

Jemena Gas Networks (NSW) Ltd

2015-20 Access Arrangement

Response to the AER's draft decision and revised proposal

Appendix 3.1 - Demand forecasting report – response to draft decision

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Jemena Gas Networks (NSW) Ltd Access Arrangement

Response to AER Draft Decision - Gas Demand Forecast
Core Energy Expert Report

February 2015

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Glossary

Core Energy or Core	Core Energy Group Pty Ltd
Original submission or Forecast	The report and models relating to a forecast of JGN consumption between 2015 and 2020 which was prepared by Core Energy and submitted to the AER in June 2014.
Revised Forecast	This report and related models and data relating to a revised forecast of JGN consumption between 2015 and 2020 which was prepared by Core Energy.
AER	Australian Energy Regulator
JGN	Jemena Gas Networks
MDQ	Maximum Daily Quantity
CD	Contract Demand
GJ	Gigajoule
ACQ	Annual Contract Quantity
I&C	Industrial & Commercial
NSW	New South Wales
SFD	State Final Demand
GSP	Gross State Product
GHDI	Gross
HHDI	Household Disposable Income
AEMO	Australian Energy Market Operator
NGR	National Gas Rules
M/H	Medium-High

1. Executive Summary

1.1. Scope of this Report

This report has been prepared by Core Energy Group Pty Ltd (“**Core**”) for the purpose of Jemena Gas Network’s (“**JGN**”) consideration of the Australian Energy Regulator’s (“**AER**”) Draft Decision on JGN’s forecast of gas consumption for its natural gas distribution network in New South Wales, (“**NSW**”) for the review period (1 July 2015 to 30 June 2020)¹.

Core prepared JGN’s consumption forecasts as part of JGN’s access arrangement proposal for the review period (**Core’s original submission or forecast**).

The AER engaged Deloitte Access Economics (“**DAE**”) to advise on Core’s consumption forecasts and to assist it in developing alternative consumption forecasts.

DAE advised the AER that Core Energy’s approach was “*transparent, clear and generally sound in terms of methodology*”.² However, the AER, relying upon DAE’s advice, did not approve aspects of Core’s original submission for gas consumption of tariff V customers.”³ DAE agreed with JGN’s proposed tariff D consumption forecasts, and they were accepted by the AER.⁴

JGN has re-engaged Core Energy to:

- review the AER’s Draft Decision and consider and respond to each of the departures made by the AER to Core’s original forecasts; and
- revise its forecasts of gas consumption per customer and connections taking into account, where relevant, matters raised by the AER and any updates to information.

1.2. Key findings of this report

1.2.1. Core’s response to the AER’s Draft Decision

Our response to each of the aspects of the AER’s Draft Decision, which results in a departure from Core’s original forecasts, is summarised in the table below.

¹ AER Draft Decision, Attachment 13 – Demand, November 2014.

² DAE Report, August 2014, p ii; DAE Report, November 2014, p 7.

³ DAE Report, August 2014, p ii; DAE Report, November 2014, p 7. Tariff V customers are expected to consume less than 10TJ of gas p.a. Tariff D customers are expected to consume more than 10TJ of gas p.a.

⁴ AER Draft Decision, Attachment 13 – Demand, November 2014, p 13-13.

Table 1.1 AER Draft Decision Aspects

Section	AER's Draft Decision	Core's summary response	Conclusion
Forecast of consumption per connection			
3.2	<p>The AER determined that the absence of a specific variable to capture future economic activity is likely to underestimate consumption per connection.</p> <p>The AER included GSP and SFD as an explanatory variable for forecast Tariff V residential and I&C consumption per connection respectively.</p>	<p>Core had undertaken analysis of the relationship between economic activity and Tariff V demand per connection for both the residential and I&C customer segments, and has now undertaken further extensive analysis.</p> <p>Core has been unable to observe a statistically significant relationship between SFD and residential demand consumption per connection. This analysis, inclusive of FY2014 data, also suggests that the regression model for GSP and I&C consumption per connection to be unstable and therefore produces unreliable results.</p> <p>Core is of the opinion that the inclusion a specific factor for SFD or GSP as an explanatory variable results in an overestimate of consumption per connection.</p>	Following further detailed analysis, Core has not revised its forecasts of Tariff V residential and I&C consumption per connection to include a specific variable for future economic activity.
Forecast of consumption per connection			
3.3	The AER determined that there was evidence of a structural change since 2008 in small business per customer consumption, and therefore, have excluded data from 2003 to 2007.	<p>Core notes inconsistency between the AER and DAE as to which data series evidenced the structural change - connections or consumption per connection. Core is of the opinion that a structural change in one data series (connections) will not necessarily extend to a structural change in the other data series (consumption per connection).</p> <p>Core analysis finds no evidence of a structural change since 2008, in either small business connections or consumption per connection.</p> <p>Core is of the opinion that the longer data series of 2003-2013 provides a better basis for developing a forecast.</p>	Core has not revised its forecasts to remove the time series data from 2003 to 2007.
3.4	The AER determined an alternative low cross price elasticity factor (0.5 vs 0.1 proposed by Core).	Core has reviewed the AER decision to reduce the cross price elasticity factor, and has identified no evidence to support the proposed revision in the cross price elasticity factor. The arguments made by DAE to support the use of an estimate of 0.05 in its forecasts and misconceived and do not establish that Core's estimate are too high.	Core has not revised its approach to estimating the cross price elasticity factor.
Forecast of customers			
3.5	The AER rejected Core's dwelling split assumption between new estate connections and medium/high (M/H) density connections (48 and 52 per cent respectively). The AER determined an alternate dwelling split relying upon HIA data.	<p>Core's estimate was consistent with the best information available at the time of the original submission.</p> <p>Core is of the opinion that AER has not identified adequate evidence to support its revised proposal.</p> <p>Core has reviewed latest third party analysis to update its forecast.</p>	Core has not adopted the AER's approach to dwelling split between new estate and M/H density dwellings. Core has revised its forecasts consistent with current specialist third party analysis.
3.6	The AER considered that the inclusion of data from 2003 to 2007 to estimate forecast of small business connections results in an overstated number of connections, as a result of a structural break in the series in 2008. The AER used a 2008 to 2013 time series.	See response to 3.3 above.	As above, following detailed analysis, Core has not revised its forecasts to remove the time series of data from 2003 to 2007.
3.7	The AER considered that Core's forecasts for residential disconnections is too high because of the inclusion of 2002 to 2010 data. The AER used 2011 and 2013 data only, as it represents a stable time series.	Core is of the opinion that a short time series of 2011-2013 as proposed by AER is inadequate to support a five year forecast. In the absence of a clear structural change, Core believes that a longer term time series provides a better basis for deriving a forecast for residential disconnections	Core has not revised its approach to estimating residential disconnections.

