Response to AER on its draft determination on ACT energy forecasts

ACTEWAGL

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Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Floor 11, 452 Flinders Street
Melbourne VIC 3000
PO Box 312, Flinders Lane
T +61 3 8668 3000
F +61 3 8668 3001
www.jacobs.com

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1. Introduction

In May 2014 Jacobs prepared load projections for ActewAGL in preparation for its regulatory draft determination for the 2014/15 to 2018/19 regulatory period. In November 2014 the Australian Energy Regulator (AER), responded to the ActewAGL submission with a rejection of its energy throughput forecast. The AER proposed an alternative set of models chosen from among the list of models that ActewAGL has rejected. The AER response includes a critique of various elements of the load projections supplied, which are addressed in this document. The AER critique is summarised in Table 1, which also references the location of Jacobs' response. The order of the items is intentionally inconsistent with that presented within the AER critique to aid reader comprehension of complex material.

Table 1: Summary of AER critique

Number	AER Criticism	Jacobs response section
1	**The preferred models do not include price as an explanatory variable, which the AER considers is important in determining consumption levels**	2.1
2	**The specification of the dependent variable in preferred models is inadequate**	2.2
3	**The approach to model selection suffers from the biasing effects of autocorrelation**	2.3
4	**The drivers of customer forecasts were not considered in sufficient detail,** including how the profile of customers may change over the forecast period.	3
5	**ActewAGL did not conduct tests to ensure it has not double-counted energy efficiency schemes.** This is especially important in the Residential GP category where energy efficiency has a particularly strong effect.	4

2. Model choice issues

In the electricity market, usage is derived from the use of associated services including appliances and equipment; these appliances and equipment are operated under different conditions (e.g. temperature sensitive or process related operation), and such equipment is in operation over different lifetimes, reflecting varied rates of stock replacement over the various markets serviced by electricity companies. In addition to these, there is some scope for consumption to reflect behavioural changes associated with price response or changing economic conditions. These factors can make the forecasting of electricity usage especially challenging, as analysts must contend with determining appropriate processes for dealing with:

- Weather adjustment
- Technology change, including energy efficiency and increasing presence of embedded, distributed generation[1]
- Changing retail prices and economic conditions
- Lagged impacts of any of the above

There exist a number of approaches to the forecasting of electricity load. Econometric modelling and end-use modelling, and various combinations of these, are the most often used methods for medium and long term load forecasting. The approach chosen by ActewAGL is an econometric approach, which combines statistical techniques with economic theory. Either least-squares approaches or time series approaches are generally adopted; however, as the load forecasts generated for ActewAGL are based on least-squares approaches, the following discussion will be restricted to this topic.

The approach typically adopted by forecasters in the development of top-down econometric models is to undertake weather normalisation based on seasonal data prior to selection of an appropriate economic model using annual data. Often modellers will also add back elements reflecting structural change in the market such as energy efficiency and embedded generation to better reflect consumer response to external factors such as price and wealth measures. These approaches were adopted in the modelling undertaken for ActewAGL.

Overall, the ActewAGL modelling was undertaken with a completely open slate – all models considered reasonable were estimated and compared and the preferred models were selected based on rigorous statistical criteria rather than a priori preferences for using certain explanatory variables.

2.1 Choice of explanatory variables

Extract from the AER response:

"ActewAGL preferred models do not include price as an explanatory variable and the subsequent failure to undertake post-model adjustments to account for the effect of price on consumption. Given the acknowledged importance of price in determining consumption, it is common practice to account for price either directly in the regression model or as a post-model adjustment.[2] With the reduction in price following the removal of the CPRS the consumption forecasts may be too low without explicit price adjustments."

A prevalent issue in econometric modelling is that no fixed approach works in every situation. The analyst must judge whether an explanatory variable is justified by the additional explained variance in situations of variable sample size and model specification is not known a priori. The most common objective approaches to model selection include stepwise approaches, the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC), which was the approach used to undertake the modelling for ActewAGL. Each of these approaches is described in Table 2, including a summary of limitations and advantages. Other approaches exist, such as the deviance information criterion, the focused information criterion, Mallows' C_p, and cross-validation. However the focus of this review has been limited to the most commonly used / well known approaches to facilitate a speedy response to ActewAGL.

[1] Fuel switching would be considered important in the longer term but for the five year period of these forecasts is considered unlikely to materially influence electricity consumption

[2] See for example AEMO (2014), Forecasting methodology information paper, available from http://www.aemo.com.au/Electricity/Planning/Forecasting

