Review of Constant Price Revenue Growth model for 2015-20 Default Price-Quality Path

A REPORT PREPARED FOR WELLINGTON ELECTRICITY LINES LIMITED

August 2014

Review of Constant Price Revenue Growth model for 2015-20 Default Price-Quality Path

Contents

Review of Constant Price Revenue Growth model for 2015-20 Default Price-Quality Path

Figures

Tables

Executive summary

Frontier Economics was engaged by Wellington Electricity Lines Limited (WELL) to review the New Zealand Commerce Commission's model for forecasting constant price revenue growth for electricity distribution businesses (EDBs) in New Zealand.

The overall finding of the critique of Commission's econometric model is that the model is not robust or fit-for-purpose. This is based on a number of identified issues:

- the elasticity estimate used is sensitive to the dataset used for the estimation
  - the model uses 0.73 as the elasticity of total net line revenue with respect to GDP based on 2004-2012, while 0.52 is the elasticity used for the Commission's Revised Draft Reset in 2012 based on 2004-2011. The difference between these estimates is large and would lead to vastly different answers for the assumed revenue growth
- elasticity estimation does not consider differences between subsets of EDBs
  - when Frontier estimated the elasticity of EDBs and allowed for differences between 'large' EDBs and 'small' EDBs, the elasticity of revenue with respect to GDP is considerably different to the Commission's estimate
- the model is for total revenue, not for industrial & commercial revenue
  - the dependent variable used in the model is 'Net Line Charge Revenue Received' as reported in the disclosures (covering both the residential and non-residential customers). Hence the estimated elasticity of revenue with respect to GDP indicates how total revenue from both residential and non-residential customers responds to changes in GDP
  - for many EDBs, the residential component of revenue exceeds 50%. The main driver of residential revenues in the 'residential' component of the Commission's approach is assumed to be the number of residential customers. This variable is not included in the econometric model, and hence the econometric model is misspecified, and the estimated elasticity is likely to be a biased estimate of how industrial & commercial revenues respond to changes in GDP
- non-stationarity
  - statistical tests show that the revenue variable in the Commission's econometric model is non-stationary, and that the variables in the model are not cointegrated. This could mean that the Commission's model is a so-called spurious regression, and that the results are not valid from a statistical point of view.

We also identified a number of issues regarding the validity of model inputs, including:

- residential consumption per connection — the Commission assumes fixed consumption per connection, however recent observations are lower than prior years at the NZ level and within the Wellington network.
- the relationship between population and connections — the Commission assumes residential customer growth can be proxied by population growth. Although population per connection has remained relatively constant, there is significant variation between EDBs, and recent growth in Wellington ICPs has been starkly lower than population growth in the region.
- the use of regional GDP to 'drive' non-residential electricity demand — the Commission's use of GDP fails to capture the high proportion of service sector GDP in the Wellington region and the changing composition of GDP.

1 Introduction

Frontier Economics was engaged by Wellington Electricity Lines Limited (WELL) to review the New Zealand Commerce Commission's model for forecasting constant price revenue growth for electricity distribution businesses (EDBs) in New Zealand.

1.1 Background

Wellington Electricity and 15 other EDBs in New Zealand are subject to Default Price-quality Path (DPP) regulation as implemented by the Commerce Commission (Commission). Orion NZ Ltd is currently subject to Customised Price-quality Path regulation by the Commission.

In 2012, the Commission completed the first reset of EDB DPPs since the finalisation of its input methodologies framework. The DPP regime aims to determine price and quality paths for regulated EDBs in a low cost manner, whilst satisfying the objectives of Part 4 of the Commerce Act 1986 (the Act). To remain low cost, the DPP framework has been developed such that the methods and models applied by the Commission to estimate each component of the DPP are the same across all EDBs, although inputs to the models can reflect an EDB's geographical location and other objective characteristics such as customer numbers and growth, line length and so on.

In order to reset the DPPs in 2012, the Commission developed forecasts of general and input price inflation, capex growth, opex growth, productivity, and volumes.

The Commission uses a building block model to forecast each EDB's revenue requirement. The Commission applies a weighted average price cap (WAPC) as the form of control. To implement the WAPC, the Commission forecasts the expected revenue growth that an EDB would receive each year as a result of changes in the demand for electricity, assuming prices were held constant ('constant price revenue growth').