Each of Core's findings on the above matters are set out in section 3.

1.2.2. Summary of revisions to Core's original forecasts

Core's approach to revising its forecasts was to take into account the most recent input information and revise any related forecast assumptions, to ensure that its forecasts are based on a consistent and rigorous approach, utilising the best possible data and information available under the circumstances, which is presented in a transparent fashion.

1.2.2.1 Tariff V

Table 1.2 to Table 1.4 summarise the net revisions to Core's initial forecasts of consumption per connection, connections and total consumption.

Table 1.2 Difference in JGN Tariff V Consumption per Connection Forecasts | GJ⁵

	2014	2015	2016	2017	2018	2019	2020
Residential	0.24	0.11	0.02	-0.04	-0.11	-0.20	-0.30
Small Business	17.26	-10.08	-7.68	-7.38	-7.60	-7.83	-8.16
I&C	-29.36	1.54	6.94	5.08	1.93	-1.27	-4.45

Table 1.3 Difference in JGN Tariff V Connection Forecasts | No.⁶

	2014	2015	2016	2017	2018	2019	2020	TOTAL (2016-2020)
Residential	8,617	16,202	21,012	21,541	20,789	18,764	14,479	96,586
Small Business	39	79	122	167	215	266	321	1,092
I&C	583	631	678	721	765	811	858	3,832
Total	9,239	16,913	21,812	22,429	21,770	19,842	15,658	101,510

Table 1.4 Movement in JGN Tariff V Consumption Forecasts | GJ⁷

Customer	2014	2015	2016	2017	2018	2019	2020	TOTAL (2016-2020)
Residential	447,979	436,538	412,976	335,831	218,836	55,265	-159,940	862,969
Small Business	390,809	-211,852	-154,783	-144,740	-148,344	-152,944	-161,087	-761,898
I&C	-211,340	320,180	395,714	377,928	333,567	284,325	235,810	1,627,343
Total	627,449	544,866	653,908	569,019	404,060	186,646	-85,217	1,728,415

In summary, the movements in forecast consumption from Core's original forecast are attributed to changes in both forecast consumption per connection and forecast connections. Changes in forecast consumption per connection have arisen from:

- updates for FY2014 actual data in relation to consumption per connection for Tariff V customers. In making these updates, Core has derived forecasts using an extrapolated historic trend line, as derived from the 2002 to 2014 data;
- updates to the forecast of retail gas used in the analysis of price elasticity of consumption to account for the repeal of the *Clean Energy Act 2011* (Cth) (**Clean Energy Act**);
- updates to IPART's forecast of retail electricity prices to reflect more recent estimates published by the Australian Energy Market Commission (**AEMC**) in December 2014 (which also reflects the repeal of the Clean Energy Act). In

⁵ Core Energy Group, JGN GAAR Core Expert Report_Databook, February 2015, Demand Forecast Comparison Tab.

⁶ Ibid.

⁷ Core Energy Group, JGN GAAR Core Expert Report_Databook, February 2015, Demand Forecast Comparison Tab.

making the updates for retail gas and retail electricity prices, Core has only made an allowance for out of trend forecast retail gas and electricity price changes; and

- updates to the forecasts of new estate and M/H density housing to account for revised forecasts from independent data sources including BIS Shrapnel.

Changes in Tariff V connections have arisen from:

- updates for FY2014 actual data for connections; and
- updates to the forecasts for dwelling completions and residential connections to account for revised forecasts from independent data sources.

Core's revisions are set out in section 5.

1.2.2.2 Tariff D

Table 1.5 summarises the cumulative movement from Core's original forecast of total Tariff D forecast consumption to its revised forecast.