Table 2: Objective approaches to model selection

Approach	Description
Stepwise approaches	These approaches usually involve adding predictors in a step by step (stepwise) fashion or removing predictors in a stepwise fashion until the best model is reached. An issue with these approaches is that the final model chosen can vary depending on the model choices made at each step. These approaches were typically used prior to the development of more objective approaches such as the Akaike and Bayesian Information criteria.
Bayesian Information Criterion	• This approach is based on Bayes theory, which considers joint distribution of two variables. • Possible to derive a probability for each variable using Raftery's procedure • Reports probability for each possible model with the given variables, depending on the following inputs: Population size, Sample size (degrees of freedom), and deviance or chi-squared statistic • The approach requires multivariate normal data, large sample size and a nested model • Flaws include that the approach is computationally intensive, may produce over-confident results for large datasets, there have been recorded situations where random relationships sometimes pass the test, that widely varying results are possible when combined with stepwise regression, and that the only other significance testing method (re-sampling) provides no guidance on form or content of model *Source: "Using the Bayesian Information Criterion to Judge Models and Statistical Significance", presentation delivered by Paul Millar, University of Calgary,* http://www.stata.com/meeting/5nasug/Millar_BostonBIC.ppt

Approach	Description
Akaike Information Criterion (used for the ActewAGL load forecasts)	• The Akaike information criterion (AIC) is a measure of the relative quality of a statistical model for a given set of data. As such, AIC provides a means for model selection. It is generally the most widely known and used model selection tool. • The AIC statistic describes a trade-off between the goodness of fit of the model and the complexity of the model. It is based on information theory, and is calculated as follows: $AIC = 2K\text{-}2\log(L)$ where K is the number of predictors and L is the likelihood statistic, where the 2K part of the formula is similar to a penalty for including extra predictors in the model, and the -2log(L) part represents goodness of fit. There will almost always be information lost due to using a candidate model to represent the "true" model (i.e. the process that generates the data), and the model that minimises this information loss can theoretically be chosen using the AIC. The likelihood function is a mechanism which enables estimation of parameters as well as selection of them. The likelihood function reflects the conformity of the model to the observed data, so a more complex model will be reflected by a greater value of L. The optimal model is identified as that with the lowest AIC. • AIC does not provide a test of a model in the sense of testing a null hypothesis; i.e. AIC can tell nothing about the quality of the model in an absolute sense. If all candidate models fit poorly, AIC will not give any warning of that. However, AIC can be used to delineate between different fitted models having the same dimension. AIC can also be used to compare models with different probability distributions and can be used with non-nested models. The AIC is recognised as asymptotically efficient; that is, it will select the fitted candidate model which minimizes the mean squared error of prediction. • Flaws include that the formulation should be modified if the sample size is small, because the AIC will be negatively biased making comparison difficult. That is, the 2k part should be replaced with an alternative. Consequences for using AIC in small sample sizes are that the modelling may be biased towards higher dimensional models. The literature suggests that AICC (shown below) would be more appropriate[3]. *Source: "171:290 Model Selection Lecture II: The Akaike Information Criterion", Joseph E. Cavanaugh, Department of Biostatistics, Department of Statistics and Actuarial Science, The University of Iowa, August 28, http://myweb.uiowa.edu/cavaaugh/ms_lec_2_ho.pdf*
Akaike Information Criterion with Correction (AICC)	The AICC is the same as the AIC with a correction for finite sample sizes; i.e. $\mathrm{AICC} = AIC + \frac{2k(k+1)}{n-k-1}$ where *n* denotes the sample size and k denotes the number of explanatory variables. The AICC is therefore equivalent to the AIC with a greater penalty for extra parameters. AICC converges to AIC as n gets large. The formulation provided holds when the model is linear with normally distributed errors.

Of the methods presented, the AIC or AICC present theoretical advantages over the BIC, because it will select the model with the least mean squared error in most practical situations, and converge to an optimum scenario at a faster rate[4].

Based on the descriptions provided in Table 2, the approach undertaken to select models for the development of forecasts for ActewAGL is robust, appropriate and objective. In addition, the approach was comprehensive, as the original forecasting exercise examined a large set of model structures for each market, taking into account zero efficiency/gross energy considerations, total consumption/consumption per customer/consumption per person variations, and variations based on set of independent variables considered and transformations on

[3]Burnham, K. P.; Anderson, D. R. (2002), Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach (2nd ed.), Springer-Verlag, ISBN 0-387-95364-7

