2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

APPENDIX 5.07

KPMG

Review of Demand and Energy Forecasting Methodologies

Delivering better value

cutting through complexity

Review of demand and energy forecasting methodologies

Prepared for Powerlink Queensland

23 October 2015

Disclaimer

Inherent Limitations

This report has been prepared as outlined in the Scope Section. The services provided in connection with this engagement comprise an advisory engagement, which is not subject to assurance or other standards issued by the Australian Auditing and Assurance Standards Board and, consequently no opinions or conclusions intended to convey assurance have been expressed.

No warranty of completeness, accuracy or reliability is given in relation to the statements and representations made by, and the information and documentation provided by, Powerlink Queensland management and personnel consulted as part of the process.

KPMG have indicated within this report the sources of the information provided. We have not sought to independently verify those sources unless otherwise noted within the report.

KPMG is under no obligation in any circumstance to update this report, in either oral or written form, for events occurring after the report has been issued in final form.

The findings in this report have been formed on the above basis.

Third Party Reliance

This report is solely for the purpose set out in the Scope Section and for Powerlink Queensland's information, and is not to be used for any other purpose or distributed to any other party without KPMG's prior written consent.

This report has been prepared at the request of Powerlink Queensland in accordance with the terms of KPMG's engagement letter dated 24 September 2015. Other than our responsibility to Powerlink Queensland, neither KPMG nor any member or employee of KPMG undertakes responsibility arising in any way from reliance placed by a third party on this report. Any reliance placed is that party's sole responsibility.

Electronic Distribution

This KPMG report was produced solely for the use and benefit of Powerlink Queensland and cannot be relied on or distributed, in whole or in part, in any format by any other party. The report is dated 23 October 2015 and KPMG accepts no liability for and has not undertaken work in respect of any event subsequent to that date which may affect the report.

Any redistribution of this report requires the prior written approval of KPMG and in any event is to be complete and unaltered version of the report and accompanied only by such other materials as KPMG may agree.

Responsibility for the security of any electronic distribution of this report remains the responsibility of the Powerlink Queensland and KPMG accepts no liability if the report is or has been altered in any way by any person.

Review of Powerlink's demand and energy forecasting methodologies

Executive summary

In September 2014, KPMG was engaged by Powerlink to review Powerlink's demand and energy forecasting methodologies and processes and make recommendations on areas for improvement. KPMG provided Powerlink with a number of recommendations. Some of these recommendations could be implemented easily while others related to longer term initiatives.

In September 2015, Powerlink commissioned KPMG to provide an update to the 2014 review, as part of Powerlink's preparation for its Revenue Proposal for the 2017/18 – 2021/22 Regulatory Control Period. The updated review focuses on changes to the methodology introduced by Powerlink since the 2014 review and includes an additional qualitative assessment of Powerlink's forecasting models against the AER's principles of best forecasting practice[1].

The remainder of this section provides a summary of our assessment against the AER's principles of best forecasting practice.

Summer and winter maximum demand models

The forecasts of summer and winter maximum demands are made up of two parts: forecasts of DNSP demands and forecasts of non-DNSP (or directly connected) loads.

DNSP demands

The summer and winter maximum demand models for DNSP customers are well documented and transparent. They can be easily replicated by a third party to generate the low, medium and high forecasts. **Based on the information provided, KPMG assesses that Powerlink's DNSP maximum demand models meet the AER's criteria with the following caveats.**

a. A detailed description is provided of the weather correction process applied by Powerlink to adjust the maximum demands. However, the information provided is not sufficient for a third party to replicate the results of this process.

b. The R-squared of 0.46 for the winter WD model suggests that further improvement in this model may be possible. We understand that Powerlink's hypothesis is that winter in North Queensland is still hot and air conditioning load remains positively related to temperature, whereas in Southern Queensland air-conditioning load is greatest when it is cold. If this hypothesis is correct we expect the forecasting model will be improved by the incorporation of this mechanism.

c. Minimal details are provided on in-sample model performance but no details are provided regarding in-sample or out-of-sample forecast performance. Given the significant evolution of Powerlink's maximum demand forecasting models over time, KPMG notes that robust backcasting exercises are difficult to implement. Powerlink has plans in place to conduct

[1] The AER's principles of best forecasting practice are based on material in AER (Nov 2011), "Draft Distribution Determination Aurora Energy Pty Ltd 2012-13 to 2016-17".

such exercises in future. However, in-sample forecasting performance of the model can still be checked with the current sample size of 15 observations.