Table 1.5 Difference in JGN Tariff D ACQ, MDQ and CD Forecasts | GJ⁸

	2014	2015	2016	2017	2018	2019	2020	TOTAL (2016-2020)
ACQ	2,012,035	2,325,303	2,513,715	2,336,790	2,302,979	2,270,059	2,238,008	11,661,550
MDQ	45,490	15,110	14,380	12,410	12,674	12,704	12,704	64,872
CD	56,932	15,110	14,380	12,410	12,674	12,704	12,704	64,872

The movement in Tariff D consumption forecasts is attributed to new information provided by JGN relating to FY2014 actual consumption, new connections and disconnections.

1.3. Structure of Report

This report comprises the following sections:

- section 2 provides an overview of Core's approach to forecasting gas consumption per connection and connections for Tariff V customers in its original forecasts;⁹
- section 3 provides Core's response to the matters raised in the AER's Draft Decision on Tariff V consumption forecasts;
- section 0 sets out the revised Tariff V and Tariff D consumption forecasts; and
- section 5 explains the adjustments made by Core to derive the revised Tariff V and Tariff D consumption forecasts.

⁸ Core Energy Group, JGN GAAR Core Expert Report_Databook, February 2015, Demand Forecast Comparison Tab.

⁹ As Core's approach to forecasting Tariff D consumption has not departed from by the AER, we have not reconsidered it in this section.

2. Core's original forecasts for Tariff V consumption

2.1. Core's general forecasting approach

Core's approach to forecasting consumption favours a trend or time-series approach for forecasting tariff V consumption, which focusses on those factors which are expected to materially impact future normalised consumption and connections relative to the historic trend.

Core's adopted best practices to forecasting JGN's gas consumption over the review period – specifically guided by the following forecasting principles.

- **disciplined approach** – Core continually targets best practice approaches and analysis, consistent with international quality management standards. In the demand forecasting area, Core maintains a continuous review of relevant domestic and international forecasting analysis and precedents. This includes review of analysis and methodologies adopted by AEMO, AER and ERA access arrangement decisions, including expert submissions, as well as by the US Department of Energy and International Energy Agency.
- **evaluate key drivers** – Core's approach involves a rigorous analysis of the key drivers (both direct and indirect) of gas consumption. In accordance with best practice, Core adopts a balance of top down and bottom up analysis, including consideration of the following factors:
 - > Connections: population, household density, housing stock, construction trends
 - > Consumption per connection: energy efficiency, appliance trends, dwelling type, energy substitution.

To the extent that forecasts of underlying drivers are expected to follow a similar pattern to that observed historically, or there is no reasonable basis to quantify an out-of-trend adjustment, then future gas consumption has been assumed to conform to a historical time trend – for example, appliance efficiency and energy substitution.

Where Core identified material changes in those drivers to historic trend, it has made an out-of-trend adjustment, for example in its analysis of own price and cross price elasticity due to a step change in forecast prices as validated by independent third party analysis.

- **remove bias** – Core's forecast avoids bias — that is, careful data screening excludes data which consistently over or under-predicts outcomes. Specifically, Core applied a rigorous approach to normalise demand for weather, analysed historical trends to observe any changes in trend, ensured data sourced from third parties was independent, reviewed apparent outliers in a data series, and used widely accepted best practice methodologies to conduct statistical analysis.
- **use accurate and up-to-date data** – Core forecasts are based on most recent data available, and data sources and outcomes are validated, via independent third party analysis, and where this is not reasonably available, extensive literature review. Specifically, Core updated its forecasts to reflect new information - all forecasts were updated to reflect: 2014 actual results, updated electricity prices, the repeal of the Clean Energy Act, and revised connections forecasts based on new BIS and HIA data.
- **model rigour, transparency and validation** – Core adopts best practice in the design and development models and data books used to support forecasts. All inputs, calculations and outputs are clearly set out in a transparent manner and validation processes are consistently applied.

Core takes care to ensure all models and data books can be subject to review and revision in an efficient and consistent manner. Examples include clear model documentation, highlighting of key variables and formatting of output table summaries and detailed underlying data.

The steps taken to forecast, most relevantly, Tariff V consumption included the following:

1. Compile, collate and normalise data

- Compile and collate historical connections and consumption per connection data
- Weather normalise demand per connection data to address impact of variation in climatic factors.

2. Develop a complete, transparent forecasting model

- Excel model defined for each project, utilising common principles and approach
- Establish relationship between inputs, calculations and outputs
- Provide clear explanation of basis for inputs/assumptions.

3. Undertake times series analysis to derive historical trend

- Undertake historical time series analysis to identify trends in data using a balance of quantitative (including statistical regression) and qualitative analysis:
 - > Macro factors: economic activity influences; population, dwelling completions, household density; dwelling mix
 - > Micro factors: appliance substitution; energy efficiency; price response; energy policy.

4. Derive forecast movements from historical trend

- Undertake historical analysis of quality data to identify those factors which are expected to cause future demand to depart from the historical trend, using a balance of quantitative (including statistical regression) and qualitative analysis:
 - > Macro factors: economic activity influences; population, dwelling completions, household density; dwelling mix
 - > Micro factors: appliance substitution; energy efficiency; price response; energy policy.