On 4 July 2014, the Commission published its draft decision on the methods it will apply for the DPP for the 5 year period commencing on 1 April 2015. The draft decision is based on the same model used for the previous DPP period from 1 April 2010 to 31 March 2015. This model, when applied in 2012 at the last reset, significantly overestimated Wellington Electricity's actual constant price revenue growth. Consequently, Wellington Electricity has been unable to recover the revenue requirement estimated by the Commission. Wellington Electricity seeks to address this through an independent review of the Commission's model.

1.2 Task

The central task of this project is to review the Commission's model, including:

- identification of the assumptions which sit behind the Commission's model, and an assessment of the validity of each of those assumptions, including:
  - the relationship between population growth forecasts and growth in residential sector connections
  - the forecast growth in residential sector consumption per connection
  - the relationship between industrial sector and commercial sector demand growth
  - the relationship between GDP and each of industrial and commercial sector growth
  - the robustness of the econometric model
  - the appropriateness of the data used and/or excluded from the econometric analysis
  - any other assumptions
- given the findings of the above and by testing model forecasts against outturn, this project will make an assessment of the general ability of the model to forecast constant price revenue growth for all EDBs in New Zealand.

1.3 Structure of this report

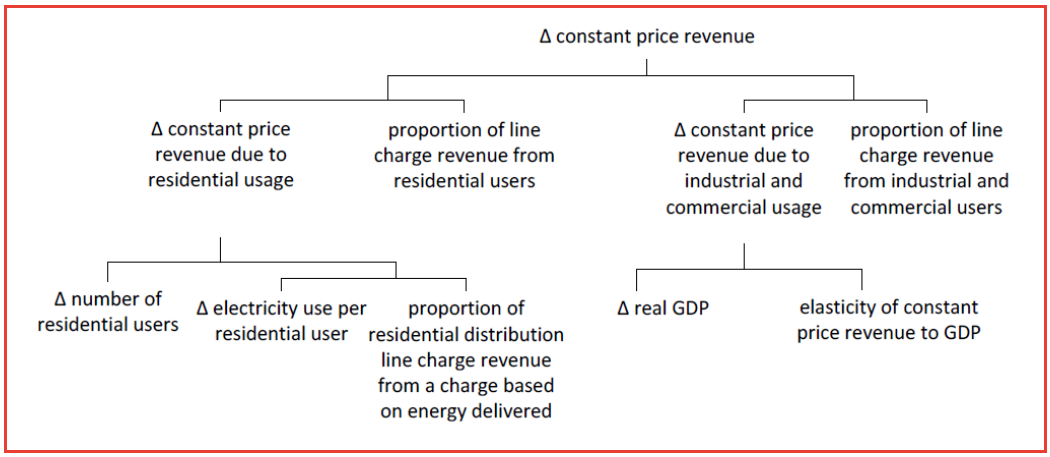
The remainder of this report is structured as follows:

- Section 2 provides a description of the Commission's approach
- Section 3 presents a critique of Commission's econometric model
- Section 4 considers other issues relevant to the assessment of the Commission's approach.

2 Description of the Commission's approach

The Commission proposes to model constant price revenue growth separately for residential users, and industrial and commercial users. The Commission's approach is shown schematically in Figure 1.

Figure 1: Commission approach to modelling revenue growth for EDBs



Source: Commerce Commission 2014

Algebraically the percentage change of total revenue[1] is forecast as:

$$\Delta Revenue = \Delta Revenue_{res} * w_{res} + \Delta Revenue_{ind\&comm} * w_{ind\&comm} \quad (1)$$

where Δ stands for growth rate, the subscripts res and $ind\&comm$ stand for the residential and non-residential market segments respectively, w_{res} is the proportion of line charge revenue from residential users and $w_{ind\&comm}$ is the proportion of line charge revenue from industrial and commercial users.

The percentage change of revenue for residential users is forecast as:

$$\Delta Revenue_{res} = \Delta customers_{res} + \Delta electricity_{res} * w_{energy\ delivered} \quad (2)$$

where $customers_{res}$ is the total number of residential customers, $electricity_{res}$ is the electricity use per residential customer, and $w_{energy\ delivered}$ is the proportion of residential distribution line charge revenue from a charge based on energy delivered.

The percentage change of revenue for industrial and commercial users is forecast as:

$$\Delta Revenue_{ind\&comm} = \Delta GDP * \epsilon \quad (3)$$

[1] 'Revenue' as used in this section refers to constant price line revenue net of discretionary customer discounts and rebates.

where GDP is regional GDP and ϵ is the elasticity of revenue with respect to GDP.

The proportions w_{res}, $w_{ind\&comm}$ and $w_{energy\ delivered}$ in equations (2) and (3) are determined from data collected from the EDBs in 2011.

