A General Equilibrium Analysis of Proposed Changes to the Electricity Industry

for BusinessNZ

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Authorship

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Summary

Infometrics has been requested by BusinessNZ to undertake a general equilibrium analysis of "NZ Power"; a restructuring of the wholesale electricity market, as proposed by the Labour and Green political parties.

The proposals include a number of components, some of which differ between the two parties. We focus on what seems to be the main objective of the proposals; to reduce the price of electricity.

This is modelled by a tax/subsidy switch - profits in the electricity generation industry are transferred to electricity consumers, especially households, via lower electricity prices.

The modelling results indicate that if investment in electricity generation is not deterred by the new industry structure there are very small macroeconomic gains from the simulated lower electricity prices; between zero and 0.1%. Much of the potential gain to residential consumers is lost to higher personal taxes. Personal tax rates rise in order to prevent deterioration in the fiscal balance caused by lower dividends and tax receipts from the electricity industry.

The lower electricity prices lead to an increase in electricity demand of about 3.1%, met primarily met from thermal (gas-fired) generation. It is assumed that the appropriate investment in additional generation capacity is forthcoming, although it is acknowledged that this may not be the case if investment in generation is seen as riskier under the NZ Power proposals than under the status quo.

These results should not be interpreted as forecasts. They are scenarios conditional on a set of input assumptions. There are a few areas in which the model is weak and which could cause the results to be too optimistic.

Model Scenarios

Modelling Rules

Before getting into the detail of the make-up of the scenarios, it is worthwhile outlining the variables that are held constant between scenarios. These rules are consistent with generally accepted modelling practice:[1]

1. The current account balance is fixed as a percentage of GDP. This means that if New Zealand has to purchase more international emissions units to offset higher emissions from more thermal electricity generation, that liability cannot be met simply by borrowing more from offshore.

2. Except with regards to electricity generation, the post-tax rate of return on investment is unchanged between scenarios. This acknowledges that New Zealand is part of the international capital market and ensures consistency with the preceding closure rule.

3. Any change in the demand for labour is reflected in changes in wage rates, not changes in employment. Instead of fixed employment, wage rates could be fixed at BAU levels. This implies, however, that the long run level of total employment is driven more by events in the electricity industry than by the forces of labour supply and demand, which we consider unlikely.

4. The fiscal balance is fixed across scenarios. This means for example that if government revenue falls because of lower dividends paid by state owned electricity companies, or because of lower taxes on the earnings of privately owned electricity companies, other tax rates must rise. We assume that personal income tax rates are the equilibrating mechanism. Lowering government expenditure is an alternative option.

5. The mix of public-private ownership of electricity generation companies is held constant across the reference case and scenarios.

Finally, Layton (2013) estimates that it would take five years to set up NZ Power.[2] As our analysis is not concerned with transition issues we set our scenarios in 2025, being a year that is representative of a fully functioning alternative industry structure. We examine two scenarios as described below.

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[1] See NZIER and Infometrics (2009): *Economic Modelling of New Zealand Climate Change Policy*. Report to Ministry for the Environment, May 2009. And *Macroeconomic impacts of climate change policy. Impact of Assigned Amount Units and International Trading*. Report to Ministry for the Environment, July 2009.

[2] Layton B. (2013): *The Economics of Electricity*. Electricity Authority, June.

Scenario Specification

The Reference Case:

The structure of the electricity market continues as it is currently.

Scenario 1: Lower Household Electricity Prices

The specification is identical to the Reference Case except that the proposed changes to the electricity industry in the NZ Power proposals are in place. While the proposals include a number of components, some of which differ between the two parties, for ease of comprehension it is best to model one component at a time. As the main objective of the proposals seems to be to lower electricity prices to households, this is what we simulate in Scenario 1.

To maintain comparability between studies, we assume a reduction in residential retail electricity prices of 13%, which is consistent with the expectations of the NZ Power proposals and modelling by BERL.[3]

The price reduction is simulated as a subsidy on electricity prices to households at the point of sale, paid for by an equivalent corporate tax surcharge on the operating surplus of (particularly hydro) generators. In effect a share of the operating surplus is forcibly transferred to residential consumers via lower electricity prices.

