Drayton Analytics

ADVANCED ECONOMIC MODELING & ANALYSIS

Competition Benefits and the ACCC Regulatory Test

Overview of Submission by Drayton Analytics to ACCC on behalf of ElectraNet SA

28 July 2003

Contents

1. Primary Issues

- Agree that benefits arising from reductions in market power are legitimate economic impacts that should be included in the benefit-cost assessment, however:
  - Benefits from market power reduction are implicitly included in the test's definition of 'market benefit' *i.e.* they are allowable under the current test; and
  - Singling out 'competition benefits' implies (incorrectly) that these benefits are not allowable under the current test; and further
  - This may inadvertently lead to proponents overlooking or disregarding other legitimate benefits from consumption changes that have no relationship to market power reductions.

1. Primary Issues, Continued

- The test allows for demand-side impacts, and these should be made more explicit.
- In the current framework, the only attempt to proxy such effects is through the estimation of reductions in unserved energy (priced at VoLL).
- Although short-run demand is highly inelastic, it is not zero, and over the life of a project, demand elasticity may be significant.
- By ignoring this, the current test places disproportionate emphasis on supply-side effects e.g. reduction in fuel costs, and delay of capital.
- Thus it is **not** necessary to develop a separate test to specifically address benefits from market power mitigation.

1. Primary Issues, Continued

- The current lack of clarity is the primary source of confusion, misapplication, and manipulation.
- The ACCC review should focus on improving the clarity of the current test w.r.t. evaluating changes in the net value of consumption resulting from price changes.
- All the proposed methodologies require some assumption about the movement of prices post interconnection relative to the *status quo*.
- Optimization-based simulation provides the most effective and robust tool for this analysis.

2. Recommendations

1. The definitions of producer and consumer surplus should be explicitly stated, and the test should clarify that if these measures are calculated correctly, the include all relevant economic benefits and costs.
2. If ‘competition benefits’ are to be drawn out specifically, they would be better termed ‘consumption benefits’ and include any real benefits (or costs) that accrue from interconnection creating changes in the value of consumption.

2. Recommendations, Continued

3. The ACCC should develop guidelines for proponents addressing both data and methodology, recognising that:
   - Electricity demand is not completely insensitive to price changes, and modeling can estimate such relationships and the resulting price impacts on consumption; and
   - Modeling anti-competitive (strategic) behaviour by generators under a range of plausible scenarios is an integral component of assessing these benefits.

3.1. Hirshmann-Herfindahl Index

- HHI is a measure of market concentration (num. of suppliers and their market shares).
- HHI has a theoretical basis in competition theory (under very rigid assumptions), but this does not diminish its limitations:
  - HHI provides information about the distribution of sales among producers but it says nothing about the impacts of an increase/decrease in price by one or more firms.
  - Specifically it ignores nature of the product, producer behaviour, price elasticity of demand, market entry and exit.
- And further, in applying the HHI it is necessary to identify the markets, but this requires an estimate of the pre and post interconnection market shares, and the hours of constraint (hours in which the two regions are a single market versus separate markets).
- Thus the HHI does not (on its own) provide a measure of benefits.

3.2. Commercial Benefits Test

- CBT uses historical levels of settlements residues as a proxy for competition benefits.
- The concept is sound *i.e.* reducing future congestion is beneficial, however:
  - Use of historical data to proxy benefits avoids the complexity of market modeling but it may produce outcomes that are entirely uneconomic.
  - The current proposal attributes the same level of benefit to any size of interconnection, which is clearly not consistent.
  - Reductions in settlement surpluses do not necessarily reflect changes in market power *i.e.* surpluses will change regardless of whether or not market power is mitigated.

3.3. Stanwell Competition Index

- SCI is a qualitative approach.
- Qualitative approaches are appropriate where benefits and/or costs cannot be easily monetised.
- It has not been demonstrated in this context that competition benefits cannot be monetised, although the computational requirements may be onerous.
- However, the SCI would need to produce ranges of likely benefits and it is not clear how this would be done without reference to market simulation studies.
- Further, the introduction of qualitative aspects to the test is likely to lead to further dispute.

3.4. Powerlink Benefits Test

- Market simulations, to capture competition benefits, would be applied only if a project's circumstances meet certain criteria.
- Thus this proposal can be characterised as 'conditional' market simulation.
- Refer to Market Simulation Studies later in this presentation.

3.5. Market Simulation Studies

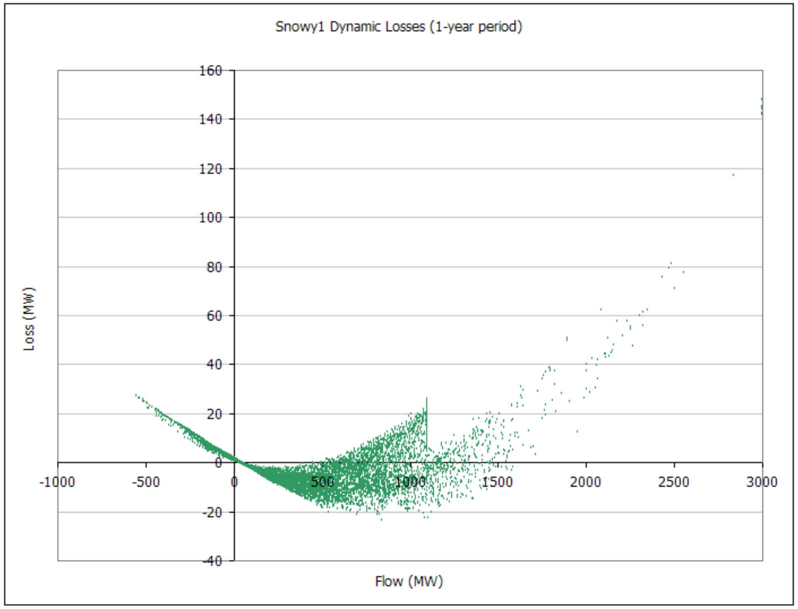
- Market simulation is required by most of the proposed measures of competition benefits.
- Rather than standing alone as a measure of competition benefits it is best thought of as an integral (and unavoidable) component of these benefit-cost studies.
- Market simulation consists of four components:
  1. Analytical engine and solution method.
  2. Network model.
  3. Behavioural model.
  4. Input data.

3.5.1. The Analytical Engine

- Choice of heuristic (rule-based), and optimization (mathematical programming based) methods.
- Heuristic models are inflexible, algorithmically fragile, not open to audit ('black boxes'), and inconsistent with methods (linear programming) used to clear 'real' markets.
- Mathematical programming (can be) flexible, and is algorithmically robust, directly auditable, and consistent with market clearing models *e.g.* NEMDE (SPD)
- Math. Programming also produces additional information (*e.g.* dual solution values) that have direct economic interpretations (in fact this is how price discovery occurs).

3.5.2. Network Model

- Regions and nodes;
- Inter-regional transmission;
- Supply and demand balance
- Marginal loss factor equations;
- Network security constraints (generic constraints)
  - Settlements.



3.5.3. Behavioural Model

- "How does one model pricing above SRMC in a manner that can i) closely match observed historical behaviour and ii) sensibly react / adapt to future periods and changes in interconnector and generating capacities?"
- There are a number of possible approaches:
  - Sample published bids or calculate historical price-cost markups and project forward (see later discussion on RSA).
  - Use a Cost Recovery model (*e.g.* to recover fixed costs or historic levels of net revenues)
  - Use a Game Theoretic model of imperfect competition.