For the residential equation (2), the growth rate in customer numbers is proxied by forecasts for the local population growth rates produced by Statistics New Zealand. The growth rate in electricity consumption per residential user is assumed to be zero over the forecast horizon.

For the industrial & commercial equation (3), the growth rates for regional GDP are obtained from NZIER.

The elasticity of revenue with respect to GDP is estimated using an econometric model; we review this model in the following section.

3 Review of Commission's econometric model for industrial & commercial revenue

3.1 Description of the Commission's econometric model

To obtain an estimate of the elasticity ϵ in equation (3) the Commission uses a random effects panel data model of the form:

$$\ln(real\ revenue)_{it} = \alpha + \epsilon * \ln(real\ regional\ GDP)_{it} + \mu_i + \upsilon_{it} \quad (4)$$

where μ_i is an EDB-specific random effect.

The model is estimated with log of total net line charge revenue as the dependent variable and log of real regional GDP as the independent variable.

The Commission estimates model (4) using a dataset that covers the period 2004-2012 for the 17 non-exempt EDBs. The Commission identified a number of observations as extreme and excluded them from the estimation dataset, leaving 127 observations available for estimation.

There are two stages in the Commission's approach to identifying extreme observations. Firstly, the Commission used its judgment and exploratory analyses of the data to identify the following extreme observations:

- Orion in 2011 — because of the impact on revenues of several earthquakes in the 2011 financial year.
- Wellington in 2009 — because data for that year do not cover the complete year. Also note that no data for Wellington are available prior to 2009.
- Vector in 2008 and in 2009 — because of the impact of the sale of the Wellington network.
- OtagoNet in all years — because the Commission considered the relationship between GDP growth and revenue growth for this EDB to be anomalous.

Secondly, the Commission relied on the results of four statistical tests for the detection of outliers in the remaining data to identify the following extreme observations:

- Vector in all years — because all observations failed three out of the four tests for not being outliers.

The Commission's approach to identifying extreme observations follows good statistical practice, and we have not re-examined the specific exclusions in this review. However, we note that the statistical tests are dependent on the particular model that has been estimated, so any change to the model could also produce a different set of outcomes from the statistical tests.

We also surmise that the identification of all years of Vector as outliers is likely due to the sale of Wellington in 2009. In effect there are two Vectors; Vector1 before the sale of Wellington and Vector2 after the sale. Perhaps including Vector in the dataset in this way would overcome the rejections in the outlier tests.

In the following sections we comment on some of the concerns we have with the Commission's model for estimating the elasticity of revenue for the industrial & commercial sector with respect to GDP.

3.2 The model is not robust

The elasticity is sensitive to the period used for estimation

The estimated elasticity of total net line revenue with respect to GDP in the Commission's preferred model is 0.73.[2] The dataset used to estimate this model covers the period 2004-2012.

- We re-estimated the model using data from 2008 to 2012 and obtained an elasticity estimate of 1.00.
- The same model specification was used for the Revised Draft Reset in 2012. The dataset used in this estimation covers the period 2004-2011, and the estimated elasticity was 0.52.[3]

The differences in these estimates are large, and hence the estimated elasticity is not robust with respect to the dataset used for estimation. The different estimates of the elasticity would lead to vastly different answers for the assumed revenue growth over the regulatory period.

The elasticity is not constant across subsets of EDBs

We also investigated whether the elasticity differs substantially across EDBs. We estimated two modified versions of the Commission's preferred model which allowed either the intercept or the slope to be different for large versus small EDBs. We considered an EDB to be 'large' if it had more than 80,000 customers in 2012.

---

2 Commerce Commission (4 July 2014), "Low Cost Forecasting Approaches for Default Price-Quality Paths", pp. 66-67.

3 Commerce Commission (21 August 2012), "Revised Draft Reset of the 2010-2015 Default Price-Quality Paths", pp. 97-98.

Table 1: Commission's preferred model with different intercept or slope for large versus small EDBs

	Commission's preferred model	Level shift	Slope shift
lngdp_real	0.731 (0.000)	0.637 (0.000)	0.591 (0.000)
Difference in intercept for large EDBs		1.674 (0.000)	
Difference in elasticity for large EDBs			0.185 (0.000)
_cons	4.069 (0.000)	4.347 (0.000)	4.745 (0.000)
N	127	127	127
$R^2_{overall}$	0.167	0.779	0.782
$R^2_{between}$	0.237	0.803	0.802
R^2_{within}	0.211	0.211	0.217

Source: Frontier analysis
Note: probability values (p-values) are in parentheses.