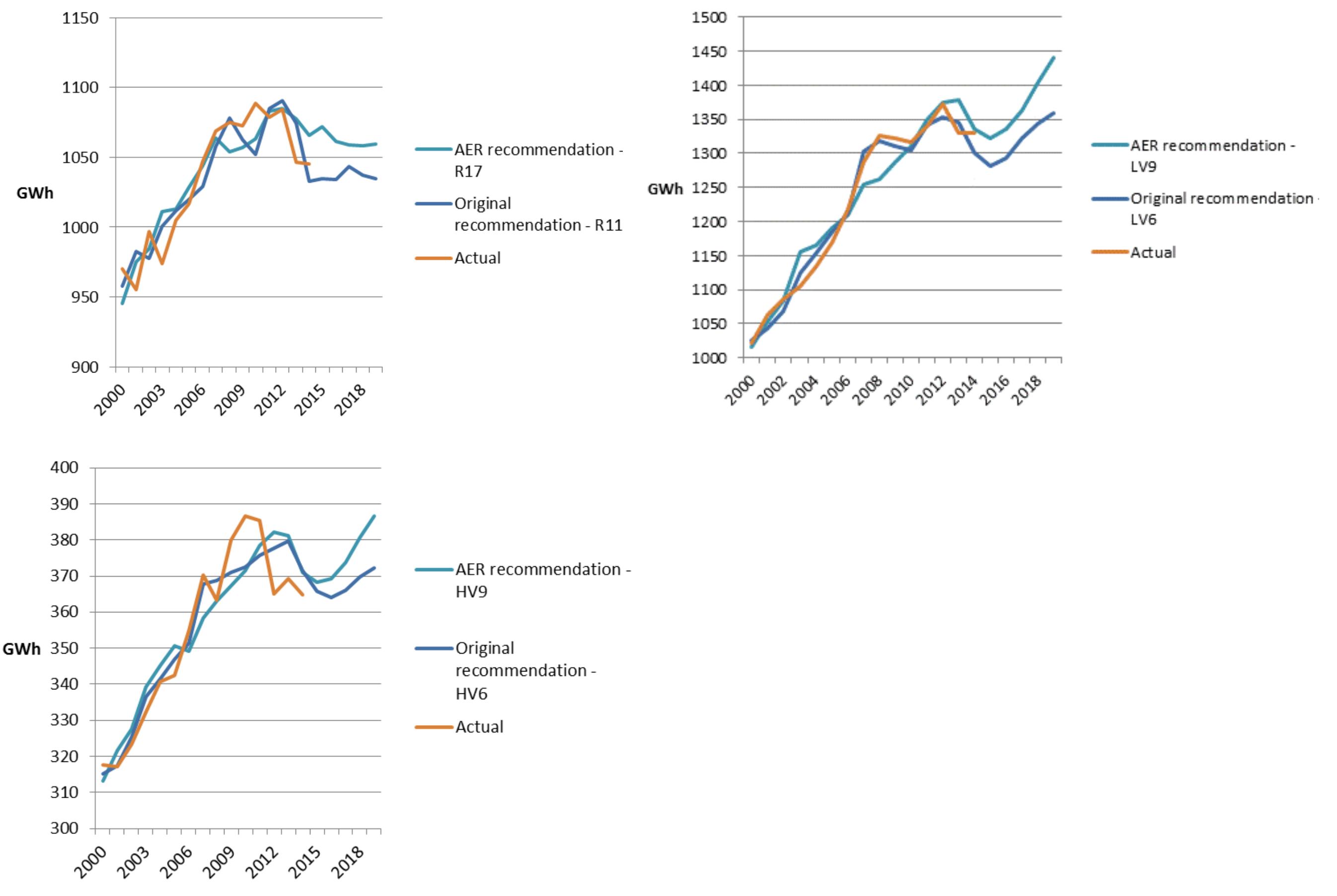
[4]Yang, Y. (2005), "Can the strengths of AIC and BIC be shared?", Biometrika 92: 937–950, accessible at http://www.jstor.org/discover/10.2307/20441246?uid=3739912&uid=2134&uid=2487708073&uid=2&uid=70&uid=3&uid=2487708063&uid=3739256&uid=60&sid=21105439652993

those independent variables including taking logarithms. At least 182 models were considered for the residential sector, and at least 28 models were reviewed for the LV sector.

It is the aim of statistical regression modellers to develop parsimonious yet robust models. That is, models that are as simple as possible (i.e. fewest predictors needed to satisfactorily explain variation in load), yet provide a reasonable amount of explanatory power. Model parsimony is important because over-parameterisation can lead the model to be overly influenced by chance events in the existing dataset and so provide inferior predictions as compared to a simpler model. However, the AER approach does not appear to have undertaken such an objective approach to model selection; in both the residential and LV markets the model selected appears to be the one that has yielded the highest load forecast (see Figure 1) without regard to indicators of model quality. In particular, the AER has specified a preference for models that include price predictor variables, even if these variables do not add to the information quality of the model. One reason why the AER claims price is required is to adequately assess potential increases to demand following the repeal of the CPRS. However, it is worth remembering that the federal government provided significant levels of compensation payments to consumers when this was introduced so it is possible that the impact of the CPRS in FY2013 was not material enough to be measurable by an econometric model in the presence of other market price increases, and this assertion appears to be supported by the model selection process.

Figure 1 also provides an indication of model performance when the newly available FY2014 load is included for comparison. The FY2014 data appears to be consistent with preferred model outcomes, especially in the residential and HV sectors.

Figure 1: Comparison of projections under the AER and Jacobs preferred models



Source: Jacobs' analysis

The literature review underlying Table 2 also reveals a potential area for improvement in the Jacobs approach, and that is that the models were compared with the AIC statistic rather than the AICC statistic. This means that the preferred model could have been over-specified because the sample size is small. While this would seem unlikely (because all models chosen had only two independent variables) it was felt that it would be worthwhile to review the results with the AICC statistic instead to remove any doubt. Undertaking this exercise revealed that the models selected would not change using the AICC statistic.