Non-DNSP demands

Forecasts of non-DNSP summer and winter maximum demands are derived on the basis of forecasts supplied by the customers. Powerlink's approach of deriving forecasts of non-DNSP demand from their customer's forecasts is appropriate. We recognise that these forecasts are commercially sensitive but we believe that some additional high level documentation about the raw forecasts supplied by clients and the transformations applied by Powerlink would increase the transparency of this part of the forecasting process without revealing commercially sensitive information.

Energy model

Powerlink's energy forecasts are also made up of two parts: energy forecasts for DNSP customers and energy forecasts for non-DNSP (or directly connected) customers.

DNSP energy forecasts

Powerlink's energy forecasting model for DNSP customers is well documented in Appendix B of the 2015 Transmission Annual Planning Report (TAPR). KPMG notes that Powerlink has taken up KPMG's recommendation of considering alternative approaches to forecasting energy by looking at the economic drivers of energy consumption.

Based on information provided, KPMG's assessment is that Powerlink's DNSP energy model meets the AER's criteria with one exception. Similar to the maximum demand models, there are no details provided on any forms of in-sample and out-of-sample forecast performance. KPMG notes that this is the first year that Powerlink has implemented an econometric energy model. Hence, similar to the maximum demand models, robust backcasting exercises can only be implemented at a later stage. Powerlink has plans in place to perform backcasting tests. However, with a current sample size of 15 observations, it may be possible for the in-sample forecast performance of the energy model to be checked.

Non-DNSP energy forecasts

Forecasts of non-DNSP energy demands are derived on the basis of forecasts supplied by customers. Powerlink's approach of deriving forecasts of non-DNSP demand from their customer's forecasts is appropriate. We recognise that these forecasts are commercially sensitive but we believe that some additional high level documentation about the raw forecasts supplied by clients and any adjustments made by Powerlink would increase the transparency of this part of the forecasting process without revealing commercially sensitive information.

1. Introduction

KPMG was engaged by Powerlink Queensland (Powerlink) in September 2014 to review Powerlink's energy and demand forecasting methodologies. The review was delivered to Powerlink as a final report that included a number of recommendations for improving Powerlink's forecasting procedures.

In September 2015, as part of Powerlink's preparation of the Revenue Proposal for the 2017/18 – 2021/22 period, Powerlink engaged KPMG to provide an update to the review undertaken in 2014. This updated review focuses on the changes made to the methodologies since the review, and includes a qualitative assessment of the methodologies against the Australian Energy Regulator (AER)'s principles of best forecasting practice. The review covers an assessment of Powerlink's summer and winter maximum demand models and their energy model. The summer and winter maximum demand models have been assessed together, as they generally follow the same forecasting methodologies.

For this engagement, Powerlink has provided KPMG with:

- an excel spreadsheet setting out the changes made to the models since the last review;
- an excel spreadsheet containing the regressions for the models;
- a commercial-in-confidence spreadsheet containing the maximum demand and energy forecasts for non-DNSP customers;
- a publicly available excel spreadsheet detailing the three models with input data, results of model estimations and diagnostic testing; and
- the publicly available Transmission Annual Planning Report Chapter 2 and Appendix B outlining the forecasts and forecasting methodologies.

The next two sections summarise our review and assessment of the three models against AER's principles of best forecasting practice.

2. Summer and winter maximum demand models

The Queensland summer and winter maximum demand forecasts comprise of four components:

1. Non-weather dependent (NWD) DNSP forecasts based on the NWD econometric regression model
2. Weather dependent (WD) DNSP forecasts based on the WD econometric regression model
3. Transmission customer forecasts
4. Impact of new technologies

In the remainder of section 2 we describe then assess the maximum demand forecasting process.

2.1. Model summary

The maximum demand forecasts are made up of two parts: forecasts of DNSP demands and forecasts of non-DNSP (or directly connected) loads.

DNSP demands

The NWD and WD models for DNSPs are econometric regression models estimated using financial year annual data from 2000/01 to the latest available data. The NWD DNSP demand model has the financial year annual NWD DNSP demand as the dependent variable and the one year lagged business electricity price and the one year lagged Queensland Gross State Product (GSP) as the independent variables. The historical NWD DNSP demand is based on the median weekday maximum demand in September.