The results are collected in Table 1, with the results of the Commission's preferred model shown in the first column for comparison. Note that the two modified models have a much higher overall R^2 than the Commission's preferred model (0.78 compared with 0.17) and all the explanatory variables are statistically highly significant.

Table 2: Comparing elasticity estimates

	Elasticity estimate
Preferred Commission model (2012)	0.52
Preferred Commission model (2014)	0.73
Frontier – level shift model	0.64
Frontier – slope shift model	0.59 (small EDBs) 0.78 (large EDBs)

Source: Frontier and Commission analysis.

The elasticity estimates in the modified models are considerably different to the Commission's preferred elasticity of 0.73. These results (recast in Table 2) demonstrate that there are important differences between the EDBs that are not taken into account in the Commission's preferred model.

3.3 Model is for total revenue, not for industrial & commercial revenue

The dependent variable used in the Commission's model is 'Net Line Charge Revenue Received' as reported in the disclosures. The reported revenue covers both residential and non-residential customers. Therefore, the estimated elasticity of revenue with respect to GDP indicates how total revenue from both residential and non-residential customers responds to changes in GDP.

For many EDBs the residential component of revenue exceeds 50%. The main driver of residential revenues in the Commission's modelling is assumed to be the number of residential customers, not GDP. This variable is not included in the Commission's econometric model. Hence the model is misspecified as a model for total revenue, and the estimated elasticity is likely to be a biased estimate of how industrial and commercial revenue responds to changes in GDP.

Table 3: Commission's preferred model with number of connections

	Commission's preferred model	Commission's preferred model augmented with ICPs
lngdp_real	0.731 (0.000)	0.186 (0.000)
lnicps		0.919 (0.000)
_cons	4.069 (0.000)	-0.784 (0.052)
N	127	123
$R^2_{overall}$	0.167	0.988
$R^2_{between}$	0.237	0.992
R^2_{within}	0.211	0.265

Source: Frontier analysis
Notes:

- *probability values (p-values) are in parentheses*
- *we do not have data on the number of connections for Orion before 2008, hence in the augmented model there are four less observations than in the Commission's model*

We have re-estimated the model with both GDP and the number of connections as explanatory variables.[4] The estimated elasticities are reported in Table 3. Note that this model fits the data much better than the Commission's model, with an overall R^2 of 0.99 compared with the Commission's model overall R^2 of 0.17. We are not proposing that this model replaces the Commission's model (given the other issues discussed in this report) but rather note the significantly better fit to the data of total revenue.

At present, there is insufficient information on the split of revenue into residential and non-residential to enable a separate model to be developed for industrial & commercial revenue. The Commission obtained information on this split for 2011 and uses the results in some of its analysis. However, to develop a meaningful econometric model for industrial & commercial revenue, we would need this split for all years in the dataset, and, within EDBs, we would need some variation in the split over time.

3.4 Non-stationarity

The presence of non-stationarity in the time series used in an econometric model could lead to spurious estimates of the parameters in the model. To investigate whether this might be an issue for the Commission's model, we tested the dependent variable (log of revenue) for the presence of unit roots in all panels. We used a panel data unit root test in Stata that relies on individual Phillip-Perron unit root tests with zero lags.[5] The results are reported in Table 4 and they show that the revenue variable is non-stationary in all panels.

Table 4: Test for unit root of log of revenue in all panels

Statistics	Value	p-value	Result
Inverse chi-squared (30)	18.373	0.952	Accept H_0
Inverse normal Z	1.916	0.972	Accept H_0
Inverse logit t(74)	2.013	0.976	Accept H_0
Modified inv. chi-squared	-1.501	0.933	Accept H_0

Source: Frontier analysis
Note: the null hypothesis H_0 is that log of revenue has a unit root in all panels.

4 The numbers of connections is included in logs.

5 Since the time series in the dataset are quite short, some of the unit roots or cointegration tests for panel data cannot be carried out, while others restrict the number of lags that can be included in the test.