Table 3 compares indicators of model quality under each recommendation. The table demonstrates that the models chosen to include a price variable lose significant ability to minimise information loss, implying lower predictive capability. The AER models chosen for the HV and LV markets also exhibit auto-correlation.

Table 3: Models chosen and comparison of indicators of model quality

Model type	Model choice	Model	R^2	Relative likelihood to first feasible model with minimum AICC	Notes
Residential GP	Original submission	R11	60%	100%	
	AER preference chosen to include a price variable	R17	54%	37%	
LV	Original submission	LV6	99%	100%	
	AER preference chosen to include a price variable	LV9	96%	0.01%	Significantly auto-correlated
HV	Original submission	HV6	95%	100%	Auto-correlated
	AER preference chosen to include a price variable	HV9	90%	1%	Significantly auto-correlated

Source: Jacobs' analysis. Relative likelihood refers to the probability that a chosen model will minimize information loss in the dataset relative to a model with the minimum AIC value, calculated using the function $\exp((AIC_{min}-AIC_i)/2)$

2.2 Specification of dependent variables

Extract from the AER response:

"The ActewAGL preferred model for the Residential GP category modelled consumption per person.[5] However, we understand it is standard procedure to conduct consumption forecasts on the basis of consumption per customer as this accounts for factors such as disconnections and customer density.[6] Changes in population will not necessarily translate into increased customers if, for example, population change is driven by births as it does not result in new households. Furthermore, using population as the basis of consumption forecasts does not adequately address the increasing trend towards higher density living and the implications of this trend for the nature of energy consumption.

For the Commercial LV category, ActewAGL modelled total annual consumption.[7] We understand it is also standard practice to forecast commercial consumption on a consumption per customer basis for the Commercial LV category. By not conducting the analysis using consumption per customer, ActewAGL implicitly assumed that trends in historical commercial connections and consumption per customer will continue. However, an analysis of non-residential customers reveals that this is not a linear series. Between 2003 and 2004, commercial LV customer numbers fell by 4.7 per cent, from 13,403 to 12,797. Therefore, without validation, it may not be reasonable to assume that historical trends will continue.

For the Commercial HV category, ActewAGL also modelled total annual consumption.[8] We note customer numbers have been almost flat over the historical period, with 22 customers in 2000, 23 in 2002 and 24 in 2013. Given this, we consider it is reasonable to produce the forecasts on a total consumption basis (rather than consumption per customer)."

It is noted that the AER has a preference for forecasts based on consumption per customer rather than consumption per person. Forecasts based on consumption per customer were also tested as part of the model selection process for ActewAGL. The performance (measured in terms of relative likelihood) of the top three

[5] ActewAGL, Regulatory proposal: Attachment C3: Trends in ACT electricity consumption, 12 May 2014, p. 51.
[6] See for example ACIL Tasman, Energy consumption forecasts 2011-12 to 2016-17: Energy consumption forecasts for Aurora Energy covering six customer classes: Prepared for Aurora Energy, April 2012.
[7] ActewAGL, Regulatory proposal: Attachment C3: Trends in ACT electricity consumption, 12 May 2014, p. 52.
[8] ActewAGL, Regulatory proposal: Attachment C3: Trends in ACT electricity consumption, 12 May 2014, p. 54.

(zero efficiency residential) models is displayed in Table 4.The consumption per customer version ranks third, well behind the first two models chosen.

For the residential sector, the AER stated that "Changes in population will not necessarily translate into increased customers if, for example, population change is driven by births as it does not result in new households". We do not accept this argument. Trends in persons per household have remained very static in recent years, with recorded household size statistics of 2.6 persons per household in the Canberra statistical area for the 2001, 2006 and 2011 census as run by the Australian Bureau of Statistics[9]. It would seem unlikely that this would change over the medium term, and therefore there would appear to be little reason to switch projection methods to incorporate a change in dependent variable unless that model provided greater predictive capability, which did not appear to be the case when consumption per customer models were also tested.

Table 4: Relative performance of consumption per customer compared with consumption per person models[10]

Dependent variable type	Model	Relative likelihood
Consumption per person	R11	100%
Consumption per person	R13	94%
Consumption per customer	R15	46%

Source: Jacobs' analysis

For the LV sector the AER observed that *"(LV) is not a linear series. Between 2003 and 2004, commercial LV customer numbers fell by 4.7 per cent, from 13,403 to 12,797. Therefore, without validation, it may not be reasonable to assume that historical trends will continue."* The reduction in customer numbers observed is largely attributable to reclassification of unmetered customers, who were revised from 525 to 41 in July 2003. Also, in the process of defining customers according to NMI's, general tariff customers fell from 11,351 to 11,170, while community customers fell from 133 to 126 and Business TOU customers fell from 211 to 179. Non-linearities in customer numbers are a common feature of DNSP commercial MIRN data. They often relate to customers being switched from commercial to residential status, which has large impact on commercial numbers but not on residential, or some other data definitional change. The lack of continuity provided by reclassification of customers is the principle reason for not using a forecast dependent variable based on usage per customer.