The WD DNSP model has the financial year annual WD DNSP demand as the dependent variable, and a composite independent variable that is a measure of air conditioning capacity in Queensland – calculated by multiplying Queensland population by a Queensland air conditioning penetration rate (sourced from the Queensland Household Energy Survey - QHES). The WD demand for the winter maximum demand model is the difference between the corrected maximum demand and the NWD demand based on the following September, while the WD demand for the summer model is based on the difference between the corrected maximum demand and the NWD demand based on the previous September.

Powerlink has incorporated all the suggestions made in KPMG's 2014 review relating to the:

- sample size used to estimate the maximum demand forecasting models; and
- model selection process for the NWD model.

Non-DNSP demands

The medium-case maximum demand forecasts for non-DNSP customers that connect directly to Powerlink's transmission network are based on raw forecasts supplied by these customers. For the medium case, Powerlink includes forecasts provided by the non-DNSP customers for committed loads only. Some additional loads that are not yet committed are included in the high scenario on a probabilistic basis with the probabilities determined through discussions in meetings between internal experts and experts representing the customers. For both the medium and high scenarios, an average coincidence factor is calculated for each customer. The coincidence factor measures the ratio of the directly connected customer's peak demand to that customer's demand at the time of state peak demand. This metric is used by Powerlink to quantify the alignment between the non-DNSP customers demands and the actual state peak demand. Where possible the average of this ratio over the last 5 years is used by Powerlink to scale the raw medium and high maximum demand forecasts provided by the non-DNSP. These adjusted forecasts can then be added directly to Powerlink's maximum demand forecasts for DNSP customers. Where a five year average is not available (new or substantially modified loads) Powerlink exercises judgement in determining an appropriate coincidence factor. In forming a view, reference is made to whatever relevant history is available and to data for comparable industries. The low forecasts of non-DNSP customers are calculated as the summation of the coincident demand for the last year of recorded data and 75 per cent of the growth in the medium forecast from the last available data.

KPMG considers that Powerlink's approach of deriving forecasts of non-DNSP demand and energy directly from their customer's forecasts is appropriate. Non-DNSP customers that connect directly to the network should have superior information relevant to forecasting the quantity of energy they will consume in the future. Hence, forecasts provided by Powerlink's non-DNSP customers should, in principle, be superior to any form of forecasting by a 3rd party. We think it would be useful if Powerlink provided diagnostics relating to errors in their customers raw forecasts. Some evaluation of the estimated coincidence factors would also be useful. We recognise that customer forecasts are commercially sensitive but we believe that some additional high level documentation about the raw forecasts supplied by clients and the transformations applied by Powerlink would increase the transparency of this part of the forecasting process without revealing commercially sensitive information.

We note that Powerlink deals with LNG loads separately to other non-DNSP loads in their forecasting process. This approach is appropriate given the large size of the LNG loads, which are new to the system and expected to ramp up over the forecast horizon.

Impact of new technologies

Powerlink recognises that the impact of new technologies will become increasingly important on its forecasts of demand and energy. Powerlink incorporated the impact of solar PV into its forecasting process prior to the 2015 Transmission Annual Planning Report (TAPR). Further, the importance of other new technologies and reforms such as battery storage, energy efficiency, electric vehicles and tariff reforms are reflected in Powerlink's decision to conduct a forum of industry experts to learn more about new technologies and the impacts these technologies may have on future electrical demand and energy. Based on the information gathered from this forum, Powerlink has incorporated in its current maximum demand and energy forecasts explicit assumptions about: (1) Solar PV; (2) Battery Storage; (3) Energy Efficiency; (4) Electric Vehicles; and (5) Tariff Reform and Demand Side Management.

Powerlink has provided a transparent and detailed description of the adjustments they have made to their forecasts for each of the five technologies. The information sources used to calibrate forecasts about the impacts of each technology are clear and credible and the key assumptions made by Powerlink are reasoned and transparent. Given the nature of forecasting technical change, Powerlink's approach is commendable. The transparency provided gives third parties scope to understand the sensitivity of the forecasts to the highly uncertain impacts on new technologies. Powerlink's approach is amenable to incorporating additional information about these technologies as it becomes available.

2.2. Model assessment

This section summarises KPMG's assessment of Powerlink's maximum demand models for DNSP customers against the AER's principles of best forecasting practice[2].