5. Determine movements between Tariff V and D

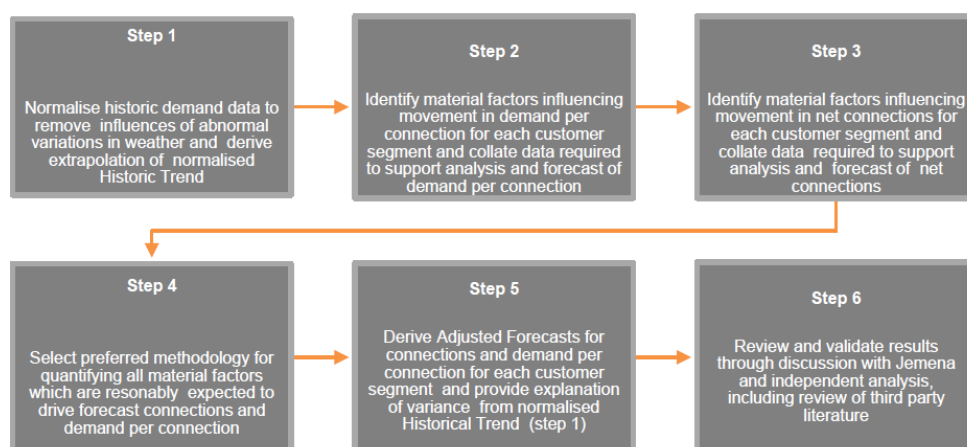
6. Derive forecast of connections and consumption per connection

- Forecast by customer tariff segment.

The outcome is a bottom up model of forecast connections and consumption per connection per each tariff class having consideration of top down analysis which is undertaken in a parallel fashion.

The above steps are summarised schematically below.

Figure 2.1 Core Methodology for Tariff V¹⁰



¹⁰Core Energy Group, Gas Demand and Customer Forecasts – Jemena Gas Networks I NSW Gas Access arrangement 2015-2020, April 2014, p 12.

2.2. Specific issues about Core's forecasting approach

There are two key issues of Core's forecasting approach which it wishes to elaborate on:

- first, the choice of model construct – that is, why Core favoured a trend or time series approach to forecasting consumption; and
- second, the model specification – in particular, why Core did not include a separate macro-economic variable in its original forecasts for gas consumption per connection.

2.2.1. Why Core used a trend approach to forecasting consumption per connection

Core's experience, which has been gained by developing gas consumption forecasts for each major jurisdiction in Australia, shows that gas consumption typically follows a series of significant trends. Therefore, Core's preferred approach is to observe actual data over a relevant historical time series as a basis for deriving forecasts.

As stated above:

- to the extent that forecasts of underlying drivers are expected to follow a similar pattern to that observed historically, then future gas consumption has been assumed to conform to a historical time trend – for example, appliance efficiency and energy substitution; and
- where Core identified material changes in those drivers to historic trend, it has made an out-of-trend adjustment, for example in its analysis of own price and cross price elasticity due to a step change in forecast prices as validated by independent third party analysis.

This approach involves rigorous analysis of the underlying drivers of gas consumption by utilising a balance of bottom up and top down analysis — both quantitative and qualitative and using professional judgement where appropriate.

Core considers this approach to have a number of significant advantages:

- It is a widely accepted approach to developing forecasts.
- It is relatively simple and logical in that it adjusts actual data trends for factors supported by appropriate evidence.
 - > For example, the historical trend includes any impact of economic activity during the sample period.
- Historical data (normalised for weather as appropriate) is by definition, accurate and overcomes the difficulty associated with using alternative data with a range of limitations.
- It ensures multiple variables which cannot be statistically analysed in isolation (with the available data) are factored into the derivation of a forecast e.g. appliance and dwelling efficiency.
- Major gas consumption drivers (including, existing (e.g. energy efficiency), past (e.g. carbon price) and prospective (e.g. gas price forecasts) trends) are typically accompanied by quality data and rigorous analysis available publicly, which provides support for the factors contributing to the historical trend.
- It avoids the pitfalls of more complex statistical techniques which often rely on aggregate measures which do not adequately reflect commercial reality.

In Core's opinion, as previously noted, in circumstances where a range of factors influence consumption, but where there may be insufficient information to reasonably determine the relationships of each of these factors, a historical trend approach provides a reasonably-based guide to forecast consumption.¹¹

¹¹ Core Energy Group, Response to DAE Report: Australian Energy Regulator I Review of Core Energy Group gas demand forecast for Jemena's NSW network, August 2014, p 7.

2.2.2. Why Core did not include economic-activity variables in its model specification for consumption per connection

As part of its planning process, Core develops a listing of the variables which have the potential to materially influence forecast gas consumption per customer and connections for each tariff segment, whether or not they are represented in the historical trend. These variables are determined through economic theory, client consultation, prior relevant experience and literature review.

This process includes consideration of the potential impact of macro-economic factors, such as Gross State Product (**GSP**), that have a potential relationship with energy consumption per customer. As noted in our August 2014 report, and discussed in some detail with DAE, Core undertook statistical analysis of GSP and its relationship with residential and I&C consumption per connection.¹² Core's statistical analysis demonstrated that there was no observable statistically significant relationship between GSP and residential or I&C consumption per connection.

Whilst the focus of this response is in relation to the usefulness of GSP and SFD as an explanatory variable in forecasting consumption per connection, it is important to note that Core has undertaken extensive analysis of macroeconomic factors relating to connections. Core's bottom-up analysis addresses factors such as population, household density and dwelling growth in deriving a forecast of connections.