This would not be a problem if revenue and GDP are cointegrated. Hence, we tested for the absence of cointegration in all panels. The results are reported in Table 5 and they show that the series are not cointegrated. If revenue and GDP are not cointegrated then the Commission's results may be spurious.[6]

Table 5: Test for absence of cointegration between log of revenue and log of GDP in all panels

Statistic	Value	Z-value	p-value	Result
G_τ	-1.174	2.514	0.994	Accept H_0
G_α	-3.102	2.777	0.997	Accept H_0
P_τ	-2.944	2.487	0.994	Accept H_0
P_α	-1.519	2.285	0.989	Accept H_0

Source: Frontier analysis
Notes:

- *the null hypothesis H_0 is that the variables are not cointegrated in all panels*
- *the alternative hypothesis for the group mean statistics G is that at least one of the cross-sectional unit is cointegrated. The alternative hypothesis for the panel statistics P is that the panel as a whole is cointegrated*
- *Wellington was excluded from the test because it did not have enough observations.*

A common approach to dealing with non-stationarity in time series when there is no cointegration is to convert the relevant variables to year-on-year changes. Since the variables are in log form, this is equivalent to estimating a model of the yearly growth rates in revenue as a function of the yearly growth rates in GDP. That is, in fact, what equation (3) specifies. Hence estimating the model in growth rate terms is analogous to the way the Commission intends to use the estimated elasticity produced by the model.

The results of estimating the model in growth rates form are shown in Table 6. The estimated model has a very poor fit to the data and is statistically not significant. The estimated elasticity is much lower than when the model is estimated using the log variables in levels (0.12 compared to 0.73), and it is statistically not significantly different from zero. The implication is that the year-on-year growth rate in GDP is a very poor predictor of the year-on-year growth rate in revenue.

6 We acknowledge that these tests may have low power and that the p-values may not be accurate in small samples. However, the p-values are very large for all the tests, which would suggest that the issue of non-stationarity needs to be given due consideration.

Table 6: Commission's preferred current model in first differences

	D.lnrev_real
D.lngdp_real	0.119 (0.507)
_cons	0.016 (0.003)
N	112
$R^2_{overall}$	0.004
$R^2_{between}$	0.006
R^2_{within}	0.006

Source: Frontier analysis
Note: probability values (p-values) are in parentheses.

We also investigated whether revenue, GDP, and the number of connections are cointegrated as a set. The results are reported in Table 7, and they show that the hypothesis of absence of cointegration in all panels is accepted in three out of four tests.

Table 7: Test for absence of cointegration between log of revenue, log of GDP, and log of number of connections in all panels

Statistic	Value	Z-value	p-value	Result
G_τ	-2.663	-2.459	0.007	Reject H_0
G_α	-2.716	3.684	1.000	Accept H_0
P_τ	-3.791	2.311	0.990	Accept H_0
P_α	-1.379	2.893	0.998	Accept H_0

Source: Frontier analysis
Notes:

- *the null hypothesis H_0 is that the variables are not cointegrated in all panels*
- *the alternative hypothesis for the group mean statistics G is that at least one of the cross-sectional unit is cointegrated. The alternative hypothesis for the panel statistics P is that the panel as a whole is cointegrated*
- *Wellington and Orion were excluded from the test because they did not have enough observations.*

4 Other issues

4.1 Residential consumption per connection

The Commission assumes zero growth in electricity use per residential user – which is fixed consumption per connection. Table 8 shows electricity use per residential connection for New Zealand from 2002 to 2012. We note that per connection electricity use in the last two years, 2011 and 2012 (bolded and underlined in the table) is lower than any of the other years over that period (and total residential consumption is reduced in 2013). Recent observations from the Wellington region are also lower than prior observations (Table 9). If this decline continues into the future, then an assumption of fixed consumption per connection will overstate future residential electricity demand.

Table 8: New Zealand aggregate residential consumption and connections

	Residential connections ('000)	Residential consumption (PJ)	Consumption per connection	Connections (% change)	Consumption (% change)	Cons. per connection (% change)
2002	1514	42.01	27.74			
2003	1557	43.50	27.95	2.8%	3.6%	0.7%
2004	1582	44.27	27.99	1.6%	1.8%	0.1%
2005	1605	43.72	27.24	1.5%	-1.2%	-2.7%
2006	1613	45.60	28.27	0.5%	4.3%	3.8%
2007	1628	44.84	27.54	1.0%	-1.7%	-2.6%
2008	1665	45.50	27.33	2.3%	1.5%	-0.8%
2009	1684	47.41	28.16	1.1%	4.2%	3.1%
2010	1696	47.44	27.97	0.8%	0.1%	-0.7%
2011	1736	**46.00**	**26.50**	2.3%	-3.0%	-5.2%
2012	1714	**45.09**	**26.30**	-1.3%	-2.0%	-0.7%
2013		**44.30**			-1.7%	

Source: MED 2014.