AER's criterion of best forecasting practice	Characteristics	Assessment
Accuracy and unbiasedness	1. Careful management of data, i.e. removal of outliers. 2. Model selection – choosing a model based on sound theoretical grounds that closely fits the sample data. 3. Weather normalisation	1. There is a clear methodological process in place to collect and compile the required data inputs Each staff member involved in the forecasting process is responsible for the collection of specific data inputs. 2. For the NWD model, Powerlink uses a rigorous model selection that runs through 204 regressions which utilises different permutations of 20 explanatory variables that are all theoretically grounded. The final model selected is based on parsimony and goodness of fit. The WD demand mainly reflects air conditioning usage. The final WD model closely fits the sample data. 3. The weather corrected 10% and 50% PoE maximum demand forecasts are obtained via a comprehensive process, that: (i) excludes outliers (mild days and holidays); (ii) accounts for variables including daily maximum, minimum and 6pm temperatures and dummies to distinguish weekdays; and (iii) a scaling process to avoid bias.

[2] The AER's principles of best forecasting practice are based on material in AER (Nov 2011), "Draft Distribution Determination Aurora Energy Pty Ltd 2012-13 to 2016-17".

Transparency and repeatability	4. Good documentation, including documentation of the use of judgment, which ensures consistency and minimises subjectivity in forecasts.	4. The maximum demand forecasting process is well documented in the TAPR 2015 Appendix B and the publicly available spreadsheet that contains the forecast models and assumptions. This documentation makes it possible for a third party to reproduce the maximum demand forecasts for the low, medium and high economic outlooks. Reproduction by a third party of the temperature corrected historical maximum demands may not be possible. The process for making the weather corrections is well described but the process is complex and key details are not reported.
Incorporation of key drivers	5. Appropriate incorporation of key drivers (inputs) of demand and exclusion of spurious drivers. 6. Incorporating impact of future reforms and new technologies.	5. The NWD model contains the key drivers – one year lagged Queensland business electricity price and one year lagged Queensland GSP. The WD model contains a constructed variable – the air-conditioning penetration rate multiplied by Queensland's population – designed to provide an estimate of air-conditioning capacity in Queensland. 6. Adjustments to the maximum demand forecasts have been made to account for the impact of new technologies (solar PV, battery storage, energy efficiency, electric vehicles) and for the impact of tariff reforms and demand side management initiatives.
Model validation and testing	Where appropriate, 7. Assessment of statistical significance of explanatory variables, goodness of fit. 8. In-sample and out of sample forecasting performance of the model against actual data (using measures such as Mean Absolute Percentage Error (MAPE) and/or Root	7. The summer and winter NWD models fit the data well with an R-squared of 0.96. The summer WD model fits the data better than the winter WD model, with an R-squared of 0.79 compared to 0.46. Hence, there appears to be scope to further improve the winter WD. We understand that Powerlink's hypothesis is that winter in North Queensland is still hot and air conditioning load remains positively related to temperature whereas in

	Mean Square Error (RMSE). 9. Diagnostic checking of the models.	Southern Queensland air-conditioning load is greatest when it is cold. If this hypothesis is correct we expect the forecasting model will be improved by the incorporation of this mechanism. The coefficients of the variables have the expected signs. The explanatory variables and the NWD and WD models overall pass the standard statistical tests. However, we note that only a subset of the test statistics are published in the public domain. 8. No details have been provided on any forms of in-sample and out of sample forecast performance. KPMG notes that it will be difficult to implement backcasting exercises, given that Powerlink's models have evolved significantly over time. However, it is still possible to check for the in-sample forecasting performance of the model. 9. The Durbin-Watson statistic for the NWD models is 1.90, which indicates there is no serial correlation in the model.
Use of consistent and most recent information	10. Use of most recent available information/data to generate forecasts and comparison with other sources.	10. Powerlink uses the latest available data from AEMO and the QHES each year. Powerlink compares these input drivers with forecasts provided by Deloitte Access Economics (DAE). While the alternative inputs provided by DAE cannot be published, Powerlink provides scatter plots in Appendix B of the 2015 TAPR to show the range around the selected forecasting model of plausible alternatives, including demand forecasts driven by DAE inputs.

3. Energy models

The energy forecasts are comprised of three components:

1. Energy forecasts based on the energy econometric regression model;
2. The impact of new technologies; and
3. Transmission customer forecasts

In the following sections we describe then assess the energy forecasting process.

3.1. Model description

The energy forecasts are made up of two parts: energy forecasts for DNSP customers and energy forecasts for non-DNSP (or directly connected) customers.

DNSP energy forecasts

Powerlink has followed the recommendation made in KPMG's 2014 review to consider an alternative approach to forecasting energy for DNSP customers that incorporates economic drivers of energy consumption.

