SADEM model review

NZIER assessment of approach, recommendations and fitness for purpose

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NZIER was established in 1958.

Authorship

This report was prepared at NZIER by John Stephenson. It was quality approved by John Ballingall.

We thank Qing Yang for his assistance.

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Summary

We have reviewed the results of the SADEM model review and the overall approach to the review undertaken by MED.

Our review was conducted in two stages. We provided initial feedback on draft results of the review and the MED Energy Information and Modelling team refined its approach on the basis of our feedback and conducted further investigation. We have subsequently reviewed the final results of MED's review.

We are satisfied that the approach taken is reasonable and fit for purpose within the limits of the time and resources available to the MED Energy Information and Modelling team.

We recommend that forecast model performance be reviewed each year using the model performance diagnostics in MED's SADEM model review and extended to include measures of model error due to external forecast error.

Table 1 summarises our assessment of the review's main recommendations.

Table 1 Recommendations

MED recommendation	NZIER assessment
Recommendation 1: maintain the current two stage forecasting process	Agree
Recommendation 2: reject the current econometric models and re-specify as follows: Residential demand = Numbers of Households * Demand per household, where Demand per household = f(GDP per household, Energy Price, Constant) Commercial demand forecast is a weighted average of following forecasts: Log Commercial demand = f(log Commercial GDP, log Commercial demand t-1, Constant); Commercial demand annual %Δ = f(Commercial GDP annual %Δ) Light industrial demand annual %Δ = f(Industrial GDP annual %Δ, Energy price annual %Δ)	Agree
Recommendation 3: replace the current market share elasticity parameter with separate elasticity values for each fuel, based on the relative prices between the fuels	Agree
Recommendation 4: remove the current "fuel conservation" price elasticity parameter, and instead introduce the "Aggregate price" indicator variable into the stage one forecast for Residential and Light Industry.	Agree
Recommendation 5: consider alternative electricity-specific forecasts (as well as the MED Outlook forecast) when determining the GPA demand forecasts	Agree

Source: NZIER

Fitness for purpose

The purpose of the SADEM model is as an input into MED's annual Energy Outlook publication which is intended to provide a view on structural trends in energy demand and supply and to inform public debate on these issues.

The results of the MED review will produce forecasts which are fit for this purpose. A full list of our criteria for assessing fitness for purpose is contained in Annex 1.[1] In our view, the approach taken by MED in its SADEM models strikes the right balance across these criteria.

Forecast models and approaches need to be tailored according to the audience, time horizon, and practical constraints. This is of particular importance in the context of long term forecasting, as is the case for the Energy Outlook. Long term forecasts need to put a premium on understanding structural trends (as opposed to short term deviations from trends) and make specific allowance for the introduction of qualitative or judgemental input (i.e. external validation and Delphi processes).

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[1] The framework is based on the forecasting literature and on NZIER staff's collective practical experience in forecasting and the use of forecast models for informing debate amongst people without technical forecasting expertise.

The proposed SADEM forecasts justifiably put a premium on:[2]

1. **Transparency**: This is very important because the forecasts are likely to be of interest to a wide and non-technical audience.

2. **Simplicity**: This will assist in enhancing transparency. It requires a trade-off against short term accuracy but this is appropriate given the long term forecast horizon used in the Energy Outlook and the necessary focus on trends. Simplicity will reduce costs on the forecast process in terms of updates, model maintenance and knowledge management. It will also assist when introducing qualitative judgement (or Delphi processes) to the forecasts.

3. **Explicability**: The models include variables which make intuitive sense as drivers of energy demand (e.g. prices and incomes), while complexity has been minimised. This will aid in communicating forecast results, especially to a non-technical audience, and will facilitate the inclusion of qualitative judgement in the forecast process.

We agree with the assessment that the SADEM forecasts on their own <u>may</u> not be adequate for the purpose of Grid Planning Assumptions (GPAs) and that further attention probably needs to be paid to the electricity demand forecasts if they are to be used for grid planning purposes.

Using forecasts for grid planning is quite a different, albeit related, purpose to the MED Energy Outlook. It may be that grid planning demands more detail and a smaller premium on transparency, simplicity, and explicability compared to the case of the Energy Outlook.

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[2] The importance of these attributes for long term forecasting are also discussed in a Statistics Research Associates (2010) review of the Electricity Commission's 2009 demand forecast model. http://www.ea.govt.nz/industry/modelling/demand-forecasting/demand-forecast-review-documents/.

Process and diagnostics

The review process has been systematic and the need for model improvements has been clearly identified.

This view is based on our assessment of:

- Transparency of explanations and availability of information
- Systematic evaluation criteria used (e.g. model error and back-cast errors as well as parameter and error stability)
- Exploration of a range of potential explanatory variables and model specifications.

We are also satisfied by MED's response to issues raised by our initial review and to requests by us for further information on forecast procedures and diagnostics.

Practicality

MED's approach is reasonable given various practical constraints faced by the MED Energy Information and Modelling team, such as: data quality, software availability, knowledge management and accessibility for new staff who may have to carry out forecasts.