Core notes that DAE appeared to place substantial weight on GSP during its earlier analysis¹³ and review of Core's forecast. Core completed a detailed analysis of the DAE finding and demonstrated that it was not statistically significant for residential consumption per connection. Core submitted its analysis to DAE who confirmed that it could find no issue with Core's analysis. At this time, DAE had not raised that it was also considering SFD as a relevant parameter to forecasting residential consumption.¹⁴ Prior to the release of the AER's Draft Decision Core did not extend its analysis to consider SFD as there was no particular reason to expect any relationship between gas consumption and change in SFD given the results of the GSP analysis, and that expenditure in the State of NSW (i.e. SFD) is unlikely to be a driver of Tariff V residential and I&C consumption per connection in NSW.

As previously stated, Core has completed consumption forecasts for every major jurisdiction in Australia and has observed material variances in the relationship between economic aggregates and consumption per connection. Core considers that a case-by-case approach to determining the relevant drivers of consumption is necessary to determine reasonably-based, best estimates under the circumstances.

Our opinion was that DAE had not presented any compelling analysis or evidence that SFD has a causal relationship with residential gas consumption per connection in the specific circumstances under consideration in NSW. This was the view we expressed at the time¹⁵ and we continue to hold that view. Specifically, we considered that there was inadequate evidence that GSP based forecasting would produce a forecast which is better (as required by the rules) than the forecast produced under the approach adopted by Core, as summarised in its original report".¹⁶

¹² Core Energy Group, Response to DAE Report: Australian Energy Regulator I Review of Core Energy Group gas demand forecast for Jemena's NSW network, August 2014, section 4.1.1.

¹³ DAE Access Economics, Australian Energy Regulator – Review of Core Energy group gas demand forecast for Jemena's NSW network, 11 August 2014, section 3.1.

¹⁴ DAE Access Economics, Australian Energy Regulator – Review of Core Energy group gas demand forecast for Jemena's NSW network, 11 August 2014.

¹⁵ Core Energy Group, Response to DAE Report: Australian Energy Regulator I Review of Core Energy Group gas demand forecast for Jemena's NSW network, August 2014, p 7.

¹⁶ Core Energy Group, Response to DAE Report: Australian Energy Regulator I Review of Core Energy Group gas demand forecast for Jemena's NSW network, August 2014, p 7.

Core also completed an analysis of the relationship between a broader range of variables and consumption per connection, including but not limited to:

- appliance mix trends - e.g. in water heating and room heating market;
- energy policy - e.g. BASIX and NSW Energy Savings Scheme
- appliance and dwelling efficiency - e.g. E3 program; and
- price impact.

In Core's opinion, a range of factors influenced consumption per connection and there was insufficient information to arrive at conclusions as to the statistical significance of each variable independently. In contrast to a multi-variable regression approach, where the reliability of its results depends on the statistical significance and predictive value of its parameters, a trend approach reflects the relevant drivers of consumption in the trend. We see this as the key advantage of the trend approach, in circumstances of limited historic data.

Specifically, Core's approach takes into consideration important influences of appliance and dwelling efficiency, appliance substitution and energy policy. Core considers that DAE's approach does not adequately address these influences as its regression approach simply accounts for GSP/SFD and own price elasticity.

Core notes that it did use an economic variable, Gross Household Disposable Income (**GHDI**) (not GSP as stated in the AER's Draft Decision¹⁷), as an explanatory variable to forecast residential consumption per connection in the historical review of Victoria gas consumption for the Envestra network.¹⁸ Stated simply, we observed a statistically significant relationship at that time, which we could not observe in the case for JGN.¹⁹ Several factors could explain the significance of the relationship we observed in Victoria (as compared to NSW), including a materially higher penetration rate of gas connection in Victoria, a materially different climate and consumption per connection in Victoria which is approximately double that observed for NSW.²⁰

¹⁷ "This seems inconsistent with Core Energy's forecasting approach for Envestra's Victorian gas distribution network. In that report, Core Energy included GSP in the forecast." AER Draft Decision, Attachment 13 – Demand, November 2014, p 13-12.

¹⁸ Core Energy Group, Demand, Energy and Customer Forecasts Envestra Limited – Gas Access Arrangement Review Victoria and Albury Networks (2013 to 2017), March 2012, p 2.

¹⁹ Core Energy Group, Demand, Energy and Customer Forecasts Envestra Limited – Gas Access Arrangement Review Victoria and Albury Networks (2013 to 2017), March 2012, p 2.

²⁰ Core Energy Group, Response to DAE Report: Australian Energy Regulator I Review of Core Energy Group gas demand forecast for Jemena's NSW network, August 2014, p 7.

3. Core's response to the AER's Draft Decision

3.1. Summary of AER's departures from Core's initial forecasts

In this section we:

- consider the elements of our original forecasts which the AER has departed from; and
- determine whether, on the basis of the AER Draft Decision, and the accompanying DAE analysis, it leads Core to change its forecasting approaches.

DAE determined that the approach adopted by Core was "transparent, clear and generally sound in terms of methodology".²¹ However, the AER Draft Decision, relying upon DAE's analysis, did not accept elements of Core's original forecasts to derive a forecast of JGN consumption over the review period.