The energy forecasts for DNSP customers are now generated from an econometric regression model of energy that is estimated using financial year data in logarithmic form from 2000/01 to the latest year for which data is available. Two independent variables, Queensland total electricity price and Queensland Gross State Product (GSP) are both lagged by one year. These are used to forecast the dependent variable, DNSP-delivered energy, for the financial year. The historical energy data is adjusted to account for solar PV prior to the estimation of the regression.

Similar to the maximum demand models, the energy forecasts in Powerlink's TAPR 2015 incorporates the impact of new technologies, namely solar PV, energy efficiency, battery storage, electric vehicles, and expected tariff and demand management reforms.

Non-DNSP energy forecasts

The energy forecasts for non-DNSP customers that connect directly to Powerlink's transmission network are based on raw forecasts supplied by these customers.

- For the medium case, Powerlink includes forecasts provided by the non-DNSP customers for committed loads only. In cases where forecasts are not supplied by customers for a particular period, Powerlink exercises judgement and uses previously supplied forecasts by that customer or infers a forecast based on the customer's historical energy usage. Powerlink also uses judgement in adopting the raw forecasts of customers with new loads where there is no history.

- For the high case, Powerlink uses raw forecasts supplied by customers for their high scenario. For those customers that do not supply energy forecasts for the high scenario Powerlink uses the customer's raw medium case forecasts. Some additional loads that are not yet committed are included in the high scenario on a probabilistic basis consistent with the summer and winter maximum demand models.
- The low case energy forecasts for non-DNSP customers are determined at the aggregate level as the sum of the aggregate usage of energy by the direct-connect customers in the last recorded year plus 75 per cent of the growth projected from that year in the medium case aggregate energy forecasts.

KPMG considers that Powerlink's approach of deriving forecasts of non-DNSP demand and energy directly from their customer's forecasts is appropriate. The energy forecasting process for non-DNSP customers necessarily contains judgemental elements. The impacts of these judgements on the final forecasts that Powerlink adopts can vary from one forecasting round to another. The transparency of this part of the forecasting process would be enhanced by additional documentation.

3.2. Model assessment

This section summarises KPMG's assessment of Powerlink's energy forecast model for DNSP customers against the AER's principles of best forecasting practice.

AER's criterion of best forecasting practice	Characteristics	Assessment
Accuracy and unbiasedness	1. Careful management of data, i.e. removal of outliers. 2. Model selection – choosing a model based on sound theoretical grounds that closely fits the sample data.	1. Similar to the maximum demand models, there is a clear methodological process in place to collect and compile the data inputs required for the energy forecasting process. 2. For the energy model, Powerlink utilises the same procedure used to select the NWD model. Their model selection procedure runs through 192 regressions based on different permutations of theoretically grounded variables – 3 electricity price variables and 16 economic variables. The preferred model is selected on the basis of parsimony and goodness of fit.

Transparency and repeatability	3. Good documentation, including documentation of the use of judgment, which ensures consistency and minimises subjectivity in forecasts.	3. The energy forecasting process is also well documented in the TAPR 2015 Appendix B and the publicly available spreadsheet containing the forecast models. It is possible for a third party to reproduce the energy forecasts for the low, medium and high economic outlooks. The sample used for this model is different to the other models because of data timing issues. A footnote to this effect would be helpful.
Incorporation of key drivers	4. Appropriate incorporation of key drivers (inputs) of demand and exclusion of spurious drivers. 5. Incorporating impact of future reforms and new technologies.	4. The energy forecast model is specified in log form and the explanatory variables –aggregate electricity price for Queensland and Queensland GSP, both lagged one year - are justifiable. 5. Adjustments to the energy forecasts have been made to account for assumptions about the impact of new technologies (solar PV, battery storage, energy efficiency, electric vehicles) and expected tariff reforms and demand management initiatives.
Model validation and testing	Where appropriate, 6. Assessment of statistical significance of explanatory variables, goodness of fit. 7. In-sample and out of sample forecasting performance of the model against actual data (using measures such as Mean Absolute Percentage Error (MAPE) and/or Root Mean Square Error (RMSE). 8. Diagnostic checking of the models.	6. The energy forecast model fits the data well with an R-squared of 0.97. The coefficients of the variables have the expected signs. All explanatory variables and the overall significance of the model pass standard statistical tests, including the Durbin-Watson test for serial correlation. Again, we note that only a subset of the test statistics are published in the public domain. 7. Similar to the maximum demand models, details about the about in-sample and out of sample performance of the model have not been provided. We note that this is the first time Powerlink has used an econometric regression to forecast energy, implying that genuine backcasting exercises may not be viable until the model has been used for a few years. However, in-sample