Alternative ways to simulate the policy include reducing the rate of return (which also reduces profits) or stipulating an increase in productivity. However, arbitrarily lowering an industry's cost of capital or simply assuming that the proposed restructuring would raise industry efficiency are likely to bias the analysis.

The corporate tax wedge, which is normally included in the model's link between investment and the rate of return, is turned off in the electricity industry. This means that investment in new generation capacity is not affected by the forced reallocation of profits from shareholders to electricity consumers.

Scenario 2: Lower Business Sector Electricity Prices

This scenario extends the lower electricity prices in Scenario 1 to commercial and industrial consumers, excluding the Basic Metals industry.[4] Again the lower prices are simulated by a subsidy-tax swap.

The lower residential electricity prices are retained in this scenario. Table 1 summarises the results.

[3] BERL (2013): *Results of Modelling Economic Impact of Electricity Price Changes*. Report to Office of Leader of Opposition, NZ Labour Party. April.

[4] Basic Metals includes aluminium smelting and steel production. SNZ does not separate these industries due to confidentiality restrictions.

Scenario 1: Lower Residential Electricity Prices

There is a very small gain of 0.1% in private consumption. A gain is probably expected given lower electricity prices, but one might have expected more. However, with higher household income taxes largely offsetting the increase in the real wage rate, part of the potential gain is lost.

This is a significant point. If the negative fiscal effect is ignored there is no need for corrective fiscal action, whether by reductions in government expenditure or – as we have modelled here – increases in net taxes on households. Without these actions the gain in private consumption would likely be over-stated.

The current mix of public-private ownership of generation companies is assumed. While less government ownership would reduce the fiscal impact and thus the need for tax increases, greater private sector ownership would instead see a smaller dividend flow to households. Either way there is a negative effect on household spending.

Broader measures of economic welfare such as Real Gross National Disposable Income (RGNDI) [5] show no measurable effect (that is greater than 0.05%). Similarly for GDP.

Table 1: Summary of Results

	1. Lower Residential Prices	2. Plus Lower Commercial & Industrial Prices
	% change on Reference	
Private Consumption	0.1	0.1
Gross Investment	-0.1	-0.1
Exports	0.0	0.1
Imports	0.0	0.0
GDP	0.0	0.1
RGNDI	0.0	0.1
Terms of trade	0.0	0.0
Real wage rate index	0.2	0.3
Mean effective household tax rate	0.8	1.3
CO_2 emissions	0.3	0.5
Electricity demand	1.8	3.1
Generation	PJ	PJ
Thermal	+3.2	+3.7
Renewables	+0.1	+1.8

Electricity demand rises by 1.8%, driven by a 5.9% rise in household electricity consumption – following the 13% price reduction.[6]

[5] Real Gross National Disposable Income is GDP adjusted for net offshore factor payments and for changes in the terms of trade.

Almost all of the extra demand is supplied by thermal (gas) generation, which the model selects as the best marginal increment to capacity – over and above whatever occurs in the Reference Case. Perhaps in another 5-10 years this may not be true, but the effect on the results would be minor, albeit with some impact on CO_2 emissions. However, Layton (2013) suggests that investment in thermal generation is likely to be encouraged under the NZ Power proposal relative to the status quo.

While investment in electricity generation needs to increase to meet the higher demand emanating from households, investment by other industries declines, with an overall small reduction in gross investment of -0.1%. Essentially the tax/subsidy switch reallocates resources from investment to consumption, and from investment in other industries to investment in electricity generation.

Whether the required investment would actually be attracted into electricity generation under an effective surcharge on profits (the effect of which in the model's investment demand equations has been turned off) is debatable. If not, power black-outs could occur. A rough calculation suggests that an extra 180 MW of capacity – again over and above whatever occurs in the Reference Case – would be needed by 2025.

Clearly if a higher after-surcharge tax rate of return is required under NZ Power to attract investment into electricity generation, there would be upward pressure on prices, which would choke off some of the increase in electricity demand.

Scenario 2: Lower Commercial and Industrial Electricity Prices

Scenario 2 builds on Scenario 1 by extending the lower electricity prices to commercial and industrial consumers, excluding the Basic Metals industry. The reduction is assumed to be 6%, consistent with the modelling by BERL. Again the price reduction is simulated as a 'subsidy' on the electricity price, paid for by a tax surcharge on the operating surplus of the generation industry.