The AER's made three adjustments to Core's originals forecasts for Tariff V consumption per connection, namely:

- The AER criticised Core's non-inclusion of a variable to capture future economic activity (for example, SFD or GSP) in estimating Tariff V consumption per connection forecasts for residential and industrial and commercial customers.²²

DAE derived an economic regression model which included SFD and GSP variables for Tariff V residential and industrial and commercial customers respectively, incorporating own price elasticity within the model. DAE used the results of their regression models to derive annual percentage changes in per customer consumption and then used those percentages within Core's trend model.²³

- The AER challenged the calculation of the historical trend underpinning the forecast of Tariff V small business consumption per connection, based on 2002 to 2013 data having regard to an apparent step change in the data from 2008. Relying upon this, the AER has used a 2008 to 2013 time period.²⁴
- The AER rejected Core's estimate of a cross-price elasticity estimate of 0.1, and applied a cross-price elasticity of 0.05.²⁵

The AER also made three adjustments to Core's initial forecasts of Tariff V connections, namely:

- The AER rejected Core's dwelling split for new estates and medium/high density connections. The AER applied a different dwelling split based on alternative data.²⁶
- The AER rejected the use of the 2003 to 2013 time period for estimating the historical trend for small business connections. Instead, the AER used a 2008 to 2013 time period.²⁷
- The AER rejected the use of 2002 to 2013 time period for estimating the historical trend for residential disconnections, instead adopting a 2011 to 2013 time period.²⁸

Core has reviewed the AER's adjustments and our response to each issue is set out below.

²¹ DAE Report, November 2014, p 7.

²² AER Draft Decision, Attachment 13 – Demand, pp 13-10, 13-15, 13-16.

²³ DAE Report, November 2014, pp 14, 16.

²⁴ AER Draft Decision, Attachment 13 – Demand, pp 13-10, 13-17; DAE Report, November 2014, pp 17-18.

²⁵ AER Draft Decision, Attachment 13 – Demand, pp 13-10, 13-13, 13-14; DAE Report, November 2014, pp 28-29.

²⁶ AER Draft Decision, Attachment 13 – Demand, pp 13-10, 13-15, 13-16; DAE Report, November 2014, pp 14, 16.

²⁷ AER Draft Decision, Attachment 13 – Demand, pp 13-10, 13-16, 13-17; DAE Report, November 2014, pp 17, 18.

²⁸ AER Draft Decision, Attachment 13 – Demand, pp 13-10, 13-11, 13-17; DAE Report, November 2014, pp 19-21.

3.2. Non-inclusion of an economic variable to forecast consumption per connection

3.2.1. AER Draft Decision

The AER determined that Core's original forecasts for Tariff V residential and I&C consumption per connection was not a reasonably-based, best estimate because it did not include a variable for future economic activity, such as GSP or SFD.

The AER considered economic activity over the review period would increase at a higher rate than compared to economic activity experienced in the current access arrangement period.²⁹ Therefore, the AER, relying upon DAE's advice, determined that the absence of this variable means that Core's Energy's forecasts were likely to under estimate per customer consumption.³⁰

As a result, the AER determined that:³¹

On the basis of DAE's advice, we have included GSP or SFD in our per customer consumption forecasts for tariff V residential and I&C customers. DAE estimated "own price elasticity" within the model. This resulted in different own price elasticities (the sensitivity of gas consumption per customer to changes in the gas price) being applied to tariff V residential and I&C per customer consumption forecasts compared to those applied by Core Energy.

For completeness, we note that the AER did not adjust Core's initial forecast of Tariff V small business per customer consumption in the same manner. That is, the AER accepted that Core's approach in not including any economic activity variable was reasonable, and did not prepare separate regression analysis.³²

3.2.2. Core's response

The reasons why Core did not include an economic activity variable in its original forecasts are set out in section 2.2.1 above.

Following the AER's draft decision, Core has estimated the impact of DAE including SFD and GSP as a driver on residential and I&C consumption per connection respectively. The resulting differences in residential and I&C consumption from Core's original forecasts are summarised in Table 3.1 and Table 3.2.

Table 3.1 Total Residential Consumption in Forecast Period | GJ³³

Core Energy	113,794,186
DAE	120,883,173
Absolute Difference	7,088,987
Percentage Difference	6.2%

Note: (i) Core Residential consumption is different from submitted values as the forecast is based on a no carbon scenario.

(ii) DAE Residential consumption is estimated using connections used to forecast consumption is Core's submitted forecasts, in order to compare the impact of SFD.

(iii) Note that there is an element of own price elasticity impact on the DAE residential consumption.

²⁹AER Draft Decision, Attachment 13 – Demand, pp 13-10.

³⁰AER Draft Decision, Attachment 13 – Demand, pp 13-10.

³¹AER Draft Decision, Attachment 13 – Demand, pp 13-10.

³²DAE advised that 'the strength of the downward trend over the historical period was larger than the effect of any potential explanatory variables (including price and economic conditions)'. For this reason it did not modify Core Energy's trend based forecast method. Core Energy forecast tariff V small business consumption per customer on the basis of the historical trend between 2002 and 2013": AER Draft Decision, Attachment 13 – Demand, pp 13-11.

³³Core Energy Group, JGN Statistics Work book_FY2014_REVISED_AERCONFIDENTIAL, February 2015, Residential Forecast Tab.

Table 3.2 Total I&C Consumption in Forecast Period | GJ ³⁴

Core Energy	36,988,528
DAE	41,157,017
Absolute Difference	4,168,490
Percentage Difference	11.27%

Note(i) These values are prior to any adjustments due to Tariff switching.