Jacobs considers that in these circumstances it is preferable to relate total energy directly to economic variables rather than to work with compromised data or, to avoid the data problems, to work with shorter data series. Jacobs considers that this approach results in more robust forecasts.

2.3 Testing of candidate models for autocorrelation

Extract from AER's response:

[9] http://www.censusdata.abs.gov.au/census_services/getproduct/census/2006/communityprofile/805

[10] Note that it is generally not good statistical practice to compare models with different dependent variables using AIC statistics. However in this situation, it is possible to show that the models can be re-expressed so that the dependent variable is equivalent and the scaling variable (persons or customers in this case) is a dependent variable with the coefficient forced to be 1. i.e.

$$Ln(E) = \alpha + \beta_1 ln(x_1) + \beta_2 ln(x_2) +..+ ln(P) + \varepsilon$$

Is equivalent to

$$ln\ (E/P) = \alpha + \beta_1 ln(x_1) + \beta_2 ln(x_2) +..+ \varepsilon$$

where E refers to total energy consumption, P refers to persons or customers, x_i refers to each independent variable and α, β_i refer to the model coefficients. ε refers to the error term. The above is true because ln(E/P) is equivalent to ln(E)-ln(P), and therefore this re-expression only works for log-log formulations. This means that it is reasonable to compare such models using AIC statistics in this instance.

"Our analysis of model residuals and calculation of Durbin Watson statistics revealed that some of the models ActewAGL put forward for selection suffered from an autocorrelation problem.[11] We noted earlier that ActewAGL selected its preferred model using certain criteria such as the overall models' R^2 values and the model coefficients t-statistics.[12] However, the presence of autocorrelation means the standard errors of the coefficients (and subsequently the t-statistics and R2) may not be correct and are likely to be overestimated. Hence, ActewAGL's approach to selecting the preferred model is not appropriate.

For commercial LV, our analysis indicated ActewAGL's preferred model (LV6) did not suffer from an autocorrelation problem.[13] However, two of the models that ActewAGL compared the LV6 model to did have an autocorrelation problem. Hence, we consider ActewAGL's approach to selecting its preferred model is still not appropriate."

Jacobs re-ran the regression models for the residential and LV markets from the previous stage of work and extracted the Durbin Watson test statistic to confirm whether the models suffered from autocorrelation problems. The model selection process was also rerun so that revised forecasts could be compared against the existing approach and the AER recommendation.

It was determined that none of the residential models conclusively suffered from autocorrelation, and therefore we do not accept AER's assertions that the residential modelling process was invalid.

It was also determined that three of the models assessed for the LV market do suffer from positive autocorrelation. However, these were not chosen as the final preferred model. The AER has suggested that the presence of these models has invalidated the selection process. We do not accept this argument as invalidation of the final preferred model, because an objective approach was used for model selection (i.e. the AIC approach). The presence of invalid models under this approach simply leads to exclusion of these models but the ranking of all remaining models remains the same. Jacobs notes that the AER model choice does suffer from autocorrelation, and therefore we do not accept that this model is a valid substitute.

[11] For the residual plots, see figures 5.1–5.6 and 5.8–5.12 in ActewAGL, Regulatory proposal: Attachment C3: Trends in ACT electricity consumption, 12 May 2014, pp. 46–57.

[12] ActewAGL, Regulatory proposal: Attachment C3: Trends in ACT electricity consumption, 12 May 2014, pp. 44–45.

[13] For the residual plot, see figure 5.9 in ActewAGL, Regulatory proposal: Attachment C3: Trends in ACT electricity consumption, 12 May 2014, p. 54.

3. Projections of customer drivers

Extract from AER response:

"We consider ActewAGL did not consider the drivers of customer forecasts in sufficient detail, including potential changes to customer profiles over the 2014–2019 period. We therefore consider ActewAGL should further investigate the factors we describe below when developing its customer number forecasts.

ActewAGL assumed growth in Residential GP customer numbers will mimic the moderation in population growth (using forecasts from BIS Shrapnel) in the 2014–2019 period. That is, ActewAGL assumed customer numbers increase at an annual rate of 1.36 per cent. As we describe below, this may be a simplistic way to forecast customer numbers. We note, for example, that growth in customer numbers between 2000 and 2013 was 1.9 per cent per annum, with growth at 2.4 per cent per annum between 2009 and 2013.

ActewAGL did not disaggregate its customer number projections by new connections, existing connections and disconnections. We understand disaggregating forecasts in this way is standard practice when developing consumption forecasts. Customer number forecasts should also incorporate changing trends in housing density by separating new connections into estates and medium/high density dwellings.

Furthermore, the forecasts do not account for trends in customers switching from entirely electricity-based consumption to electricity and gas-based consumption. By excluding this from the analysis, ActewAGL are implicitly assuming that the historical trend will continue over the forecast period. However, with developments in the gas market, and recent gas price rises, we would not expect this to be the case."

As mentioned in section 2.2, the number of persons per household has remained relatively static in the ACT between 2001 and 2011. Therefore it is reasonable to assume that customer numbers will grow at the same rate as population. Population growth in the ACT between 2009 and 2013 was 0.4% pa higher than growth between 2000 and 2013[14].