3.5.3. Behavioural Model, Continued

Cost Recovery:

- Cost recovery is an integrated component of the PLEXOS software.
- Generator bids are formulated dynamically, and account for:
  - Demand conditions
  - Interconnector constraints
  - Outages
- The simulation uses rounds of bidding in an attempt to recover costs (variable + fixed), but does not guarantee that all costs will be recovered (or indeed that producers won't 'overshoot' their targets)…

3.5.3. Behavioural Model, Continued

Cost Recovery, Continued:

- The benefits of interconnection can be assessed by running the simulation with and without the augmentation with fixed cost requirements.
- Differences in the net revenues of producers between the pre and post augmentation provide a proxy for ‘competition benefits’ – if it is required to isolate this effect alone; but in any case:
- this method produces plausible market dispatch and pricing outcomes and therefore should calculate benefits ‘correctly’.
- The advantage of this method is that bids dynamically adapt to market conditions, and can be based on fundamental long term drivers *e.g.* LRMC.

3.5.3. Behavioural Model, Continued

Shadow Bidding:

- Shadow bidding is built into the PLEXOS software.
- Producers set bid prices equal to the marginal cost of the next supplier in the merit order (ala Bertrand competition).
- The merit order changes dynamically as a result of:
  - Generator outages;
  - Transmission constraints;
  - Changes in market structure (e.g. interconnector expansion o new generator entry).
- Advantage is the method is relative simple, and largely preserves the SRMC merit order.

3.5.3. Behavioural Model, Continued

Nash-Cournot Competition:

- Directly models interaction of producers and demand response.
- Models an objective of profit maximization under the constraints implied by Cournot competition.
- Recent theoretical advances have made implementation of Nash-Cournot competition into ‘practical’ market simulation achievable.
- The Plexos software includes both ‘snapshot’ and medium term Nash-Cournot competition based on the work of Ben Hobbs (JIT).
- The method requires estimation of long-run (linear) demand functions.
- This has yet to be thoroughly vetted on the NEM system, although initial studies have produced promising results.

3.6. Residual Supply Analysis

- Developed by Department of Market Analysis at the California ISO as a tool for assessing market benefits of interconnection
- Drayton Analytics has worked with Cal-ISO to incorporate RSA into the Plexos software.
- Cal-ISO are using Plexos to as their production cost tool for use in RSA.
- The technique has recently been applied, by Drayton Analytics, to modeling the Australian NEM (see Plexos Knowledge Base www.plexos.info).

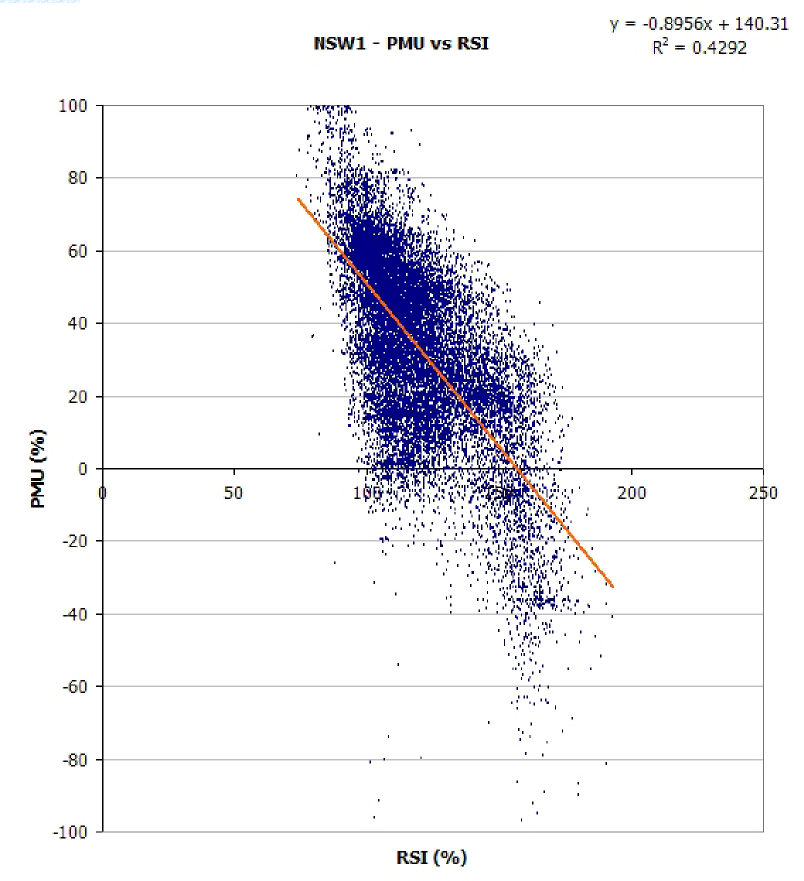
3.6.1 Methodology

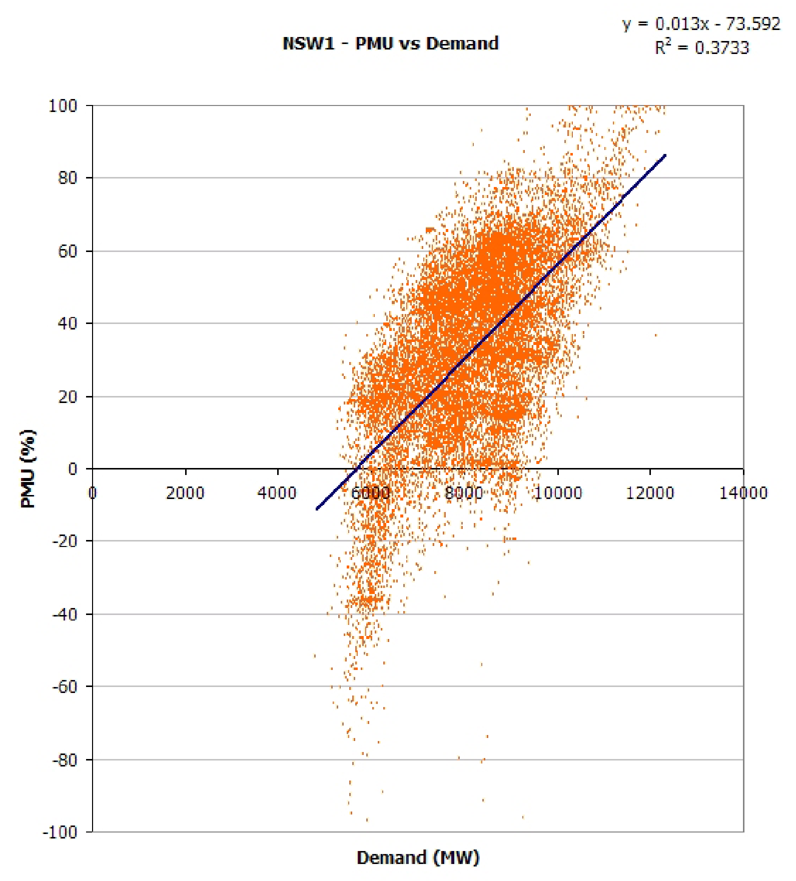
- Price-cost Markup (Lerner Index):
  - $PMU = (P - C)/P$
  - P = price outcome from market
  - C = estimated marginal-cost price
  - PMU is best thought of as a measure of the extent to which the market price consists of mark-up *e.g.* if PMU = 50% then prices are 100% above the competitive level.
- Residual Supply Index:
  - $RSI = (TAS - \text{Max}(TUC))/D$
  - *TAS* is the total available supply (sum of all available capacity) *Max(TUC)* is the available supply from the single largest supplier *D* is the demand
  - RSI represents the proportion of demand that is supplied by all but the largest supplier
  - We define RSI Gross, which is based on demand, and RSI Net, which is based on demand + net interchange