Table 9: Wellington residential consumption and connections

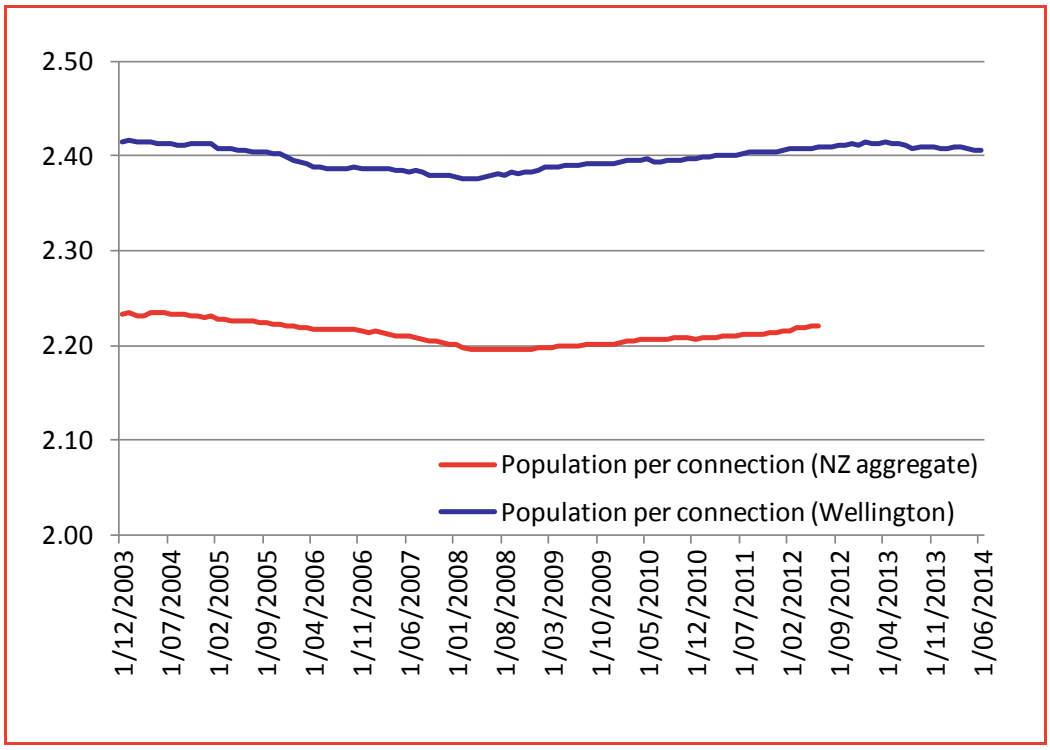
	Residential connections	Residential consumption (GWh)	Consumption per connection	Connections (% change)	Consumption (% change)	Cons. per connection (% change)
2008	1091762	145081	7.525			
2009	1108460	145805	7.602	1.5%	0.5%	1.0%
2010	1173644	146611	8.005	5.9%	0.6%	5.3%
2011	1115292	147001	7.587	-5.0%	0.3%	-5.2%
2012	1128175	147212	7.664	1.2%	0.1%	1.0%
2013	1094404	147498	**7.420**	-3.0%	0.2%	-3.2%
2014	1051750	147526	**7.129**	-3.9%	0.0%	-3.9%

Source: pers. comm. WELL.

4.2 Population and connections

The Commission assumes residential customer growth (change in the number of residential users) can be proxied by population growth. This is presumably based on the observation that average population per residential connection has remained relatively constant (Figure 2).