Table 1 shows some very small increments in activity at the macroeconomic level, with GDP and RGNDI both rising by 0.1%, driven by a similar increase in exports. There is no further lift in private consumption and gross investment is also unchanged from Scenario 1.

Electricity consumption is 3.1% higher than in the Reference Case, with some extra generation now also coming from new renewables (geo-thermal) generation. The largest proportionate increases in electricity demand occur in the Wood Processing, Pulp & Paper, and Real Estate industries. In absolute terms the largest increases are again in Wood Processing and Pulp & Paper, but also in the Trade, Restaurants & Accommodation industry.

Some Limitations to the Modelling

There are a few areas in which the model is weak and which could cause the results to be too optimistic. For example:

[6] The model incorporates coefficients, estimated from observed household behaviour, on the sensitivity of the demand for goods and services, including electricity, to changes in price. These coefficients do not change across scenarios.

1. It does not know that residential consumers are the main cause of the need for relatively expensive peaking capacity. Thus the reduction in residential electricity prices under NZ Power could mean that households do not face the marginal cost of supply.

2. The model is poor at simulating short run marginal generation costs.

3. Transactions costs are ignored so there is no evaluation of how the costs of running NZ Power compare with the current operating costs of the industry.

Including transactions costs would likely reduce the already small increment in private consumption and exports. Similarly any divergence between price and marginal cost with regard to electricity pricing is likely to reduce the overall efficiency of the economy. The effect of not modelling short run marginal costs (which is impossible in this type of model) is difficult to determine. Insofar as demand might respond to time of day pricing the aggregation of time periods would probably lead to an underestimation of the economic benefits. However, this problem is not peculiar to the NZ Power proposal.

Summary

Overall what can be inferred from the results? Ignoring possible consequential investment effects, a forced transfer of operating surplus from the electricity generation industry to electricity consumers (with residential consumers being favoured over commercial and industrial consumers) shows a negligible macroeconomic impact. Much of the potential gain from lower electricity prices to households is offset by higher taxes on personal income needed to balance the fiscal budget, to compensate for the lower tax and dividend income from the electricity industry.

Appendix A: The ESSAM General Equilibrium Model

The ESSAM (Energy Substitution, Social Accounting Matrix) model is a general equilibrium model of the New Zealand economy. It takes into account the main inter-dependencies in the economy, such as flows of goods from one industry to another, plus the passing on of higher costs in one industry into prices and thence the costs of other industries.

The ESSAM model has previously been used to analyse the economy-wide and industry specific effects of a wide range of issues. For example:

- Analysis of the New Zealand Emissions Trading Scheme and other options to reduce greenhouse gas emissions
- Changes in import tariffs
- Faster technological progress
- Funding regimes for roading
- Release of genetically modified organisms

Some of the model's features are:

- 55 industry groups, as detailed in the table below.
- Substitution between inputs into production - labour, capital, materials, energy.
- Four energy types: coal, oil, gas and electricity, between which substitution is also allowed.
- Substitution between goods and services used by households.
- Social accounting matrix (SAM) for tracking financial flows between households, government, business and the rest of the world.

The model's output is extremely comprehensive, covering the standard collection of macroeconomic and industry variables:

- GDP, private consumption, exports and imports, employment, etc.
- Demand for goods and services by industry, government, households and the rest of the world.
- Industry data on output, employment, exports etc.
- Import-domestic shares.
- Fiscal effects.

Model Structure

Production Functions

These equations determine how much output can be produced with given amounts of inputs. For most industries a two-level standard translog specification is used which distinguishes four factors of production – capital, labour, and materials and energy, with energy split into coal, oil, natural gas and electricity.

Intermediate Demand

A composite commodity is defined which is made up of imperfectly substitutable domestic and imported components - where relevant. The share of each of these components is determined by the elasticity of substitution between them and by relative prices.

Price Determination

The price of industry output is determined by the cost of factor inputs (labour and capital), domestic and imported intermediate inputs, and tax payments (including tariffs). World prices are not affected by New Zealand purchases or sales abroad.

Consumption Expenditure

This is divided into Government Consumption and Private Consumption. For the latter eight household commodity categories are identified, and spending on these is modelled using price and income elasticities in an AIDS framework. An industry by commodity conversion matrix translates the demand for commodities into industry output requirements and also allows import-domestic substitution.