3.6.1 Methodology, Continued

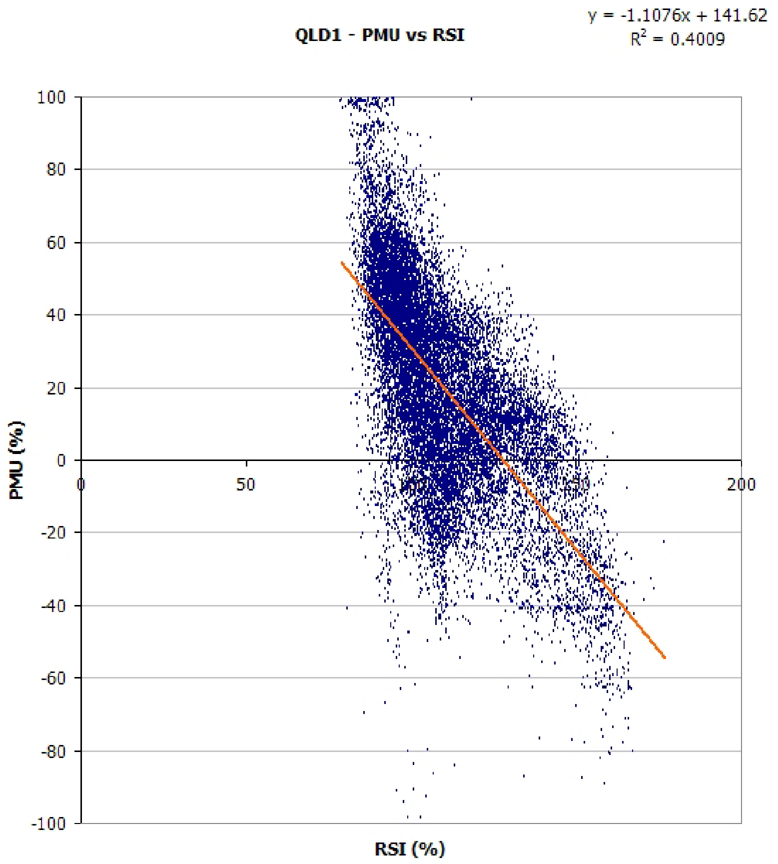
- 'C' is the market price that would have occurred under marginal cost bidding.
- Calculating 'C' is complicated by:
  - Outages and other constraints
  - Strategic withdrawal of capacity
  - Energy constrained plant *e.g.* hydro
  - Contracts
- Our approach:
  - Use simulation of the market (PLEXOS) with: estimated thermal costs, actual outages and transmission limits, hydro availability.
  - PLEXOS reproduces the market outcomes, but can also calculate RSI and 'C' and hence we can derive PMU.
  - We then regress PMU against RSI.
  - Expect that PMU falls as RSI increases *i.e.* markups decrease as the share of demand met by the residual suppliers increases and vice versa.