Disaggregation of forecasts into new and existing connections and disconnections is uncommon for studies providing annual projections[15]. In general, the number of connections and disconnections will be proportional to customer numbers on an annual basis, although we understand that seasonal patterns may affect monthly or quarterly estimates should these have been required. Exceptions may occur in developing countries where there may be significant economic, social or demographic change in a short period of time.

The AER also discusses trends in housing density, suggesting separation of new green-field estates from existing development which involves tearing down existing low or medium density development and replacing it with medium or high density development. Generally speaking, development of such a model would require greater level of detail in energy consumption data (e.g. disaggregated on the type and size of premises) than most distributors can presently access, as data collection processes are not geared around separately collecting data on new developments. This is a data issue that probably cannot be addressed in the near future. Nevertheless, it would be expected that:

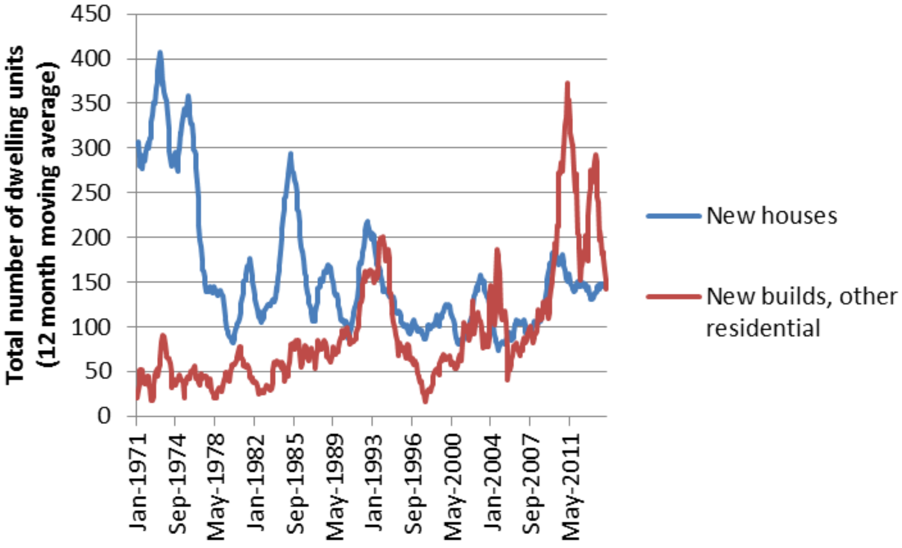
- the trends towards increasing house size in separate dwellings may increase energy usage, and this is to some extent captured in the wealth parameter of the regression model
- the trends towards higher density development will reduce energy usage per dwelling (because of lower floor space for heating and cooling, and because apartments that share walls, floor and ceilings can have lower heat losses and therefore lower energy requirements for heating), acknowledging that central facilities such as lifts, laundry, foyers and shared outdoor facilities may compensate for some of the reduction

The proportion of new higher density build will probably grow at higher rates than separate dwellings, based on recent trends in housing development (see Figure 2), and therefore the ActewAGL forecast could be overstated.

[14] Source: Jacobs' estimates of population growth, based on ABS data sourced 12/12/2014. See http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3101.0Mar%202014?OpenDocument

[15] See for example ACIL Tasman, Energy consumption forecasts 2011-12 to 2016-17: Energy consumption forecasts for Aurora Energy covering six customer classes: Prepared for Aurora Energy, April 2012.

Figure 2: Number of dwelling approvals in ACT, 12 month moving average



Source: Jacobs' analysis of ABS 8731.0

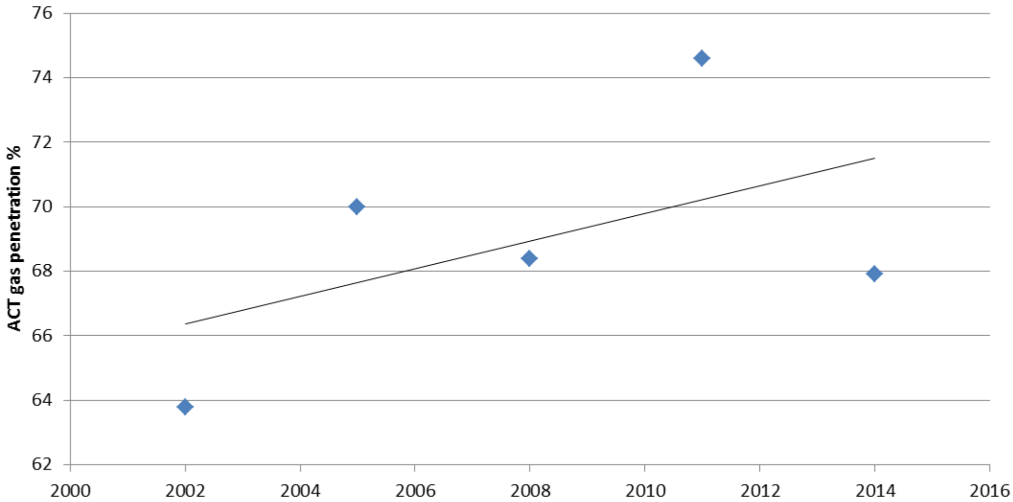
Finally, the AER is concerned that trends in fuel switching from entirely electricity-based consumption to electricity and gas-based consumption are not considered, particularly in light of expectations of gas price increases.