Figure 2: Average population per ICP

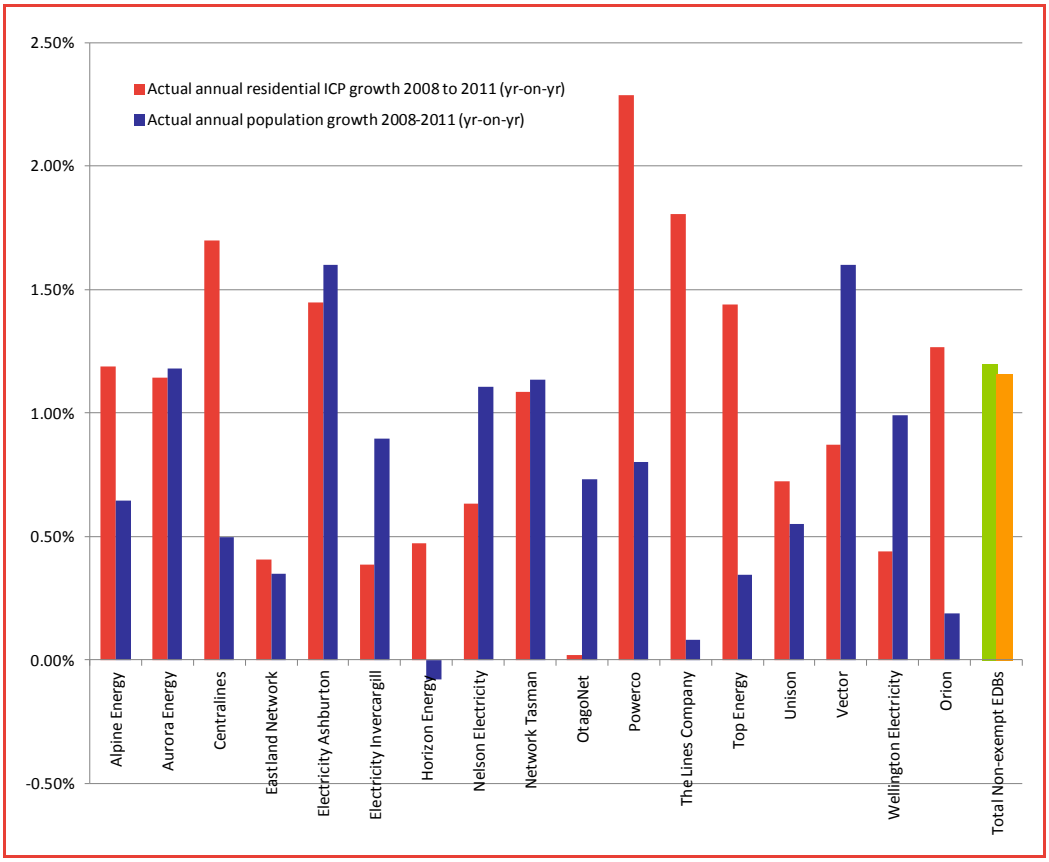


Source: Frontier analysis of EA (2014) and StatsNZ (2012, 2014)

However, the relationship between population and residential connections is highly diverse between EDBs when recent growth trends are considered. Figure 3 presents the recent marginal changes that underlie the small changes in average population per ICP calculations. Although the 2008-2011 growth in residential ICPs was very similar to growth in population in aggregate across all non-exempt EDBs, there was dramatic variation between EDBs — in particular, for WELL the average annual residential ICP growth in 2008-2011 was less than half the average annual population growth.

If residential ICP growth for WELL continues to be significantly less than population growth into the future, then the assumption that residential ICP growth is equal to forecast population growth will dramatically overstate future residential ICP growth.

Figure 3: Population and ICP growth



Note: Nelson Electricity data is based on total ICP growth rather than residential as the residential specific data unavailable.
Source: Frontier analysis of Commerce Commission (2014) with revised data provided by WELL.

4.3 GDP and electricity consumption

The Commission's use of regional GDP as an input to the model of industrial and commercial electricity demand raises a number of issues – mainly due to the geographic diversity of different industrial and commercial sectors in the economy and the varying energy intensity of different sectors. Issues of concern include:

- there is an apparent 'structural shift' in the composition of GDP with the increasing importance of service sector, which has below average electricity intensity
- there are significant differences in the prominence of service sectors in different regions
- there is an imperfect alignment of regions defined for the purposes of GDP data with EDB areas.

All three of these issues apply to WELL and the use of Wellington region GDP.