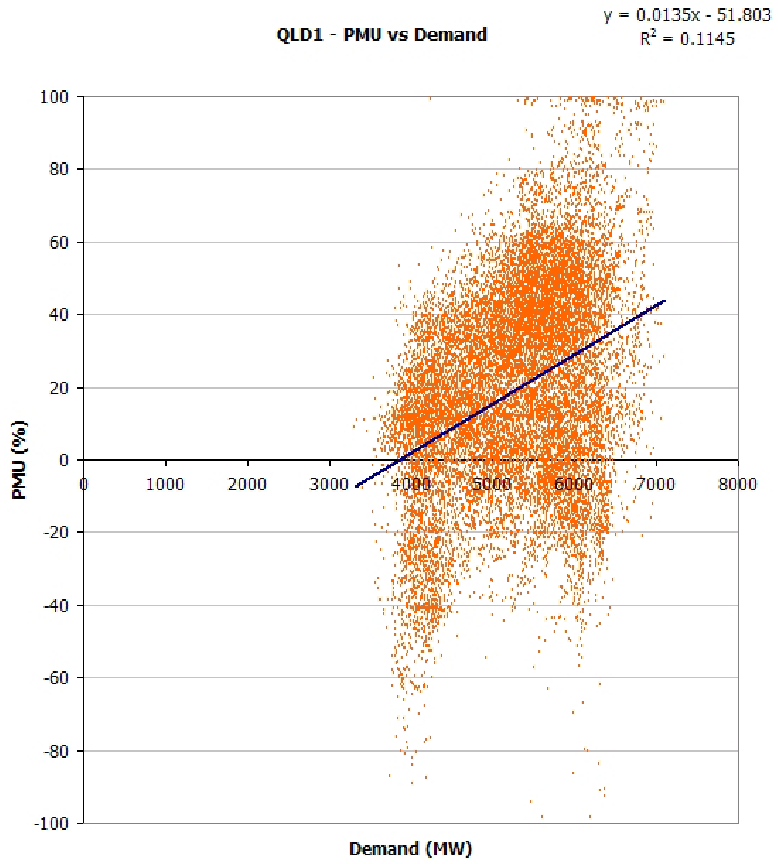
3.6.2 Regression Results, Continued



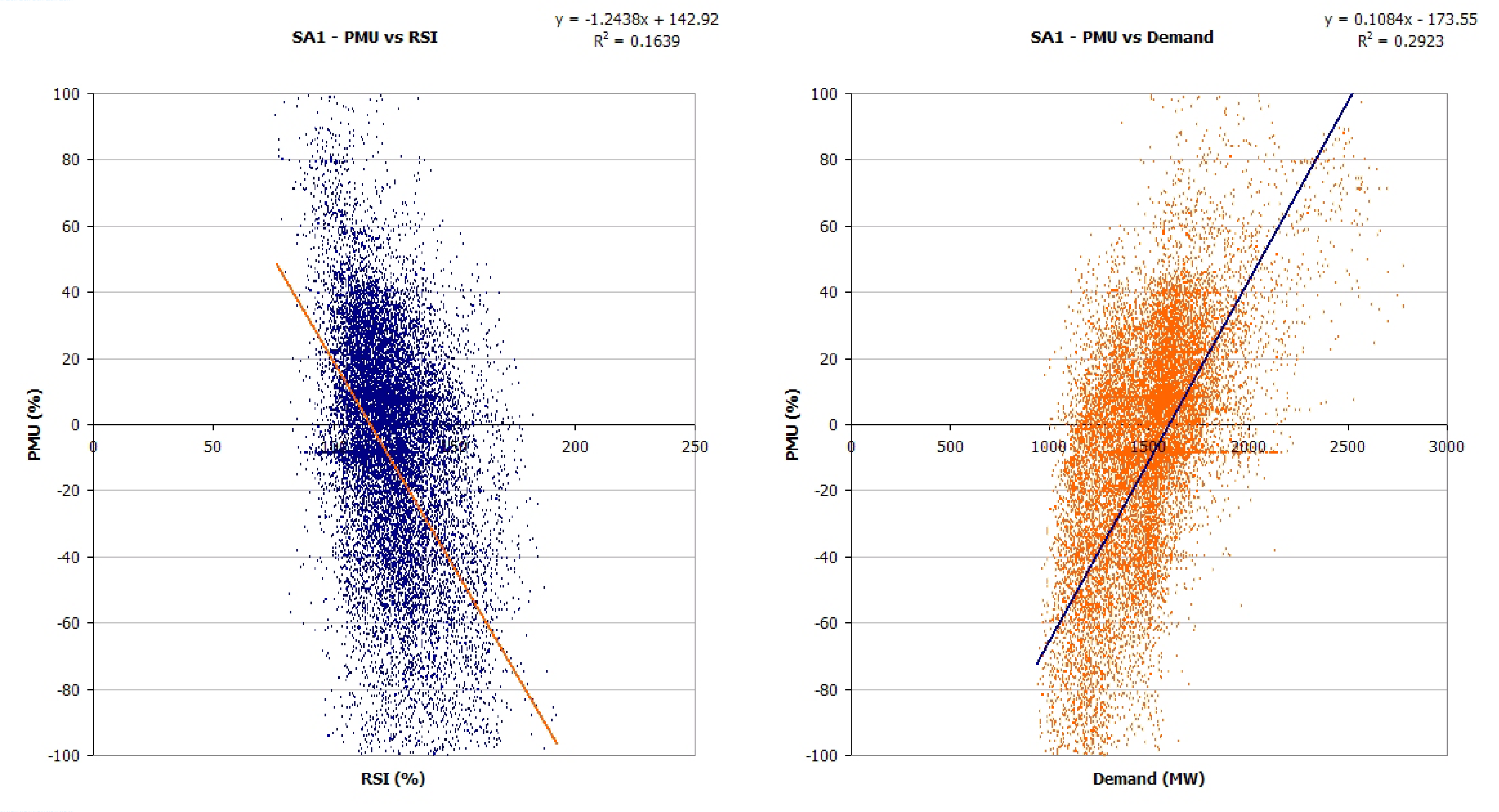


3.6.2 Regression Results, Continued

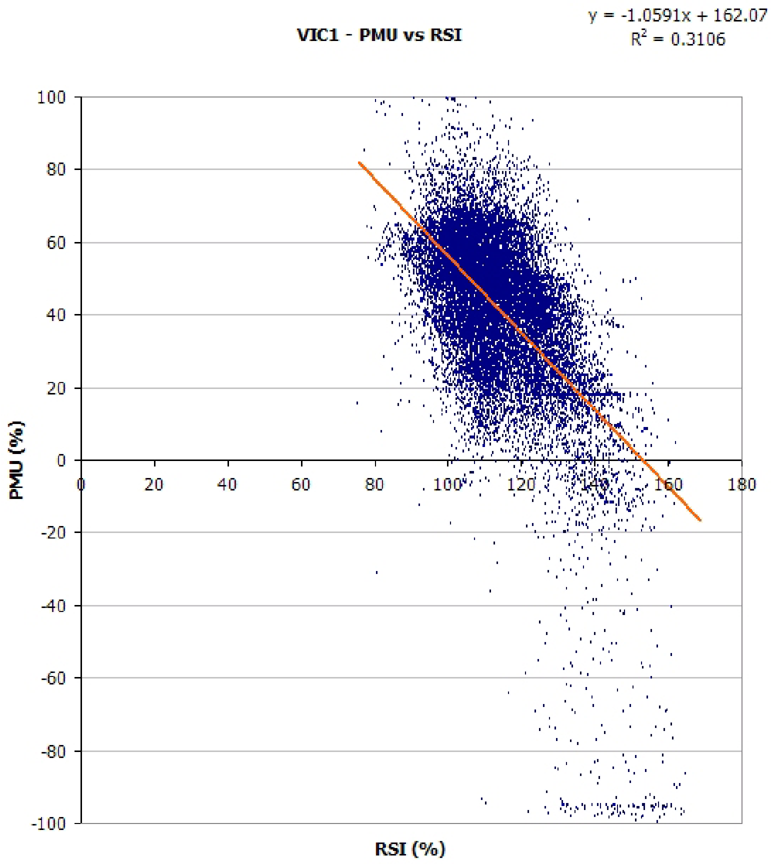


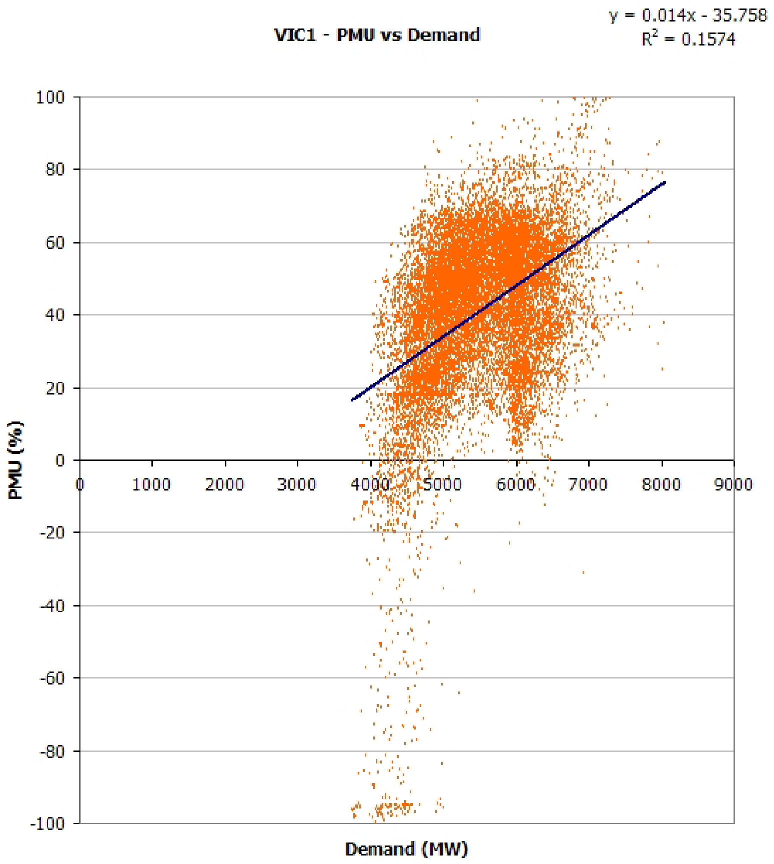


3.6.2 Regression Results, Continued



3.6.2 Regression Results, Continued





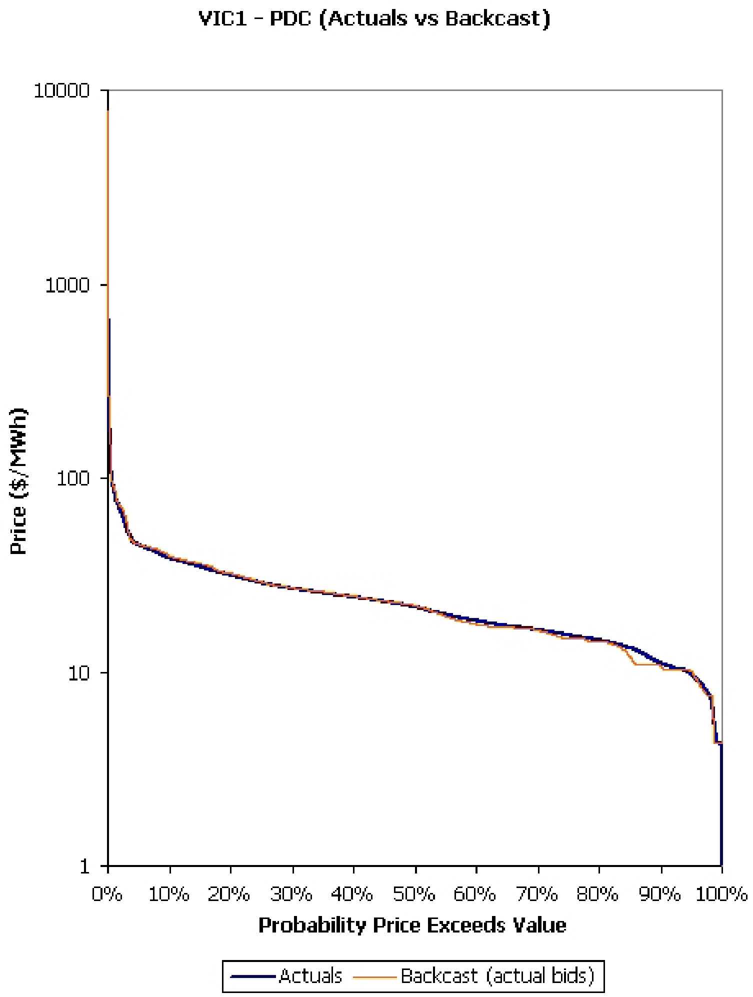
3.6.2 Regression Results, Continued

- Final regression equations use multiple regression with y = PMU and x_1 = RSI, x_2 = Demand:
  - $PMU_{NSW1} = 89.5737 - 0.7044 \times RSI_{NSW1} + 0.00338806 \times D_{NSW1}$
  - $PMU_{QLD1} = 290.0925 - 1.6708 \times RSI_{QLD1} - 0.01633612 \times D_{NSW1}$
  - $PMU_{SA1} = -120.0759 - 0.2845 \times RSI_{SA1} + 0.09635988 \times D_{NSW1}$
  - $PMU_{VIC1} = 191.8616 - 1.18 \times RSI_{VIC1} - 0.00290228 \times D_{NSW1}$
- All equations are significant (R^2 approx. 45% on 17520 observations).
- Fit of equations can be improved further by calculating separate equations for summer/winter and by time of day.