The expectations of gas price increases have recently undergone significant reduction in light of global oil price reductions. This means that future expectations of gas price rises are no longer as significant as previously thought. Internal Jacobs' estimates indicate that wholesale gas prices are likely to increase around $1.50/GJ to $3.00/GJ less than previous expectations. Depending on the level of those previous expectations, we would expect that gas prices could remain at recent levels of around $4/GJ or increase to $7/GJ.

Recent history of consumer fuel prices also indicates that movement in gas prices has not been as closely linked to gas penetration as one might expect. Between 2002 and 2011, gas penetration has trended upward from around 64% in 2002 to around 75% in 2011[16], as shown in Figure 3. However, during the same period, gas prices were increasing at a faster rate than were electricity prices (compared to a reference year of 1991), as shown in Figure 4. In 2014, gas penetration is similar to 2008 levels, even though gas prices are relatively lower than electricity prices in 2014 compared to where they were in 2008. The implication of the preceding analysis is that any modelling including gas prices would be much more complex because it would also require concurrent consideration of change to gas usage to enable sense checking of the resulting elasticity estimates. The inclusion of gas variables may also have substantially reduced the number of degrees of freedom available for testing the robustness of the model (in a relatively small data set), as it may also have required time lags appropriate to detect changes in the underlying stock of equipment to obtain a meaningful result.

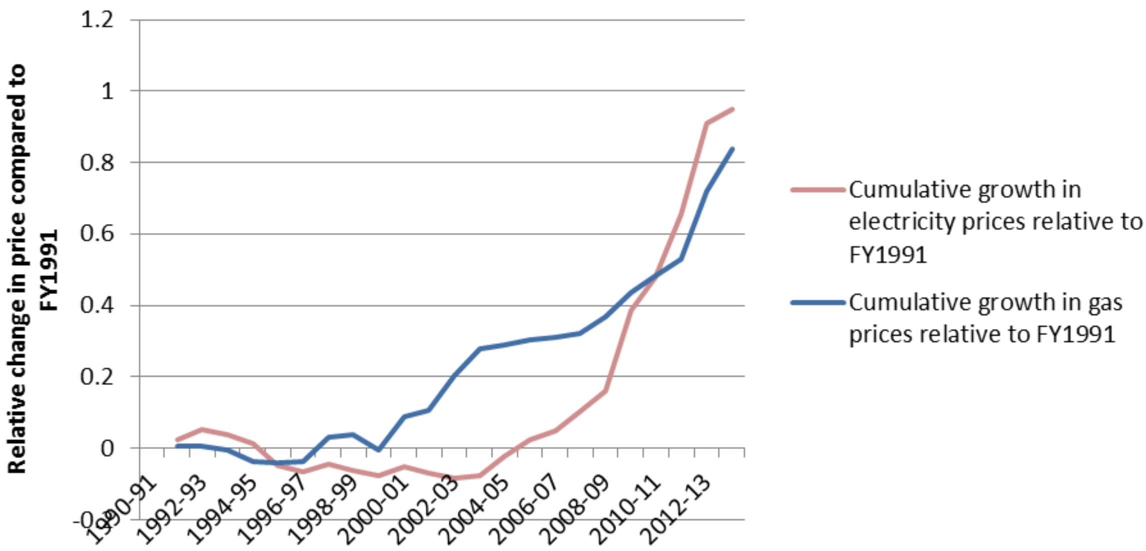
[16] Source: ABS 4602.0.55.001 Environmental Issues: Energy Use and Conservation Mar 2008, 2011 and 2014.

Figure 3 Gas penetration in the ACT



Source: Jacobs' analysis of ABS 4602.0.55.001

Figure 4 Change in real electricity and gas fuel costs relative to 1991, NSW



Source: Jacobs' analysis of ABS 6401.0, table 12

4. Energy efficiency considerations

Extract from AER response:

"ActewAGL incorporates the impacts of energy efficiency policies and PV uptake in the modelling in two different ways:

- *The first approach removes the impact of energy efficiency from the historical consumption series and conducts the regression analysis on 'zero efficiency' consumption. The 'zero efficiency' forecasts are then adjusted for forecast energy efficiency improvements and PV output. ActewAGL adopted this approach for its preferred models.*
- *The second approach includes the annual improvements in energy efficiency as an explanatory variable in the regression.*

ActewAGL assumes the impact of ACT energy efficiency policies will not affect the impact of Commonwealth policies in the short term and therefore combines the future impacts of both ACT and Commonwealth energy efficiency policies. As AEMO noted, there is potential for double counting and scheme interactions when adjusting consumption forecasts for energy efficiency policies at the state and national level[17]. ActewAGL, however, argue that ACT policies just bring the impact of Commonwealth policies forward and, as such, will not result in double counting over the 5 year forecast period.[18]