		forecasting evaluation may still be useful even with a sample size of 15 observations. 8. In sample diagnostics such as MAPE and Mean Percentage Bias are reported. The Durbin-Watson statistic for the energy model is 1.89, which indicates there is no serial correlation in the model.
Use of consistent and most recent information	9. Use of most recent available information/data to generate forecasts and comparison with other sources.	9. Similar to the maximum demand models, the latest available inputs for the energy models are sourced from AEMO. Powerlink compares these input drivers with forecasts provided by Deloitte Access Economics (DAE). While the alternative inputs provided by DAE cannot be published, Powerlink provides scatter plots in Appendix B of the 2015 TAPR to show the range around the selected forecasting model of plausible alternatives, including energy forecasts driven by DAE inputs.

Appendix A: Curricula Vitae of the Review Team

Peter Beaton

Partner
T: +61 7 3233 9630
E: pbeaton@kpmg.com.au

OVERVIEW

Peter is a partner with KPMG and leads the Risk Consulting practice in Queensland, Australia. Peter has over 20 years of experience in providing governance, risk and advisory services to organisations in both the private and public sector, however, has predominately been focused on the Energy and Natural Resources sector. During Peter's time with KPMG he has worked on large multinational engagements and has worked in many overseas jurisdictions including Canada, United States of America, South Africa, Indonesia, New Caledonia, Malaysia and Papua New Guinea.

RELEVANT EXPERIENCE

Positions held

- Peter is KPMG's national lead partner for the following accounts: Anglo American (Coal assets), Powerlink Queensland (Electricity Transmission), Arrow Energy (Energy and LNG), Wesfarmers Resources (Coal Company) and Transpacific Industries Group Limited (Waste Management).
- Peter leads KPMG's Queensland's Risk Consulting practice (consisting of four partners and approximately 80 staff)

Energy and utility recent experience

- **Powerlink Queensland** – From 2007, Peter has led the outsourced internal audit function providing independent assurance to Powerlink's Executive Management Team and Board over the design and operating effectiveness of key controls and management of strategic and operational risks. In this role Peter regularly engages with Executive Management providing views on matters concerning governance arrangements, emerging issues / risk in the energy market and opportunities for business improvement. Peter also facilitates the annual executive and board risk workshops and develops the annual assurance plan in conjunction with Powerlink management. Peter has lead reviews at Powerlink covering areas including outage management, contract & procurement activities, capital delivery, post implementation reviews, easement selection and acquisition, cyber security, asset management (maintenance strategy) and a host of financial compliance type reviews.
- **CS Energy** – In 2012, at the request of the Audit Committee, Peter reviewed the organisation's internal audit and assurance function to provide views on how CS Energy's function compares with contemporary practice and to provide recommendations for improvement. Through conducting desktop reviews of relevant information and conducting consultations with executive management and directors Peter provide a report and presented to the Audit Committee benchmarking CS Energy's function against contemporary practice and provided opportunities to move the function up the value chain.

- **CS Energy** – Between 2006 and 2008, Peter undertook a number of reviews for CS Energy at the request of management. These reviews included undertaking a payroll management review, capital project management review and a non-operator joint venture audit.
- **Arrow Energy** (unconventional gas / CSG-LNG): From 2011, Peter has worked with Arrow's Internal Audit Manager and Governance, Risk and Assurance Manager to lead the co-sourced Internal Audit Function. During this time Peter supported the organisation in developing their Internal Audit function and capabilities and provided direct support in overseeing the delivery of a number of internal audit projects covering areas including Energy Trading, Water Management, Land Access, Compliance Management, Field Services (Upstream), Tenement Management, Contract Management (Pre and Post Award), Landholder Engagement and Stakeholder management. A number of these projects were undertaken utilising integrated teams consisting of resources from Arrow Energy, Technical KPMG Subject Matter Experts (SMEs) and Shareholder representatives (Shell and/or PetroChina).
- **Arrow Energy**: In 2014, Peter led a KPMG team to comment upon Arrow's Operational Excellence (OE) Operating Standards for Upstream Activities. This assignment involved considering at a high level the contemporary nature of the Standards and comparison to industry practice; the appropriateness of the Performance Criteria (including the appropriateness of the range statements and evidence requirements) and the appropriateness and alignment of KPIs. This review resulted in amendments to the operating standards and to performance criteria.