3.7 Validation of Bidding Models

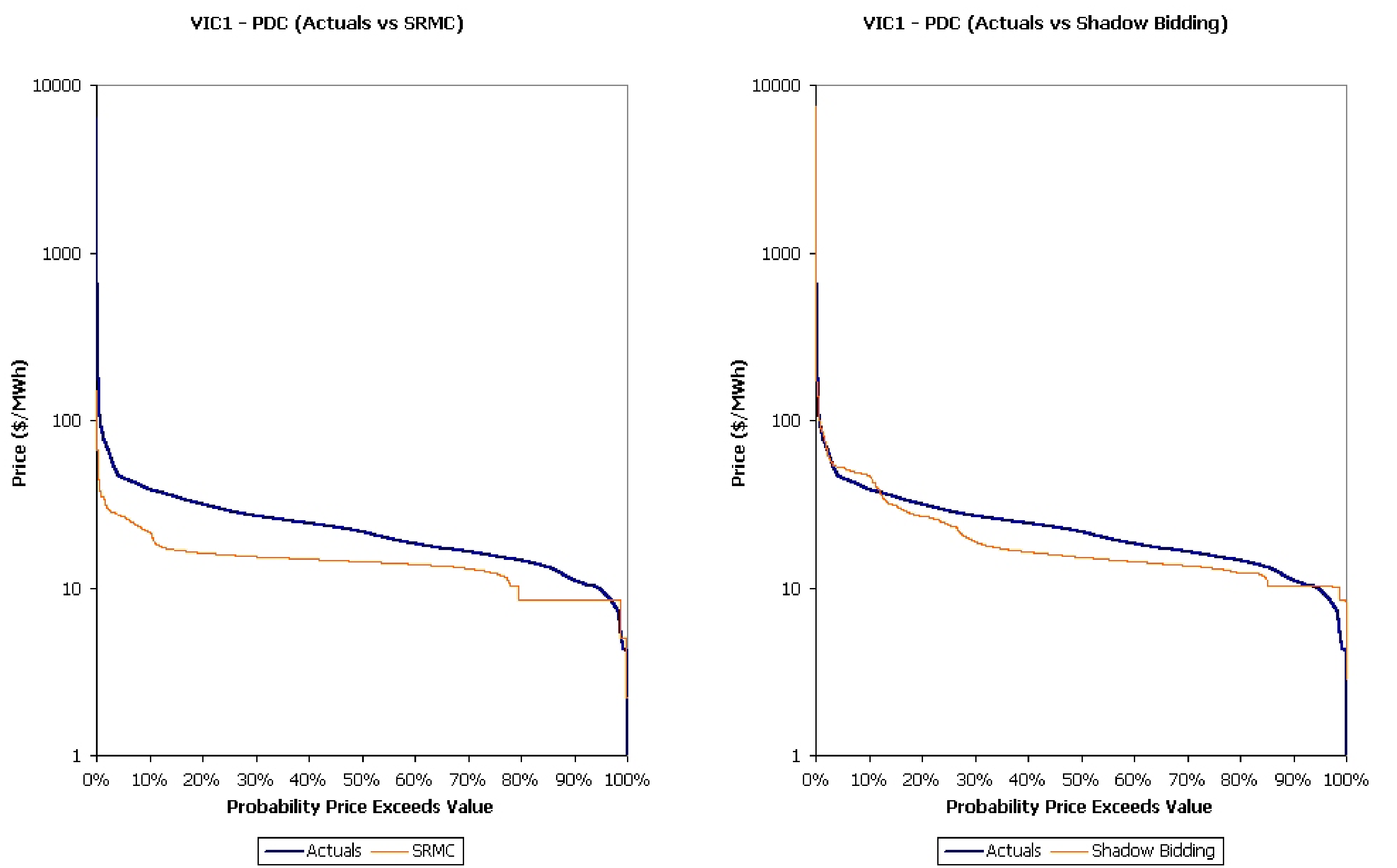
- PLEXOS includes in-built support for:
  - SRMC (using fundamental cost parameters);
  - Shadow bidding (dynamic on outages, and transmission);
  - Nash-Cournot Competition;
  - Residual Supply Analysis; and
  - Cost Recovery
- To validate these methods we:
  - Compiled all published market data for the 2002-03 year;
  - Ran the PLEXOS dispatch and pricing engine in a "backcast" using actual generator bids to confirm PLEXOS can emulate the NEM solutions;
  - Removed the generator bids and ran with each of the dynamic bidding models.