Changes in energy efficiency over history and the forecast period have a large impact on the energy consumption forecasts. We consider ActewAGL should have conducted a sensitivity analysis on the strength of the energy efficiency assumption. This is consistent with the AEMO's rapid, moderate and slow uptake scenarios.[19]

By 2019 ActewAGL assumed Residential GP consumption will be 26 per cent lower than if energy efficiency policies were not in place.[20] The assumption that ACT policies can be combined with Commonwealth policies over the forecast period (without double counting) is therefore important in the consumption forecasting process. While there is insufficient evidence to conclude this is an unreasonable assumption, we consider its effect should be tested. Furthermore, AEMO's report (on which ActewAGL based its analysis) was written prior to the removal of CPRS. Given the interaction between price incentives and the uptake of energy efficient appliances, there may be some double counting."

The energy efficiency policies considered in the projections include the Energy Efficiency Incentive Scheme (EEIS) implemented by the ACT government; Mandatory Energy Performance Standards (MEPS) for appliances implemented by the federal government and improved building insulation standards.

The AER notes that there is potential for double counting and scheme interactions when adjusting consumption forecasts for energy efficiency policies at the state and national level. However, based on a Jacobs' review[21] of the EEIS in August 2014, it is considered likely that zero or negligible[22] interactions will exist between the EEIS and MEPS. This is the case because it is the intention of the EEIS to only include energy savings above mandatory standards (if this is not the case the energy savings are not considered to be additional to what would occur without the policy in place). This occurs through the program calculating lifetime equipment emissions savings using energy use estimates from high efficiency equipment against current equipment performance standards.

AER also notes that the AEMO report indicating the level of efficiency savings was written prior to the removal of the CPRS. However, the EEIS efficiency savings are based on targets which are a percentage of projected energy use; therefore these energy savings should be provided with or without a CPRS in place. Energy savings based on efficiency standards (MEPS), should be undertaken irrespective of electricity price levels because they are mandated – customers replacing appliances can only purchase new appliances that are more efficient than their old ones. It is therefore unlikely that the ActewAGL projections include any double counting. It should therefore not be necessary to undertake sensitivity analysis[23] to test the impact of possible double counting.

[17] AEMO, 2013 Forecasting methodology information paper: National electricity forecasting, 2013, p. 5-45.
[18] ActewAGL, Regulatory proposal: Attachment C3: Trends in ACT electricity consumption, 12 May 2014, pp. 62–63.
[19] AEMO, 2013 Forecasting methodology information paper: National electricity forecasting, 2013, p. C-9.
[20] ActewAGL, Regulatory proposal: Attachment C3: Trends in ACT electricity consumption, 12 May 2014, p. 63.
[21] Jacobs' review of the EEIS supplied to the ACT government, available at http://www.environment.act.gov.au/__data/assets/pdf_file/0003/642315/ACT-EEIS-Review-Final-Report.pdf
[22] While it is expected that zero interactions are likely, there may be some low level of interaction as EEIS administrators may not adjust emissions factors in time with introduction of new standards, leading to a lagged effect.
[23] The process of undertaking sensitivity analysis could require rework of the model selection process which would require extensive rework.

5. Other considerations

5.1 Confirmation that forecasting has taken account of the net metering arrangements that apply to future installations of PV systems

ActewAGL requested confirmation that forecasting has taken account of the net metering arrangements that apply to future installations of PV systems.

The original residential sector projections developed by Jacobs were based on subtracting commercial and industrial load as well as network losses from total network inputs, where total network inputs include estimates of PV generation provided by ActewAGL. Jacobs has confirmed that this results in residential estimates net of PV exports.

ActewAGL has confirmed that existing customers were metered on a gross metering basis; that is, including PV generation with other consumption from the grid. However, from October 2013, new PV customers are metered on a net basis; i.e. only including the difference between total site consumption and generation. No change is required to the methodology used to generate residential data to accommodate this.

6. Conclusions

Table 5: Summary of AER critique

Number	Criticism	Conclusions	Action taken, if any
1	**The preferred models do not include price as an explanatory variable, which the AER consider is important in determining consumption levels**	Disagree. Refer to section2.1.	Reject suggestion
2	**The specification of the dependent variable in preferred models is inadequate**	Disagree. Refer to section 2.2.	Reject suggestion
3	**The approach to model selection suffers from the biasing effects of autocorrelation**	Disagree because model selection approach is robust. See section 2.3.	Reject AER LV and HV selection because each suffers from autocorrelation.
4	**The drivers of customer forecasts were not considered in sufficient detail,** including how the profile of customers may change over the forecast period.	Disagree. See section 3.	Provide additional explanation to AER.
5	**ActewAGL did not conduct tests to ensure it has not double-counted energy efficiency schemes.** This is especially important in the Residential GP category where energy efficiency has a particularly strong effect.	Not required because schemes are independent. See section 4.	Provide additional explanation to AER. Seek confirmation from ACT government if necessary.