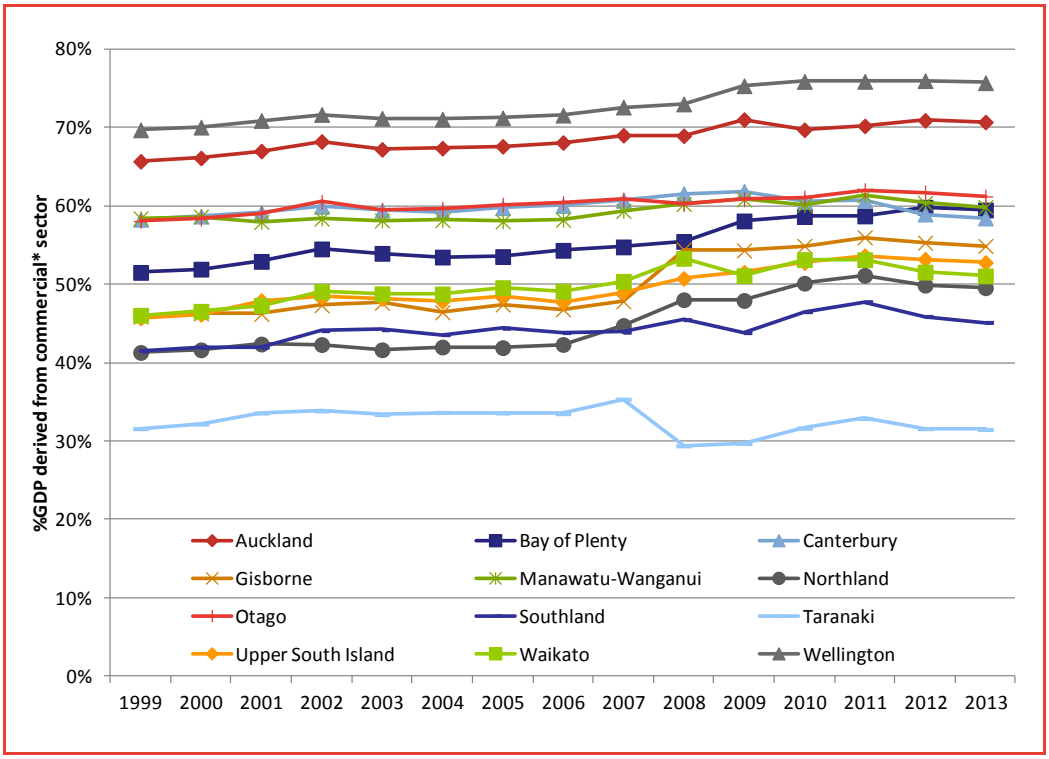
The first two issues relate to the proportion of GDP derived from the sectors that are not electricity intensive. To consider this, we define a commercial sector as total GDP excluding the following sectors: Agriculture; Forestry, fishing, mining, electricity gas water and waste water; Manufacturing; Construction and Owner-occupied dwellings. This means that the commercial sector consist of such industries as:

- retail and wholesale trade
- accommodation and food services
- transport, postal, and warehousing
- financial and insurance services
- rental, hiring, and real estate services
- professional, scientific, technical, administrative, and support services
- public administration, defence, and safety
- education and training
- health care and social assistance
- other services.

These sectors are not electricity intensive — such that GDP growth dominated by these sectors would not have the consequent growth on industrial and commercial electricity demand as would be expected if the GDP growth were dominated by electricity intensive sectors.

Figure 4 demonstrates that the Wellington region is different to the other regions of New Zealand in terms of the proportion of GDP derived from the commercial sector. Further, there has been a noticeable shift in this proportion from 70% between 1999 and 2006, to around 76% from 2009 onwards.

Figure 4: Proportion of GDP derived from the commercial sector



Note: the commercial sector has been defined as total GDP excluding the following sectors: Agriculture; Forestry, fishing, mining, electricity gas water and waste water; Manufacturing; Construction and Owner-occupied dwellings.
Source: Frontier analysis of NZIER data.

This means that the Commission's use of an elasticity (linking GDP to industrial-commercial electricity demand) based on all EDBs fails to recognise the different composition of GDP in the Wellington region.

We also understand that the Commission applies GDP for the Wellington region directly to the Wellington Network. The Wellington Network does not include a number of areas within the Wellington region that have experienced stronger growth in the recent past than the Wellington average — the districts Kapiti Coast, Carterton, Masterton, South Wairarapa and Tararua are not within the Wellington network area.

If future GDP growth in the Wellington network area continues to be dominated by the service sectors, then the Commission's current assumptions are likely to overstate future industrial and commercial electricity demand.

References

Commerce Commission 2014, Summary of individual EDBs responses to the information requests provided by WELL.

EA 2014, Market share trends by network reporting region, www.emi.ea.govt.nz/Datasets/download?directory=%2FDatasets%2FRetail%2FMarket_structure%2F20140721_Market_share_trends_by_network_reporting_region.csv

MED 2014, Electricity (Energy data and modelling), www.med.govt.nz/sectors-industries/energy/pdf-docs-library/energy-data-and-modelling/data/Electricity.xls

StatsNZ 2012, Demographic Trends: 2012, www.stats.govt.nz/~/media/Statistics/browse-categories/population/estimates-projections/demographic-trends/2012/1-pop-chge-structure.xls

StatsNZ 2014, StatsNZ population data mapped to each EDB from 1996 to 2013 provided by WELL.

FRONTIER ECONOMICS | MELBOURNE | SYDNEY
Frontier Economics Pty Ltd 395 Collins Street Melbourne Victoria 3000
Tel: +61 (0)3 9620 4488 Fax: +61 (0)3 9620 4499 www.frontier-economics.com
ACN: 087 553 124 ABN: 13 087 553 124