3.6.3 Validation of Bidding Models,
Continued

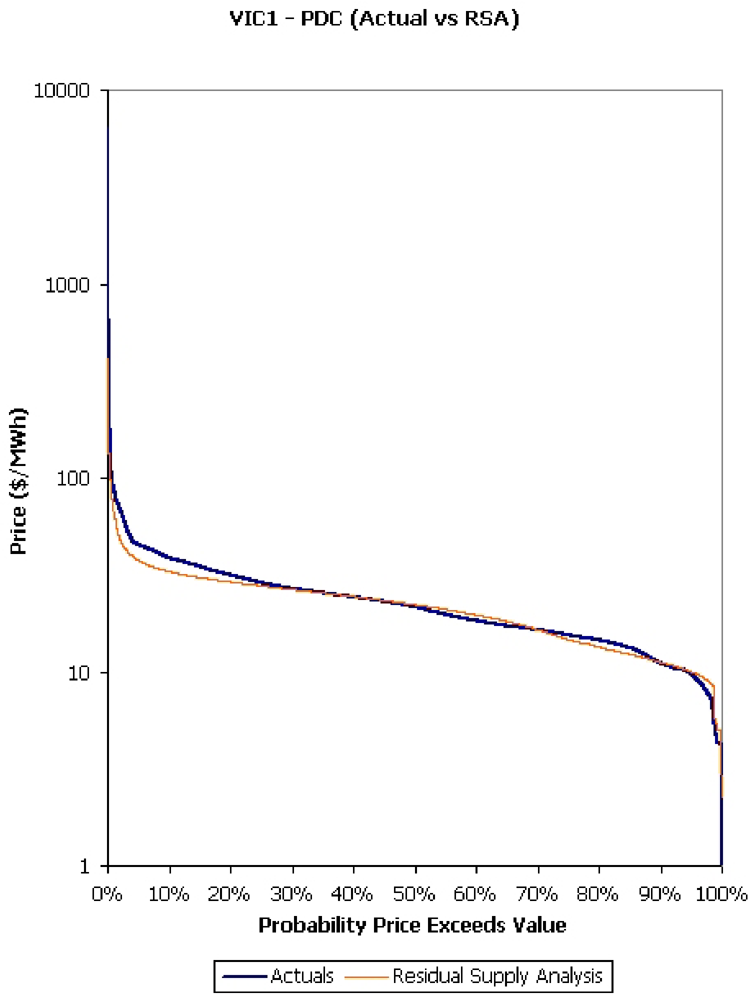


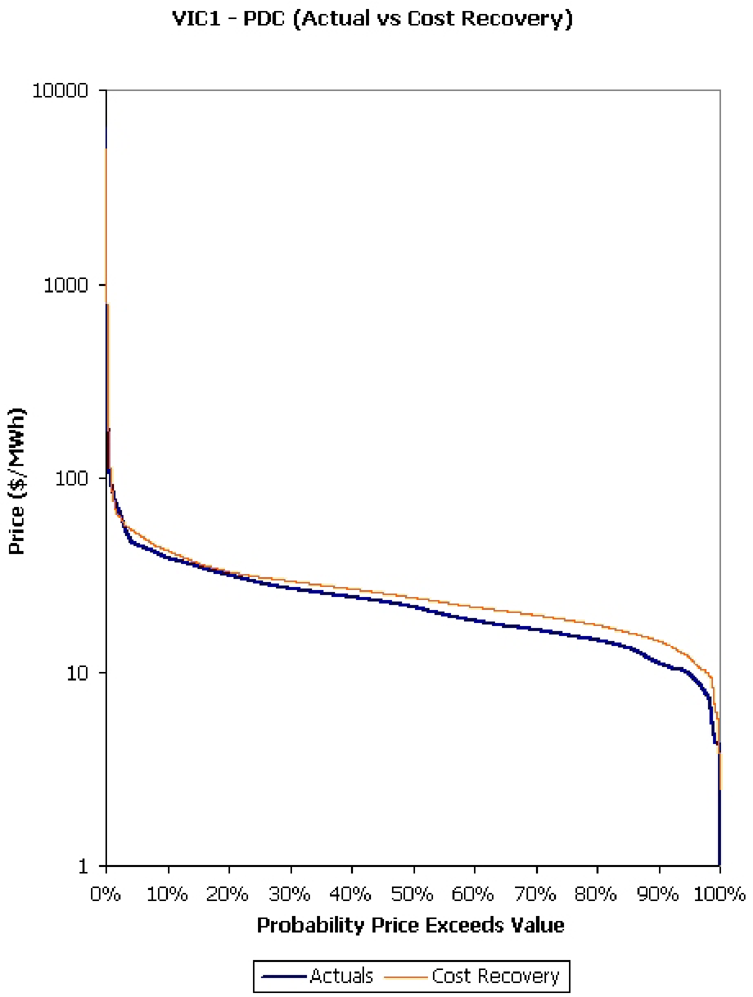
- PLEXOS uses the same linear programming formulation as the NEMDE/SPD.
- Thus, given the same input, PLEXOS will perfectly emulate NEM outcomes.
- The very slight differences shown here are a result of the backcast running on half-hourly rather than 5-minute data, and the backcast approximating generic constraints by half-hourly interconnector bounds (if the data are available, PLEXOS can use any number of generic constraints).

