

3rd International Workshop on Empirical Methods in Energy Economics (EMEE2010)

Surrey Energy Economics Centre (SEEC)

University of Surrey, UK

24th – 25th June 2010

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Forecasting Daily Peak Electricity Demand in Australia with an Economic Based Evaluation

Workshop on Empirical Methods in Energy Economics, 24th June 2010

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Contents

Forecasting Daily Peak Electricity Demand in Australia with an Economic Based Evaluation

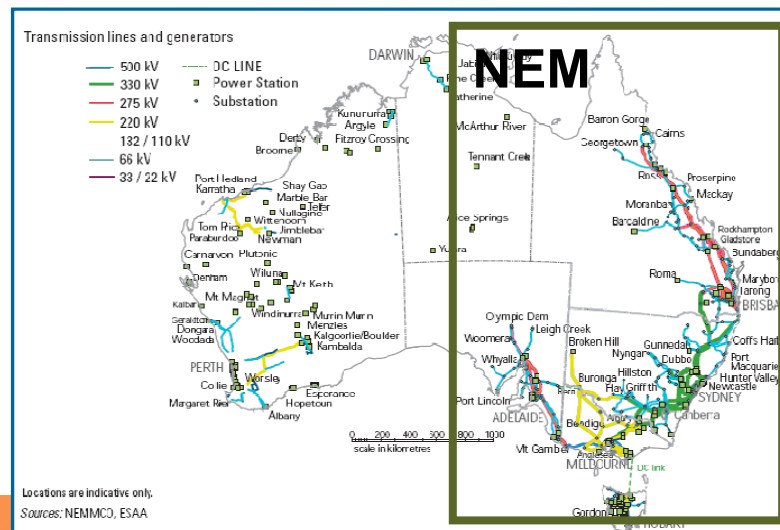
1. Background
2. Research Question
3. Data
4. Method
5. Results
6. Conclusion



Background

Medium-Term Forecasts in Australia

- The Australian Energy Market Operator (AEMO) is responsible for managing power system security and reliability.
- Task: Allocate capacity to each region to meet 10% POE demand plus Minimum Reserve Levels, according to the Reliability Standard.
- Purpose: Take and coordinate appropriate measures:
 1. Response of markets participants
 2. Contracting of additional reserve capacity is required





Research Questions

- What is the impact of accounting for spatial temperature variability on regional daily peak demand forecasts?
- What are the features of resampling techniques required for medium-term forecasting to describe the uncertainty of future temperatures in the estimation of a density forecast of peak demand?
- What can be gained by using economic based measures i.e. that the forecast would adequately advice its purpose, compared to using only statistical measures?

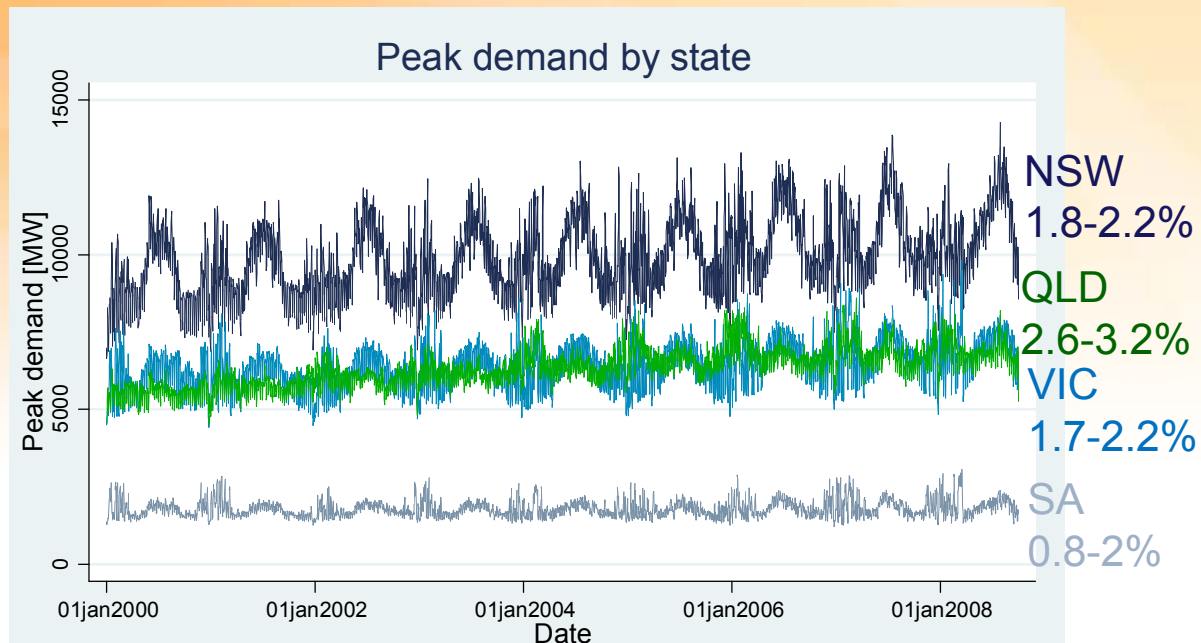
Aim:

Develop an econometric model and resampling techniques for medium-term forecasting of daily peak electricity demand which successfully combines the dynamics of short- and long-run models AND evaluate these forecasts according to provide more informative measures to market participants.

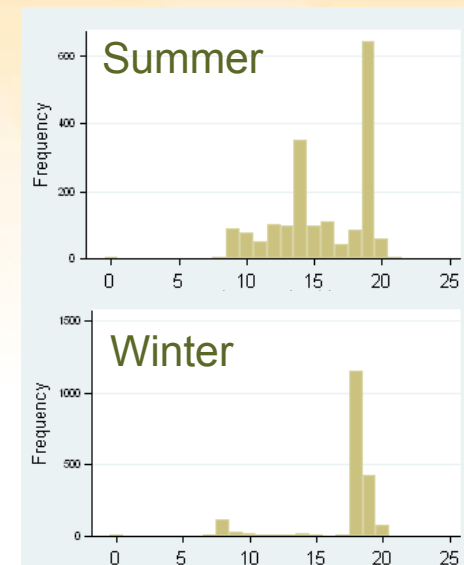


Data

- Trends, annual growth and time of the peak



Time of the day



Dataset: regional electricity demand and temperatures with half-hour resolution are transformed into a series of maximum daily demands and daily heating, cooling degrees in four NEM states (Queensland, Victoria, South Australia, New South Wales). Model based on the period 2000-2005.



Method

- A generalised ARDL model is estimated for each season:

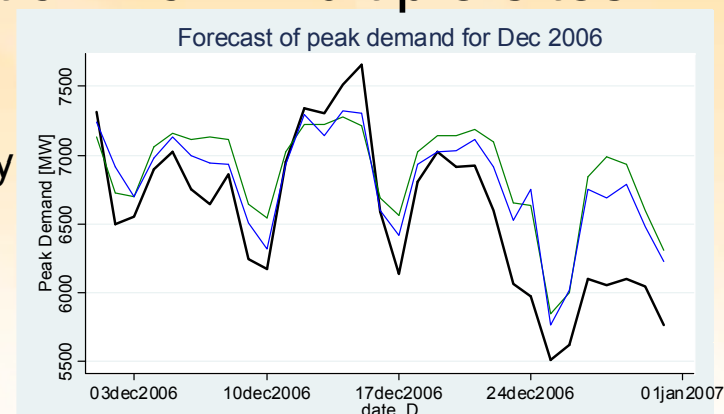
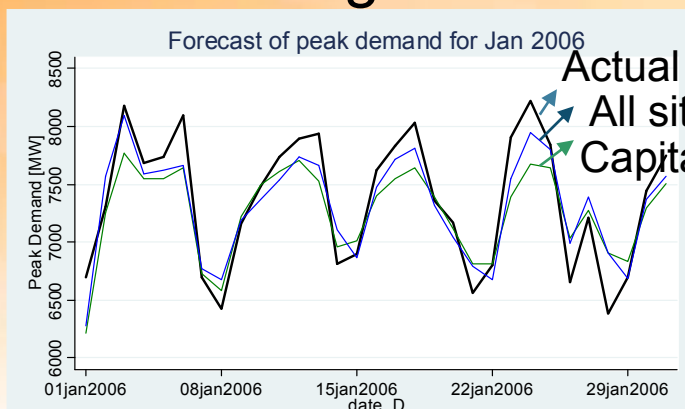
$$peak_t = \alpha_0 + \beta_0 t + \delta_1 dow_t + \delta_2 moy_t + \delta_3 hdays_t + \sum_{n=1}^8 \beta_n peak_{t-n} + \sum_{n=1,7} \vartheta_n dow_t \cdot peak_{t-n} + \sum_{i=1}^6 \sum_{n=0}^8 (\gamma_{i,n} pop_i \cdot HDD_{i,t-n} + \phi_{i,n} pop_i \cdot CDD_{i,t-n}) + u_t$$