QUALIFICATIONS

- Bachelor of Commerce, University of Queensland
- Member of The Institute of Chartered Accountants in Australia,
- Member of the Institute of Internal Auditors
- Certified Internal Auditor

Brendan Rynne

Partner

T: +61 3 9288 5780
E: brynne@kpmg.com.au

OVERVIEW

Brendan has over 20 years of advisory experience, and has been involved in nationally significant economic policy and reform engagements for all levels of Government. He has worked on major tax and economic policy initiatives (including the Henry Tax Review for the Australian Treasury), State tax reform for the Victorian and New South Wales Governments, and health funding reform policy for the Victorian Government.

RELEVANT EXPERIENCE

- **Powerlink** – Overhead cost allocation review: KPMG completed a review of Powerlink's overhead cost allocation methodology. This involved establishing the cost allocation basis utilized by Powerlink and then auditing the process to confirm what was proposed to occur, did occur. This project followed an earlier assignment to advise Powerlink on cost allocation methodologies that are considered acceptable by regulators.
- **Australian Airports Association** – Regulatory framework submission: Brendan prepared the Australian Airports Association's submission to the current Productivity Commission review into Price Regulation of Airport Services, and subsequently represented AAA at the face-to-face hearings in Melbourne.
- **Victorian Competition and Efficiency Commission** – Review of Victorian Food Regulations: Brendan led the review of the administrative, financial and compliance costs imposed by Victoria's food regulations on Victorian food businesses.
- **Brisbane Airports Corporation** – Regulatory advice: For many years Brendan has provide ongoing advice to the Brisbane Airport Corporation Ltd with respect to various regulatory and economic issues. Issues covered include:
  - Determining BACL's weighted average cost of capital;
  - Establishing a pricing policy for new investment which fall outside of the CPI-X price cap arrangements;
  - Assisting with various submissions to the ACCC on regulatory issues associated with the current prices oversight regime; and financial modelling assistance.
- **Department of Justice**: KPMG was engaged to develop an econometric model that generated forecasts of demand for legal aid services in Victoria in order to outline the future budgetary requirements of Victorian Legal Aid over the coming four years.
- **Attorney General's Department:** KPMG completed a review of the performance of the native title system since 2002. As part of this assignment KPMG completed a range of statistical / financial modelling in an attempt to forecast the financial need of the native title system for the period up to 2009/10. This included considering the cost requirements of NTU; FLLAD; FCA; NNTT; and ATSIS (now OIPC).
- **Workforce planning studies**: KPMG completed workforce planning and forecasting exercises as part of financial evaluations for the redevelopment of land from low intensive into higher employment intensive land. These exercises was completed by benchmarking 'like regions' in terms of employed persons by industry per 1,000 residents, and developing a growth path over time that would see current state evolve into a future state, including identifying what economic and social infrastructure is required to ensure the proposed outcomes are achieved. These studies were completed for: Roche Corporation (Jacobs Well); Macquarie Bank (Springfield); Lend Lease (Mango Hill); Burleigh Heads (Bond University); Brisbane Airport (Federal Airports Corporation).

QUALIFICATIONS

- Master of Applied Finance
- Master of Social Science (Economics)
- Bachelor of Economics
- Affiliate, Institute of Chartered Accountants in Australia
- Senior Fellow, Economic Society of Australia

Michael Malakellis

Associate Director
T: +61 7 3233 9592
E: mmalakellis@kpmg.com.au

OVERVIEW

Michael has over 20 years of experience in financial and economic modelling and analysis built up over the course of a professional career in academia, the government sector and the private sector. He is an expert in using models to forecast economic and financial market variables, including almost 15 years of experience in using in developing and applying forecasting models to support institutional investment decisions in global equity, fixed interest & currency markets and in the domestic infrastructure and commercial property sectors.

