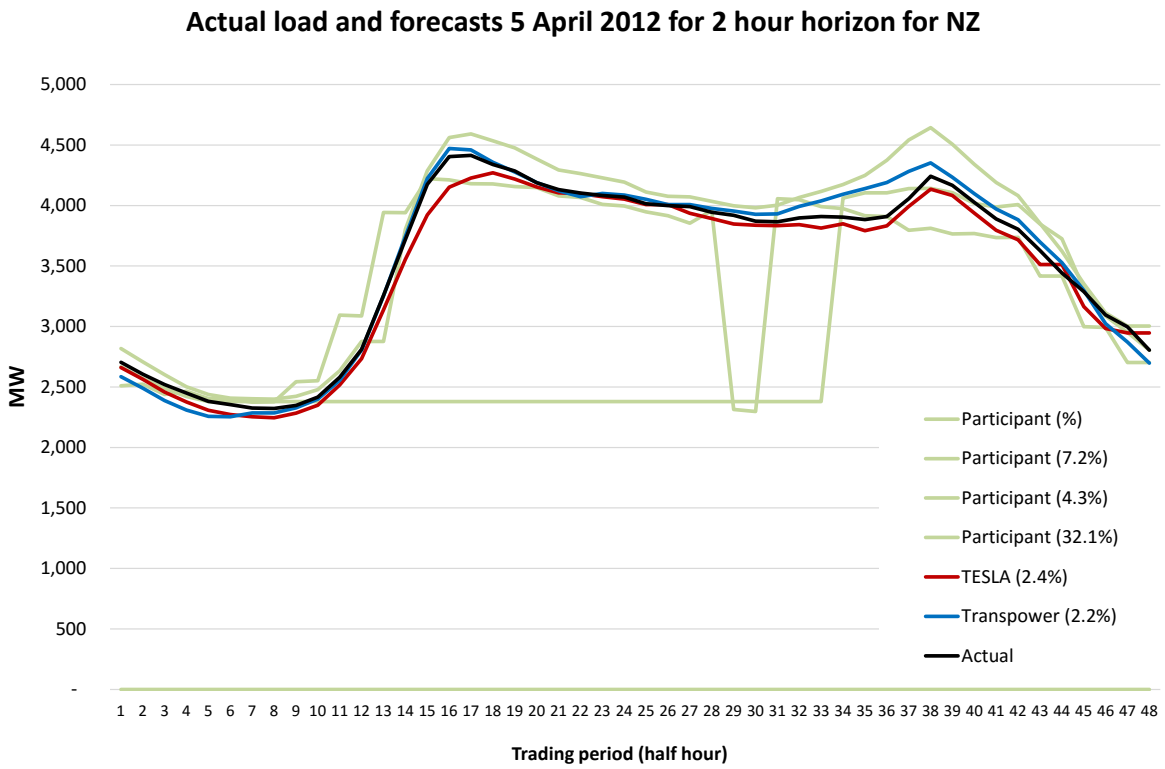


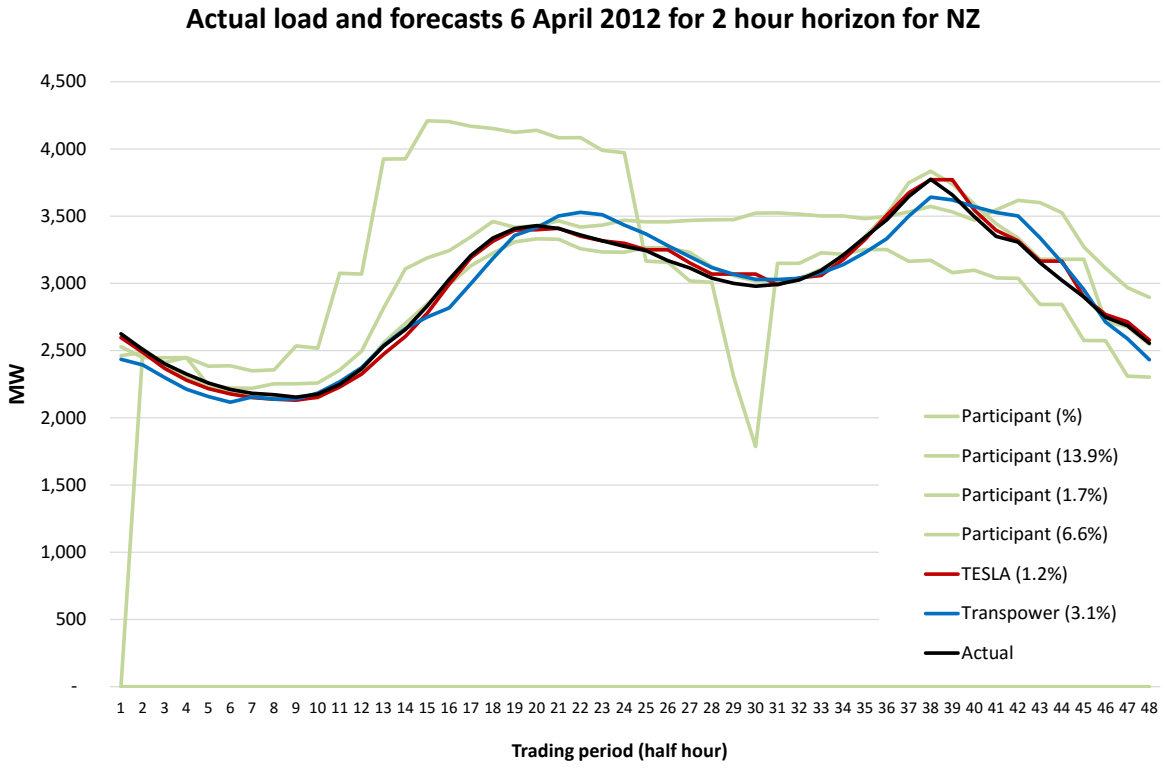
Actual load and forecasts 6 June 2012 for 1 hour horizon for CH



4.6 UNUSUAL DAYS