Where $peak_t$: peak demand on day t , dow : dummies day of the week, moy : dummies month, $hdays$: dummies for holidays, pop_i : population share at site i

- Diagnostic test: final specification for each season
- Forecast peak demand using actual values of exogenous variables. Statistical evaluation criteria: RMSE, MAPE, Theil Inequality Coef.
- Produce density forecasts: upon 1000 samples of daily blocks of historical temperatures. Account for any serial correlation or ARCH effects in the error term.
- Evaluate likely implications on decision making as a set of outcomes (use 10%POE and 90% POE values)
 - Assessing benefits or costs associated: market simulations

Results: Queensland

- Gain of using weather information from multiple sites



Seasonal Models:

- Multiplicative seasonality of peaks
- Log specification is preferred (heteroscedasticity)
- ARCH effect only present in summer
- Serial correlation only present in autumn

Statistical Accuracy:

- Root Mean Squared Error (RMSE): 740-2100MW
- Mean Average Percentage Error (MAPE): 5-6.6%
- Theil Inequality Coefficient: 0.05-0.13

Results: Queensland

Decision making

Forecasts of daily peak demand

Other input info:

- energy capacity
- maintenance outages
- wind power forecasts

Medium Term
Projected Assessment of
System Adequacy

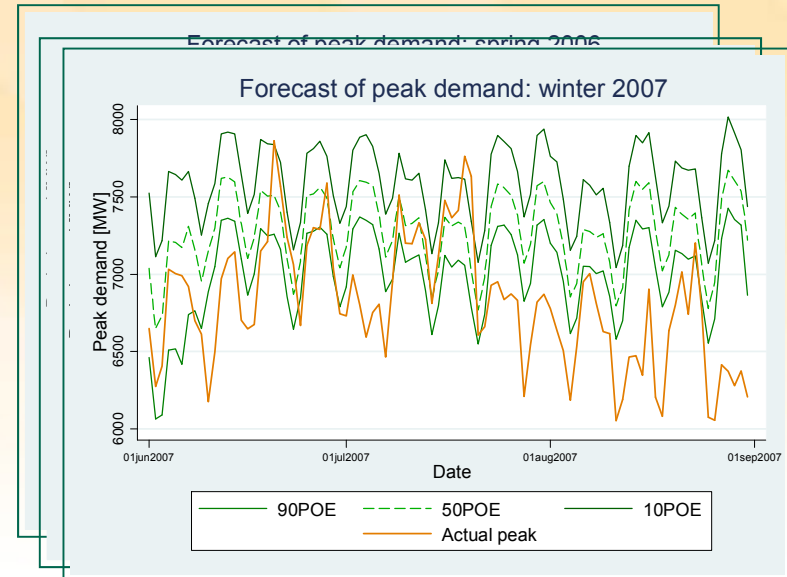
Projections of reserve levels
at daily peak:

Are minimum reserve
levels, according to
reliability standards, met?

Actions
to take:

Voluntary market response
e.g. rescheduling of maintenance

Market intervention required:
contracting for additional reserve



CASES:

- Overpredictions i.e. $90POE > \text{peak}$ ($\pi=0.57$)
 - Unnecessary actions may have been taken
- Underpredictions i.e. $10POE < \text{peak}$
 - Required contracted reserves may have not been established (no cases): scheduled capacity-peak < 500MW, otherwise
 - Contracted reserve is insufficient ($\pi=0.07$)



Conclusions

- A time series of peak demand can be modelled in four seasonal ARDL models which provide good statistical accuracy for the medium-term.
- Density forecasts:
 - Low probability of underpredicting peak demand: it adequately advises decision making in terms of contracting reserve supply.
 - Higher probability of overpredicting peak demand: it may advise unnecessary market response.
- Future work:
 - Economic based evaluation measures into one figure for the market
 - Improving current resampling techniques
 - Modelling the long-run trend.



Acknowledgements

- Supervisors: Professor Denzil Fiebig (School of Economics, UNSW), Dr. Regina Betz (School of Economics and CEEM, UNSW)
- Information and data provided by Richard Hickling from the Australian Energy Market Operator (AEMO).
- Other data: Bureau of Meteorology, the Australian Bureau of Statistics and AEMO's Statement of Opportunities 2009.

Thank you!