RELEVANT EXPERIENCE

- **Detailed Projections of Skills Gaps for Construction Skills Queensland** – generated detailed forecasts of skill gaps using KPMG's macroeconomic and multi-region CGE models. Key outputs of this analysis were measures of labour shortage or oversupply at the occupational level across industries, with particular focus on the Queensland economy. Importantly, these projections were made in a framework that ensured consistency between macroeconomic projections, the industrial structure of the economy and the occupational structure within industries.
- **Economic & Financial Market Forecasting** – over 12 years of forecasting experience at Tactical Global Management Ltd, an investment management firm, where I was responsible for developing and using forecasting models to actively manage large global investment portfolios. Around 3 years of experience at EC Partners Pty Ltd where I was responsible for forecasting economic and electricity-related variables to support investment decisions, due diligence assignments and the development of business cases for assets in the electricity sector.
- **CopperString Development Project for CuString Pty Ltd** – provided economic and financial advisory services to the proponents of the A$2.4 billion CopperString project, a regulated transmission line development running from Townsville to Mt Isa. This included successfully structuring, raising and representing institutional equity to be invested in the CopperString project alongside the proponent's equity interests. Key issues dealt with included: (i) assessment and advice regarding the appropriateness of regulatory frameworks for private investors; (ii) assessment of the economic viability of the project, including the role of government support; (iii) identification and quantification of project risks; and (iv) the negotiation of equity terms sheets with project proponents, debt providers and EPC contractors.
- **Development and Execution of a Windfarm Acquisition Strategy** – as part of a small team engaged by a large Australian superannuation fund to acquire the Emu Downs wind farm and the Badgingarra wind farm development. This involved: (i) making the business case to the Investment Committee that their portfolio would be enhanced by the inclusion of renewable generation assets; (ii) identifying Emu Downs and Badgingarra as candidate assets; (iii) conducting detailed due diligence on these assets; (iv) devising and arranging an appropriate financing structure; and (v) devising and executing a bid strategy.
- **Coal-fired Power Station Development for Mitsui & Co** – part of a small team that advised and managed a bid by Mitsui & Co. to develop a 2 x 250MW coal fired power station, valued around US$1 billion, to be located in Antofagasta in north Chile to supply BHPB's Escondida and Spence copper mines. My main responsibility was

the development and application of a comprehensive financial model to support the bid. This work included fully specified EPC and O&M programs, alternative fuel supply structures, alternative PPA arrangements, a comprehensive project finance structure as well as detailed scenario analysis.

- **Feasibility Studies for Solar Power Station for RATCH Australia Corporation** – prepared a comprehensive pre-feasibility study of a 20MW solar generation facility to be located on the site of the existing coal fired power station in Collinsville. This work was commissioned by RATCH Australia Corporation and included: a review of the technology options; identification and collaboration with potential EPC contractors to prepare a high level system design and project electricity production profiles; development of EPC and O&M schedules and budgets; analysis of the planning and regulatory issues; preparation of a development program for the project; assessment of the outlook for the electricity and renewable generation credits; development and assessment of alternative PPA and off-take structures; review of government programs that may provide support to the project; and development and application of a detailed financial model to assess the commercial viability of the proposed power station under a range of scenarios.

QUALIFICATIONS

- PhD (Economics), Monash University
- Bachelor of Commerce, University of Melbourne

Jasmine Zheng

Manager
T: +61 2 6248 1185
E: jzheng2@kpmg.com.au

OVERVIEW

Jasmine is an economist and economic modeller. She has a broad range of experience addressing diverse policy related issues through economic research and econometric modelling while working in government organisations and the energy sector in Australia and Singapore.

RELEVANT EXPERIENCE

- **Powerlink Queensland** – Assessment of Powerlink's energy and demand forecasting methodology, providing recommendations on areas for improvement.
- **Detailed Projections of Skills Gaps for Construction Skills Queensland** – generated detailed forecasts of future construction activity and skill gaps in the construction sector based on a labour demand and supply model.
- **Department of Social Services** – Forecasting the demand for Translation and Interpreting Services (TIS) National's interpretation services by different market segments using time series analysis.
- **Singapore Energy Market** – provided support to the Market Surveillance and Compliance Panel (MSCP) to assess the state of competition, efficiency and compliance in the National Electricity Market of Singapore (NEMS). Built a static econometric electricity market model to capture the price outliers in the market that requires further investigation, as it is assumed that high prices provide the first indication of inefficient market outcomes
- **Large-scale Vector** Autoregression (VAR) model developments for economic policy analysis and economic impact studies. Some of the models she has worked with include:
  - Structural VAR (SVAR)
  - Factor Augmented VAR (FAVAR)
- **Singapore Government** – provided an assessment of the Renminbi trade settlement scheme on the Singapore economy, and recommendations on the involvement Singapore could undertake.

QUALIFICATIONS

- PhD (Economics), The Australian National University
- Bachelor of Economics (Honours), The University of Queensland