3.6.3 Validation of Bidding Models,
Continued

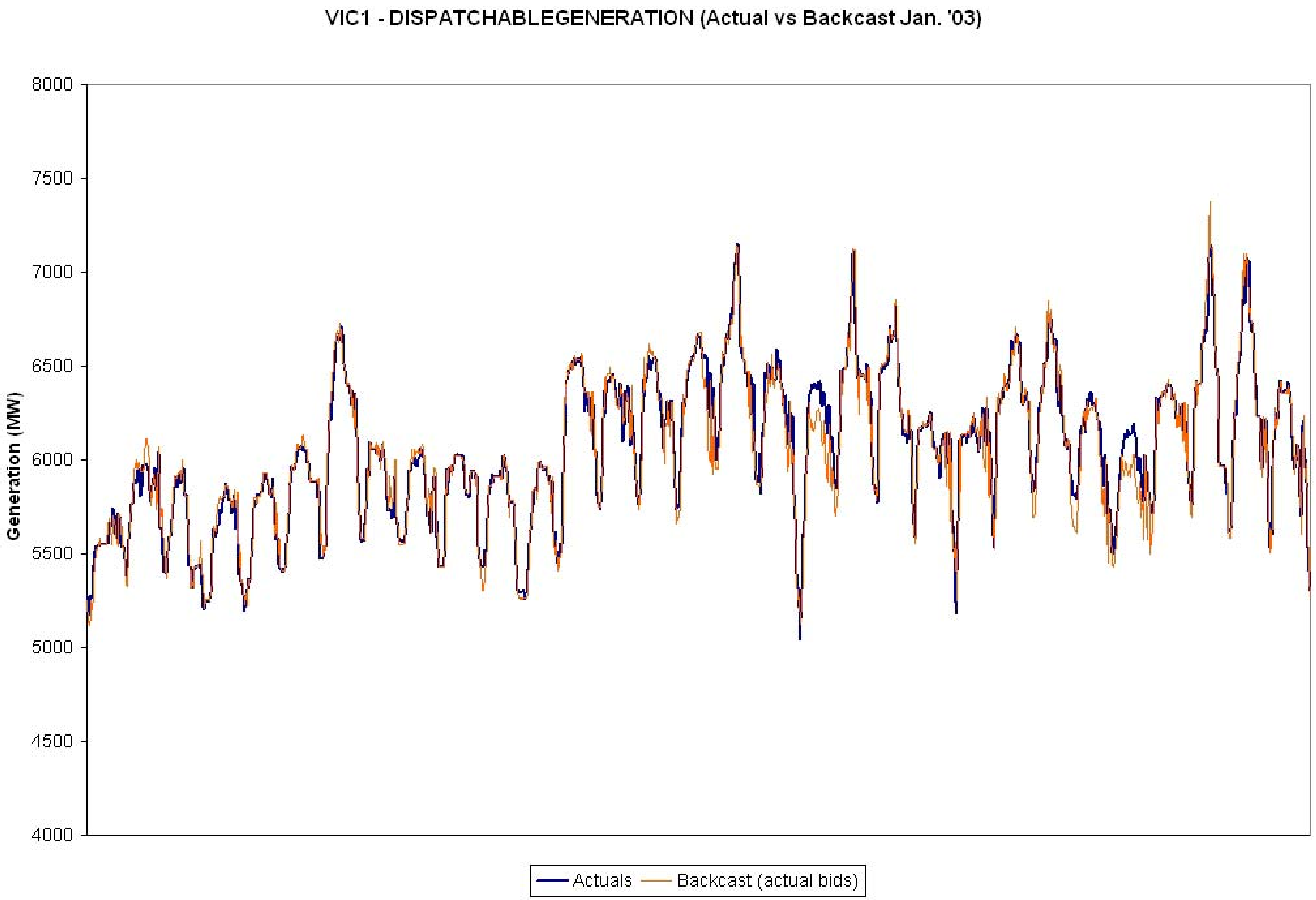


3.6.3 Validation of Bidding Models,
Continued

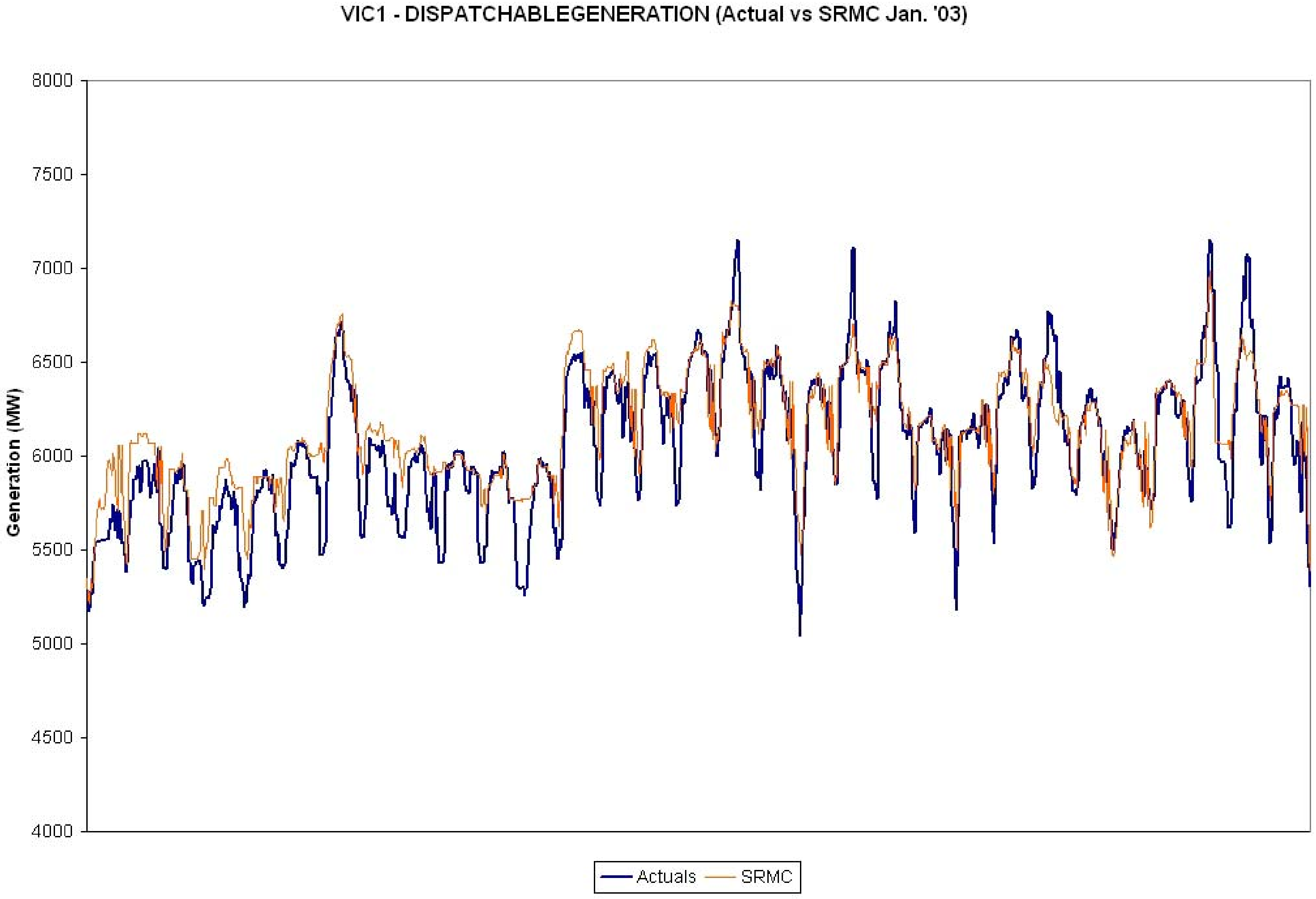




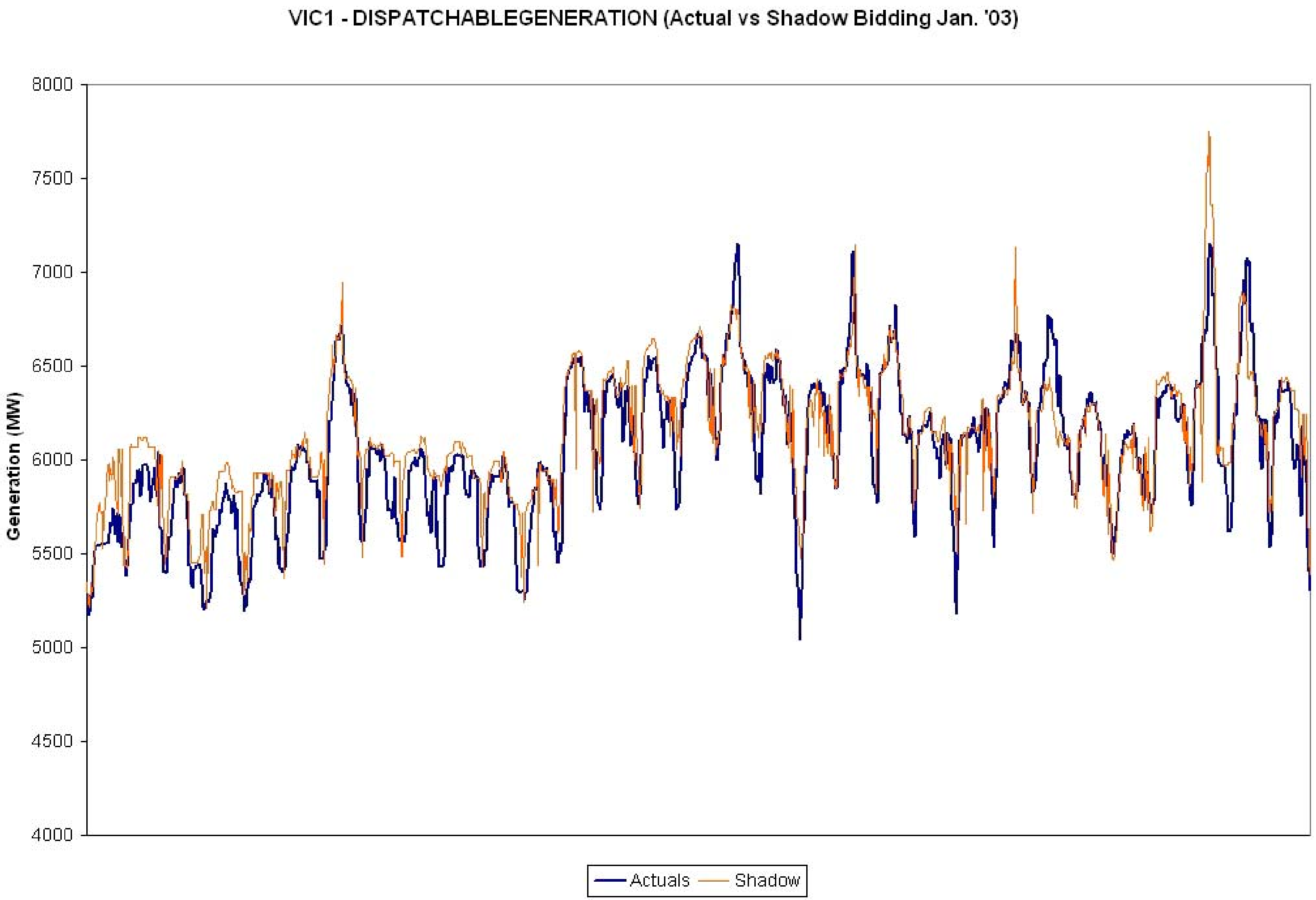
3.6.3 Validation of Bidding Models,
Continued