Most of the adjustment proposed by the AER in its Draft Decision is attributable to the inclusion of SFD on residential consumption per connection, with a lower impact (in GJs) due to the inclusion of GSP as a variable to forecast I&C consumption.

Core considers a forecast model specification should only include SFD and GSP as variables of forecast residential and I&C consumption per connection, where it is demonstrated that those parameters are consistent with economic theory, statistically significant and pass a range of tests (including a test of causation) to ensure they can be relied upon to predict future changes in consumption per connection. Otherwise, inclusion of independent variables which are not statistically significant and causatively related to the dependent variable will result in bias and therefore not deliver reasonable or reliable forecasts.

Core has reviewed the available data, and the DAE results, to test whether there is a reliable statistical basis to include GSP or SFD in its forecast model.

Core does not consider the data considered by DAE (to the end 2013), or the DAE results, demonstrate a statistically reliable relationship between GSP and residential customer consumption or SFD and I&C customer consumption.

Specifically, Core notes that:

- DAE have not provided an adequate theoretical or logical a priori basis to support economic activity as a causative driver of consumption per connection for residential and I&C tariff customers in NSW (as noted in section 2.2.1).
- DAE has, without any expressed reasoning, used a shorter historical data series than available in their regression analysis, for SFD and GSP.
 - > The use of the full data series for SFD and GSP provides results which vary materially from the results based on the partial data series, and do not provide statistical support for their specific inclusion within a demand forecast model.
- DAE's analysis does not provide statistical support for their specific inclusion of GSP or SFD within the per customer consumption forecast models.
 - > Core's own analysis shows that SFD and GSP do not have statistically significant relationships with residential and I&C consumption per connection respectively to 2013; and
 - > Using the regression coefficients estimated by DAE to forecast demand is likely to result in forecasting errors;
- DAE have not made it clear why lagged gas price is used for residential but not I&C consumption per connection.

3.2.2.1 DAE's use of partial data series

DAE's regression modelling does not account for the most recent three years of historical data for SFD/GSP or for any other parameter in their regression models.³⁵

³⁴Core Energy Group, JGN Statistics Work book_FY2014_REVISED_AERCONFIDENTIAL, February 2015, Tab I&C Forecasts.

³⁵ DAE, Copy of JGN – data for regression 21-10-14, December 2014.

Table 3.3 presents a comparison of the results of regression analysis by DAE, which relied upon a 2002-2010 data series, and the same regression analysis relying upon 2002-2013 data series which was available to DAE at the time of its report. We have also updated DAE's regression analysis given that the 2014 actual demand data is now available and these results are displayed in Table 3.3.

The coefficient for the lagged SFD change parameter using the entire data series which was available to DAE indicates that the impact of SFD falls materially.

Table 3.3 Regression results – Tariff V residential³⁶

Variable	DAE 2002-2010		Core 2002-2013		Core 2002 - 2014	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
C	5.88	0.00	5.78	0.00	5.00	0.00
SFD_CHANGE(-1)	0.012	0.01	0.008	0.00	0.0056	0.07
LOG(P_GAS)	-0.32	0.27	0.21	0.06	0.32	0.05
LOG(P_GAS(-1))	-0.13	0.26	-0.64	0.00	-0.63	0.003

These results suggest that the regression models are highly unstable and sensitive to marginal changes in the sample size. The variability of the results from using slightly different time series indicates that the model is unstable and therefore produces unreliable results.

Core undertook the same analysis for DAE's use of lagged GSP change in forecasting Tariff V I&C consumption per connection.³⁷

Table 3.4 Regression results – Tariff V I&C³⁸

Variable	DAE 2002-2010		Core 2002-2013		Core 2002-2014	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
C	8.5207	0.00	8.8725	0.00	9.22	0.00
GSP_CHANGE(-1)	0.027	0.17	0.0319	0.0860	0.036	0.026
LOG(P_GAS)	-0.3559	0.06	-0.4132	0.00	-0.49	0.00

The DAE regression analysis using the 2002-2010 time series shows that GSP is not statistically significant at a 5% confidence level. Core has extended the time series to include 2002-2013 and this analysis continues to show that GSP is not statistically significant.

For completeness Core extended the model to include 2014 data and the results are summarised in Table 3.4. Whilst the results, measured by the P value, indicate statistical significance, the coefficients are observed to change markedly with the extension of the data series. This trend and the magnitude of the variance arising from a marginal increase in sample size, in Core's view, renders the model unsuitable as a basis for deriving a best available forecast under the circumstances.

Further, Core notes that DAE has omitted the lagged own price variable from the GSP/I&C analysis. This is inconsistent with the approach used for residential analysis. Core's analysis³⁹ demonstrates that any regression using

³⁶ Core Energy Group, JGN Statistics Work book_FY2014_REVISIED_AERCONFIDENTIAL, February 2015, Tab Deloitte – SFD Regression and CORE – SFD Regression.

³⁷Ibid.

³⁸Ibid.

³⁹ Core Energy Group, JGN Statistics Work book_FY2014_REVISIED_AERCONFIDENTIAL, Tabs Core _ RDC Regressions (2013), Core – RDC Regressions (2014), Core – CDC Regressions (2013) and Core – CDC Regressions (2014).

the lag of own price for data to 2013 or 2014 results in a statistically insignificant relationship between GSP and I&C consumption per connection.

