

## Guide to demand modelling paper

Demand for electricity in New Zealand has been flat since 2008.

We wanted to understand what is driving this flattening of demand and check whether it's because of any structural changes.

This guide gives an overview of the Authority's approach to modelling historical demand information. More detail is provided in the attached technical paper.

### No evidence of structure change

We have concluded that the flattening of electricity demand since 2008 is not unusual and there is no evidence of a structural change. The flat demand is forecast to continue and the model we used performs well in terms of forecasting performance.

### Data used

We used a range of data in our model.

Variable	Description
Demand	Quarterly data from Q1 2000 through to Q3 2013 in GWh. This is the sum of total demand including demand at Tiwai.
Price	QSDEP series from the Ministry of Business, Innovation, and Employment (MBIE) in cents per kWh
GDP	Statistics New Zealand real GDP series
Population	Statistics New Zealand population series
Natural gas price	From MBIE's Energy Data File
Temperature	Nationwide average temperature from NIWA's website

### Modelling approach and diagnostics

The variables we used are non-stationary, which means they are related in a way that is not meaningful.

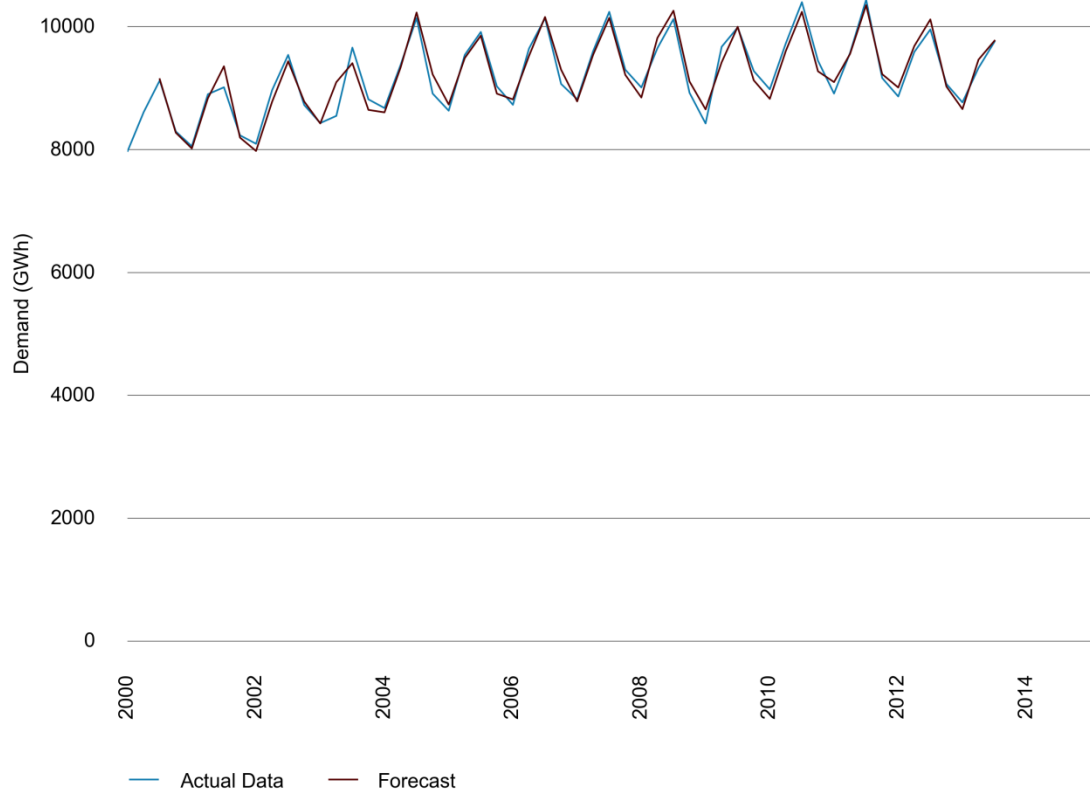
Running a regression analysis on a set of non-stationary variables can result in a spurious regression, producing 'nonsense correlation' which could lead to invalid

statistical inferences. We used co-integration analysis and an error correction model as an appropriate technique to analyse the relationship between these sorts of variables.

The model performed well. *R squared* and *adjusted R squared* are measures of how much variation in demand is explained by the model. They both range from zero to 1. An *R squared* of 1 means all variation in demand is explained by the model, and an *R squared* of zero means that none of the variation in demand is explained by the model.

The *Vector Error Correction* model (VECM) based on this co-integration equation has *R squared* of 0.997 and *adjusted R squared* of 0.990. The within sample forecasting produces a good result as shown in Figure 1 below.

**Figure 1: fitted and actual values**



## Results and parameter estimates

The relative stability of the model was confirmed by structural break tests. There is no evidence of a structural break in 2008, around the time when the flattening of electricity demand began.

The coefficients from the co-integrating equation and the VECM have the expected signs. For example we expect a higher price to lead to lower demand, so the negative sign on the price variable is expected. Conversely we expect as wealth increases so does consumption, so the positive sign on GDP is expected. The following tables summarise the results:

**Table 1: Model Coefficients for the cointegrating equation**

Variable	Coefficient
RGDP	1.2302
Electricity Price	-0.4061
Natural Gas Price	0.6967

**Table 2: Model Coefficients for the error correction model**

Variable	Coefficient
Population	4.725745
Budget Share	0.341224
Unemployment	-0.028670
Temperature	-0.211739

All the coefficients in Table 1 are consistent with economic theory. Increases in real GDP have an expected positive effect on electricity demand. An increase in the price of natural gas increases electricity demand since natural gas is a substitute for electricity. In other words, the cross price elasticity has a positive sign. The price has a negative sign and is smaller than 1 as expected. The magnitudes of the coefficients are within reasonable bounds.

Real GDP and electricity price are the most important variables in explaining the flattening of electricity demand, as is seen from the relative sizes of the coefficients.

We also carried out some diagnostics to validate the modelling approach and found that the model behaved well.

## Conclusion

Our modelling work has shown that the factors driving electricity demand are those that would be expected, and the flattening of electricity demand since 2008 does not indicate any major change in the structure of electricity demand in New Zealand.