Government Consumption is usually either a fixed proportion of GDP or is set exogenously. Where the budget balance is exogenous, either tax rates or transfer payments are assumed to be endogenous.

Stocks

The industry composition of stock change is set at the base year mix, although variation is permitted in the import-domestic composition. Total stock change is exogenously set as a proportion of GDP, domestic absorption or some similar macroeconomic aggregate.

Investment

Industry investment is related to the rate of capital accumulation over the model's projection period as revealed by demand for capital in the horizon year. Allowance is made for depreciation in a putty-clay model so that capital cannot be reallocated from one industry to another faster than the rate of depreciation in the source industry. Rental rates or the service price of capital (analogous to wage rates for labour) also affect capital formation. Investment by industry of demand is converted into investment by industry of supply using a capital input- output table. Again, import-domestic substitution is possible between sources of supply.

Exports

These are determined from overseas export demand functions in relation to world prices and domestic prices inclusive of possible export subsidies, adjusted by the exchange rate. It is also possible to set export quantities exogenously.

Supply-Demand Identities

Supply-demand balances are required to clear all product markets. Domestic output must equate to the demand stemming from consumption, investment, stocks, exports and intermediate requirements.

Balance of Payments

Receipts from exports plus net capital inflows (or borrowing) must be equal to payments for imports; each item being measured in domestic currency net of subsidies or tariffs.

Factor Market Balance

In cases where total employment of a factor is exogenous, factor price relativities (for wages and rental rates) are usually fixed so that all factor prices adjust equi-proportionally to achieve the set target.

Income-Expenditure Identity

Total expenditure on domestically consumed final demand must be equal to the income generated by labour, capital, taxation, tariffs, and net capital inflows. Similarly, income and expenditure flows must balance between the five sectors identified in the model – business, household, government, foreign and capital.

Industry Classification

The 55 industries identified in the ESSAM model are defined on the following page. Industries definitions are according to Australian and New Zealand Standard Industrial Classification (ANZSIC06).

Input-Output Table

The model is based on SNZ’s latest input-output table which relates to 2006/07.

Model Industries

Abbrev	Description
HFRG	Horticulture and fruit growing
SBLC	Livestock and cropping farming
DAIF	Dairy and cattle farming
OTHF	Other farming
SAHF	Services to agriculture, hunting and trapping
FOLO	Forestry and logging
FISH	Fishing
COAL	Coal mining
OIGA	Oil and gas extraction, production & distribution
OMIN	Other Mining and quarrying
MEAT	Meat manufacturing
DAIR	Dairy manufacturing
OFOD	Other food manufacturing
BEVT	Beverage, malt and tobacco manufacturing
TCFL	Textiles and apparel manufacturing
WOOD	Wood product manufacturing
PAPR	Paper and paper product manufacturing
PRNT	Printing, publishing and recorded media
PETR	Petroleum refining, product manufacturing
CHEM	Other industrial chemical manufacturing
FERT	Fertiliser
RBPL	Rubber, plastic and other chemical product manufacturing
NMMP	Non-metallic mineral product manufacturing
BASM	Basic metal manufacturing
FABM	Structural, sheet and fabricated metal product manufacturing
MAEQ	Machinery and other equipment manufacturing
OMFG	Furniture and other manufacturing
EGEN	Electricity generation
EDIS	Electricity transmission and distribution
WATS	Water supply
WAST	Sewerage, drainage and waste disposal services
CONS	Construction
TRDE	Wholesale and retail trade
ACCR	Accommodation, restaurants and bars
ROAD	Road freight transport
RAIL	Rail transport
WATR	Water transport
AIRS	Air Transport
TRNS	Transport services
PUBI	Publication and broadcasting
COMM	Communication services
FIIN	Finance and insurance
HIRE	Hiring and rental services
REES	Real estate services
OWND	Ownership of owner-occupied dwellings
SPBS	Scientific research and computer services
OBUS	Other business services
GOVC	Central government administration and defence
GOVL	Local government administration
SCHL	Pre-school, primary and secondary education
OEDU	Other education
MEDC	Medical and care services
CULT	Cultural and recreational services

REPM	Repairs and maintenance
PERS	Personal services