We were asked to consider if a simpler modelling approach is warranted given these limitations. In our view, the approach taken strikes the right balance between simplicity/transparency and model accuracy/sophistication. Further simplification would provide negligible benefits but would reduce the explicability and accuracy of the forecasts.

Decisions taken to forecast minor series like residential coal demand using simple averaging and judgement-based methods are the right ones given the purpose of forecasting long term trends.

Forecast equations

The forecast equations used by MED are sound. The review has taken adequate account of the explicability of model equations in terms of using intuitive and theoretically consistent demand drivers in forecast equations.

The parameter estimates from regression analyses make intuitive sense and appropriate effort has been made to account for potentially problematic or positive statistical properties such as stationarity and testing for the presence of cointegration. Relevant tests of model fit have been considered.

The approach taken to estimate fuel substitution elasticities is somewhat irregular but we believe it will serve the forecasting process well.[3] It offers a useful and simple point of focus for external validation, qualitative judgement and Delphi discussions. Furthermore, we tested alternative econometric specifications and found that more sophisticated approaches would not improve forecast accuracy (at least within the context of the overall approach taken by MED).

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[3] The estimates are conducted separately from individual fuel demand price elasticities and using a different estimation technique. Wherever possible, substitution elasticities (or cross-price elasticities) should be estimated at the same time as "own-price" elasticities as the two are clearly interrelated.

Exogenous inputs

The principal exogenous inputs used by MED are GDP and households. Alternative forecast inputs could be used which would be theoretically more justified, such as GNE, but the review has adequately justified its departure from theory by focusing on goodness of fit.

The introduction of industry GDP into the forecast models is useful in terms of explicability of forecasts and as a reference point in discussions with stakeholders and in any Delphi process. It does introduce some complications as industry level GDP is more volatile than aggregate GDP. However this is offset by enhanced explicability.

We are, however, cautious about the use of industry GDP as an explanatory variable if this means that forecasts will be based on non-government forecasts, such as those produced by NZIER. It would be best if the MED energy demand forecasts are consistent with the macroeconomic outlook produced by the Treasury. It is also important that industry GDP forecasts, if used, are consistent with GDP forecasts used in the residential demand model.

We also recommend that MED consider regularly decomposing forecast model errors into errors arising from exogenous forecasts (e.g. GDP) and those arising from forecast model error. It is unlikely that this diagnostic procedure would alter the findings of the MED review. It would, however, provide transparency around what drives model results and would assist in the communication of reasons for forecast error.

Appendix A Fitness for purpose: criteria

The principles we have used for evaluating fitness for purpose include:[4]

1. **Transparency**: Users of forecasts, if not the forecasters themselves, benefit from relationships which are mathematically obvious and easily understood, conceptually. This allows interpretation of the effects of changes to the model and avoids the problem that forecasts change simply because a statistical feature of the model has changed. In this sense, complex systems, where causation is intermediated by a variety of other variables are problematic from a user's point of view. **Transparency is not, in and of itself valuable**. It depends entirely on the audience and use of the forecasts.

2. **Simplicity**: This is closely related to 1. A forecast may be very transparent but comprise a large number of forecast equations and thus may not be simple. Simplicity is a long standing convention in both econometric analysis and analytical methods more generally (e.g. Occam's Razor). Complexity also imposes costs on the forecast process in terms of updates, model maintenance and knowledge management. Thus it needs to be traded off against potential benefits to accuracy from increased complexity.

3. **Stability**: Depending on purpose, stability is either useful or detrimental. For short term forecasting, too much stability, either in parameter values or in forecast trajectories is problematic because it limits the ability of the model to respond to new information and to incorporate it in the forecast. The end result can be a forecast which doesn't reflect current market conditions. On the other hand, when short term dynamics are incorporated into longer term or structural forecasting it can be difficult to discern trends and forecasts may change sharply from update to update. This can undermine confidence in the forecasting process.

4. **Sensitivity**: A variable may make sense conceptually but if it has little practical explanatory power or has a tiny impact on forecast outcomes, then there is little point in estimating it. Similarly, volatile exogenous variables may need to be avoided where forecast models results a very sensitive to them.

5. **Feasibility**. It may seem that it goes without saying that an approach which is not feasible is not worth pursuing, however it is important from a user's point of view to

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[4] Note that we do not include accuracy. This goes without saying, however in forecasting accuracy is unknown and is a function of other decision variables such as stability and complexity.

note that a large number of conceptually reasonable models, parameters or variables cannot be used simply because it is not technically feasible to use them e.g. for reasons of data availability, quality or length of time series.

6. **Consistency**: deviations from prior practice or forecasting conventions and methods used by other key agencies need to be well justified. The method employed should not be constrained to follow what others do or by past methods, but use of different approaches should be easily justifiable and explicable.

7. **Explicability**: Incorporating forecast drivers of intuitive relevance is important for engaging others in the forecast process and for explaining forecast outcomes. Related forecasts should also move in obviously related directions and "add up" where appropriate; which commends system-based estimation. This does, however, need to be traded off against feasibility, the need for simplicity and the need to exclude variables which have little explanatory power.