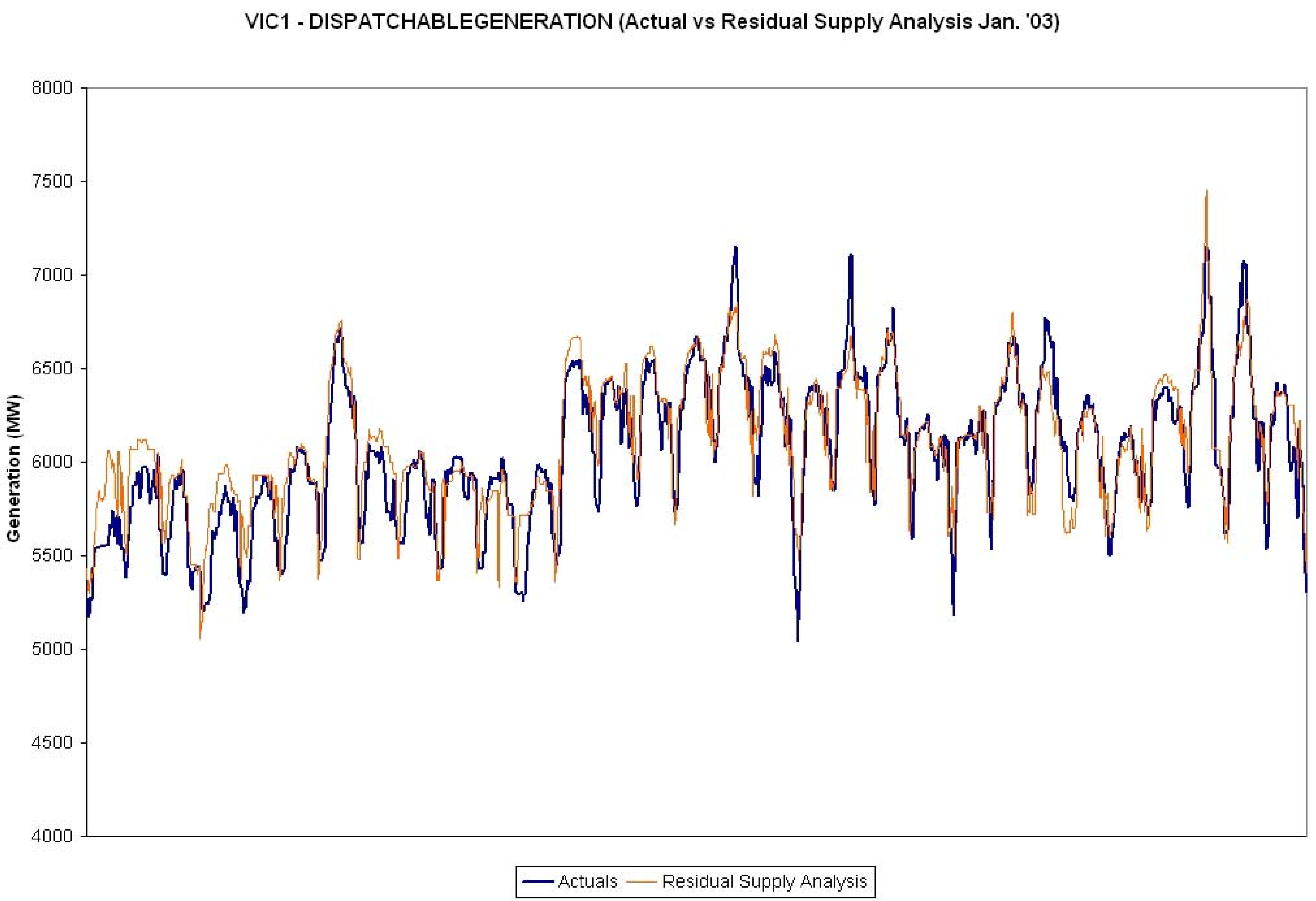
3.6.3 Validation of Bidding Models,
Continued



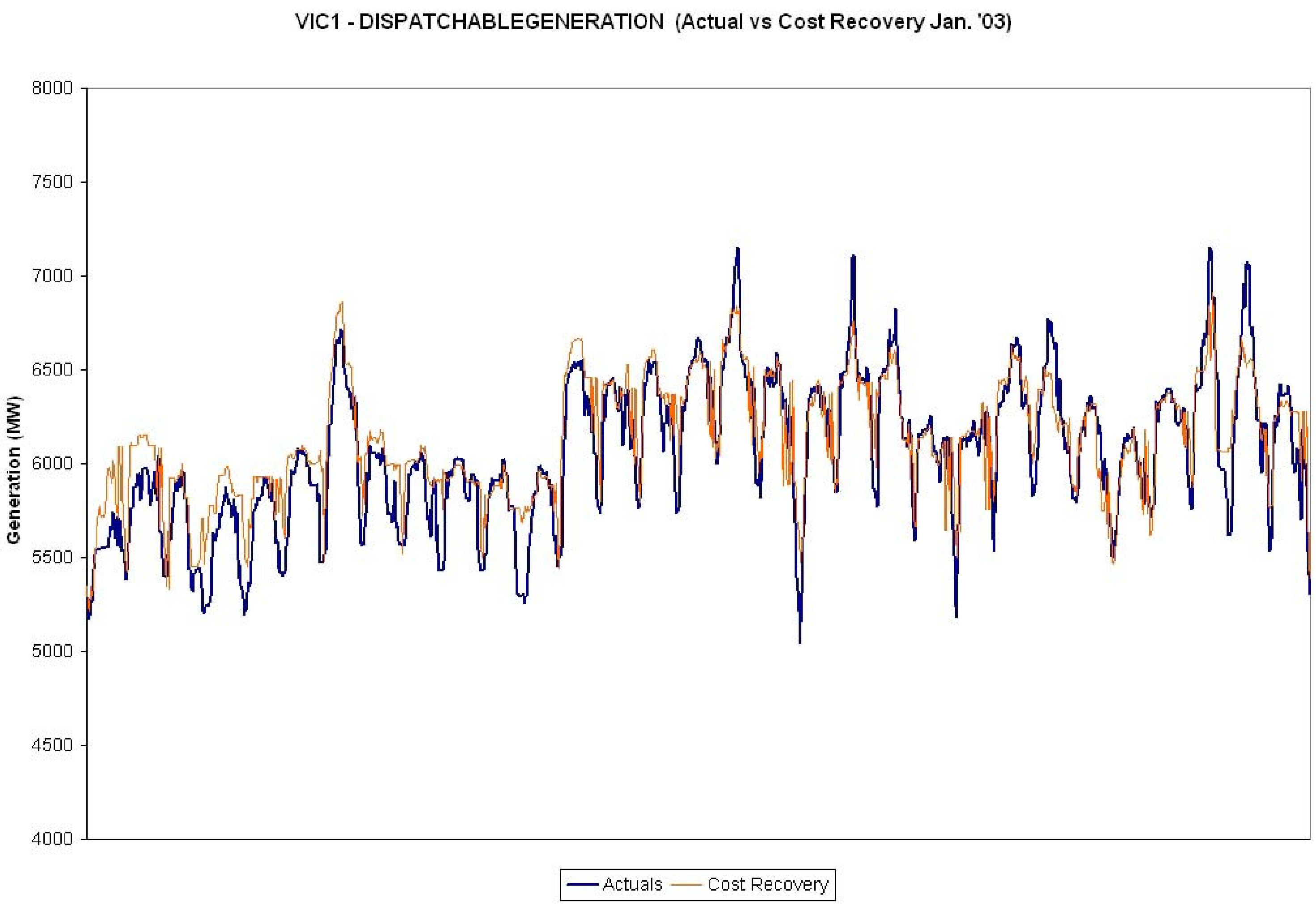
3.6.3 Validation of Bidding Models,
Continued



3.6.3 Validation of Bidding Models, Continued



3.6.3 Validation of Bidding Models,
Continued



3.6 Conclusions

- SRMC does not provide any information about competition effects, and tends to distort generation and transmission dispatch, and thus is perhaps useful only for comparison with historical market outcomes (*e.g.* in RSA to calculate 'C').
- The PLEXOS Shadow Bidding and Cost Recovery methods dynamically modify bids to account for the effect of changes in the competitiveness of the market due to interconnection augmentation.
- The Cost Recovery method is also an effective predictive model – producing bidding patterns that closely match historical outcomes.

3.6 Conclusions, Continued

- The Residual Supply Analysis also produces a close match to historical dispatch and pricing outcomes.
- However RSA does not adapt dynamically to growth in demand, and changes in market structure *e.g.* interconnector augmentation, which one would expect to alter patterns of markup.
- The same criticism can be made of modeling using patterns of historical bids, which, depending on how they are formulated, can produce a good fit to historical results in backcasting, but do not adapt to future conditions.

3.6 Conclusions, Continued

- Drayton Analytics experience with all these methods in forecasting exercises suggests that:
  - Shadow bidding tends to result in average market prices below long run marginal cost.
  - Historical bids work well for short-term forecasting, but are not reliable for forecasting more than one to two years ahead. Cost Recovery is the most “set and forget” of the methods *i.e.* it automatically adapts to future market conditions and delivers consistent, plausible results.
  - RSA can work as well as Cost Recovery, but needs careful tuning especially as demand grows (because the regression equations involve demand terms).

Contact

- Drayton Analytics:
  - www.DraytonAnalytics.com
  - PO Box 696, Prospect East, SA 5082
  - Phone: 8342 9614
  - Fax: 8342 9615
  - Contact: Glenn Drayton
- Plexos Software:
  - www.plexos.info