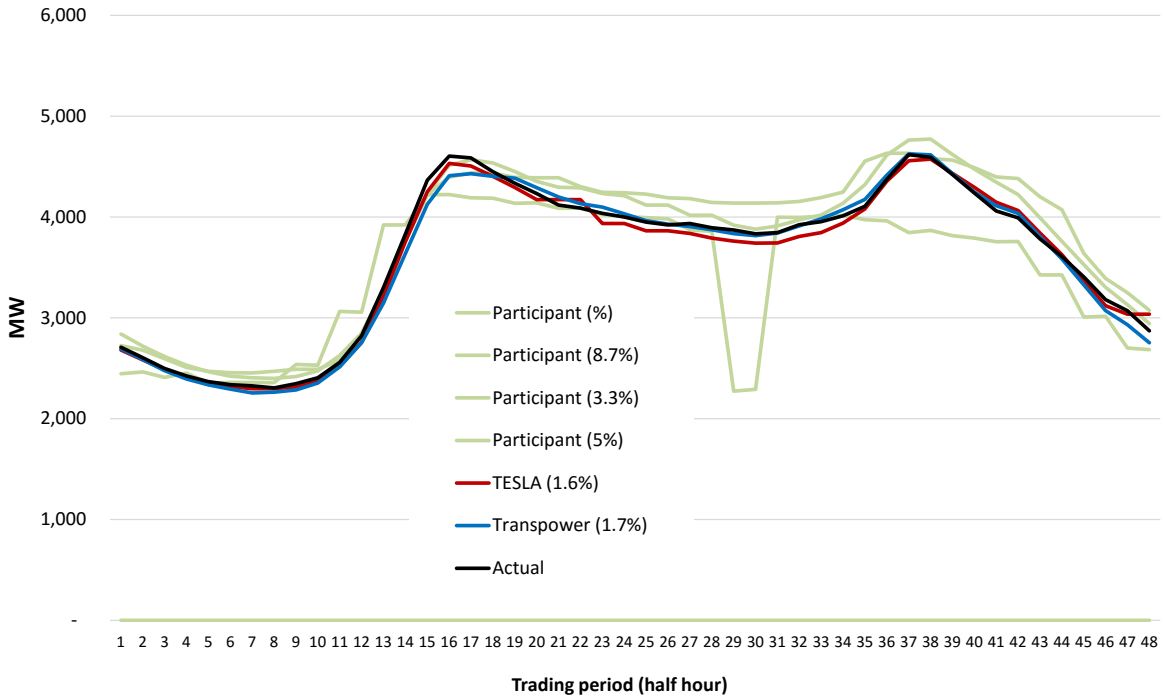
The following two graphs demonstrate performance between a (relatively) normal Thursday 5 April and Good Friday 6 April 2012 at a national level:



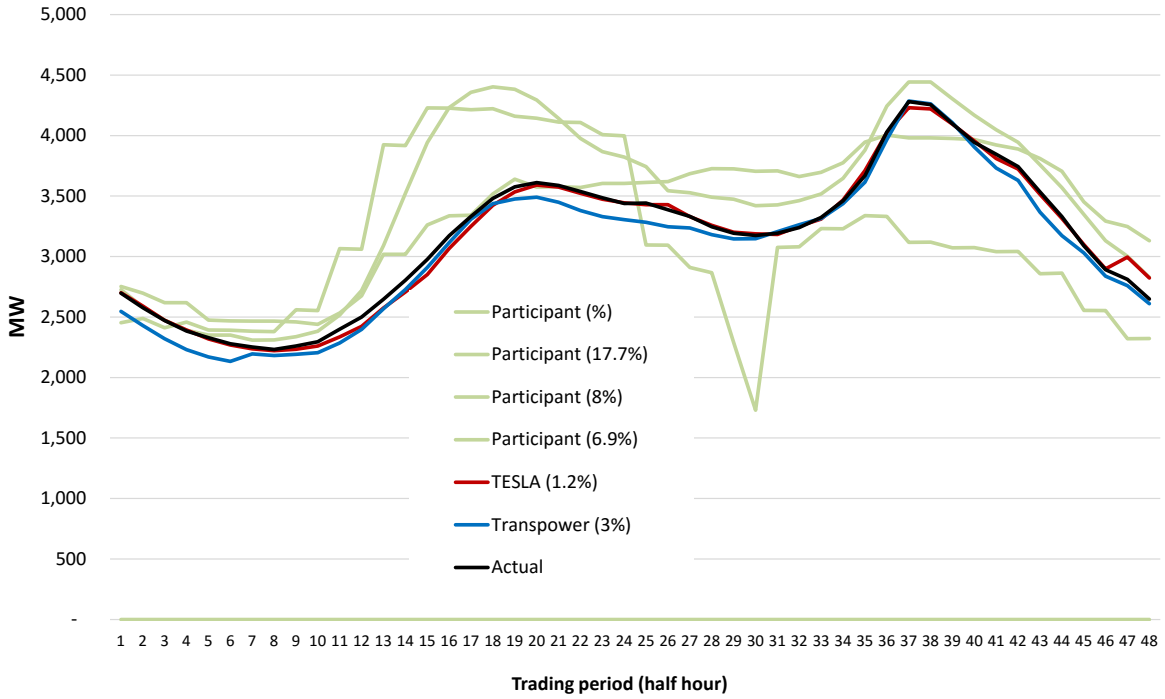


The following two graphs demonstrate performance between a (relatively) normal Tuesday 24 April and ANZAC day Wednesday 25 April 2012 at a national level:

Actual load and forecasts 24 April 2012 for 2 hour horizon for NZ



Actual load and forecasts 25 April 2012 for 2 hour horizon for NZ



4.7 CONCLUSIONS

The above graphs represent only a subset of all the possible combinations of horizon, location and measure. Considering the full results, the following conclusions can be drawn:

- Most participants improved their performance through learning during the first month or two of the trial, so the subsequent months of the trial can be considered to be most indicative of expected operational performance.
- The potential for significant improvements over the existing Transpower MTLF model were demonstrated at all levels:
    - New Zealand wide load forecasts (forecast error is at least 2 times better than the existing model)
    - Island load forecasts (forecast error is at least 2 times better)
    - Zone load forecasts (forecast error is at least 1.5 times better, depending on the zone)
    - GXP load forecasts (forecast error is in the order of 4 times better, depending on the GXP).
- TESLA demonstrated significantly more accurate forecasts than the existing Transpower MTLF model in most circumstances, and overall.

Some other participants demonstrated more accurate forecasts than the existing Transpower MTLF model, but not as accurate overall as TESLA's.