In conclusion, the variability in the statistical results between the different data series used casts significant doubt on whether DAE has established any reliable economic relationship between the variables and whether using the model provides the best estimate of consumption per connection in the circumstances. It therefore does not lead us to reconsider our forecast methods for consumption per connection.

3.2.2.1 Statistical testing

Core's statistical analysis of DAE's regression model (using the full data series available) demonstrates the unreliability of SFD and GSP as drivers of consumption per connection for Tariff V residential and I&C respectively.

Based on these tests, Core considers there is no reasonable basis for including an economic variable in its forecasts for Tariff V residential and I&C consumption per connection, and therefore we have not changed our forecast method. The results of Core's statistical testing are detailed in Attachment 2.

3.2.2.2 No proof of causation

In Core's opinion, any correlation observed through a pure statistical approach, which is then used to analyse residential consumption, must also pass a practical causation test.

SFD and GSP each contain elements which are unrelated to residential, industrial and commercial consumption for gas, and exclude other relevant influences such as efficiency gains and policies affecting gas consumption.

Specifically, Core's research indicates that:

- Efficiency gains at the appliance and dwelling level have been demonstrated to impact gas consumption per connection for the residential and I&C customer segments and this has been accepted by the AER across a range of access arrangements⁴⁰. SFD and GSP based approaches to forecasting do not adequately address this relationship.
- Certain segments that make up GSP forecasts are expected to grow faster than household expenditure related segments which will give rise to an upward bias. These segments include government infrastructure investment and private fixed capital formation, which do not demonstrate a causal link with residential gas consumption per connection.
- Economic activity variables used as a basis for energy consumption forecasting are most reliable when the energy product being considered has a high level of penetration across the economy and associated population ⁴¹ and when the level of energy used is high per capita. This is attributable to the fact that a significantly higher proportion of household income is allocated to energy consumption in such circumstances.
- Economic activity variables have a stronger correlation with connections than demand per connection, particularly in areas which have a lower rate of penetration.⁴² This is mainly due the strong influence of population growth on both GDP and dwelling construction and thus connections.

⁴⁰ For example, Envestra's Victorian and South Australian Access Arrangements; AER, Final Decision Envestra Ltd Access arrangement proposal for the SA gas network, June 2011; AER, Access arrangement final decision Envestra Ltd 2013-17 Part 1, March 2013.

⁴¹ Core Energy Group, Response to DAE Report: Australian Energy Regulator I Review of Core Energy Group gas demand forecast for Jemena's NSW network, August 2014, section 4.1.1.

⁴² The greater the divergence between Jemena's customer base, and the consumer/producer base used to measure NSW economic activity, the less appropriate it is for one to be used as a proxy for the other.

The network penetration rate in NSW is ~64%.⁴³ This is a significantly lower penetration rate compared to Victoria. For example the penetration rate higher in Melbourne is estimated to be approximately 93%.⁴⁴ Further the level of consumption per residential connection in Victoria is approximately double or greater than the equivalent residential consumer in NSW.

As noted in section 2.2.2, Core observed statistically significant relationships between economic activity variables, GHDI, and gas consumption for Envestra's network in Victoria⁴⁵. Core was unable to observe similar statistical relationships for JGN.⁴⁶ As a result, Core considers that any relationship in changes in economic activity on residential and I&C consumption in NSW will be less significant than in Victoria. Therefore, using economic activity as drivers for consumption per connection in circumstances of growing economic activity is likely to cause an upward bias, which is likely to render forecasts unreliable.

In conclusion, Core considers that DAE has not demonstrated a causal relationship exists between SFD and GSP and gas consumption, and therefore there is an insufficient basis for Core to revise its approach on this issue.

3.3. Alternative time series used to forecast small business consumption per connection

3.3.1. AER Draft Decision

Core calculated historical trend in per customer consumption when forecasting Tariff V small business based on 2002-2013 data having regard to an apparent step change in the data from 2008.⁴⁷

Specifically, DAE used a 2008 to 2013 time period, as it considered that inclusion of the full data set resulted in an overstated number of connections "due to a structural break in the series in 2008, where there was a significant step change in the number of connections"⁴⁸. The AER accepted DAE's analysis noting that:⁴⁹

"[the] data before 2008 exhibited a strong decline in per customer consumption, relative to the stable demand post-2008. DAE considers that this reflects a moderation and most likely structural change in per customer consumption post-2008."

3.3.2. Core Energy Response

As a general point, we note that there is a limited data set for undertaking a structural approach to forecasting of small business consumption per connection. Excluding data points from this small data set, we think, should be undertaken with extreme caution.

Core has calculated the impact on consumption using the AER's shorter time series as summarised in Table 3.5. The 2002-2013 historical trend is a decline of 3.2% per annum in consumption per connection, whereas the 2008- 2013 historical trend, as applied by the AER/DAE, is a decline of 2.5% per annum.

⁴³ 64% assumes 80% JGN network reach and 80% network penetration, consistent with the Att. 3 JGN Demand Forecast Model_FY2014_FINAL_AERCONFIDENTIAL, Residential Tab.

⁴⁴ Consumer Utilities Advocacy Centre, Our Gas Challenge: The role of gas in Victorian households, August 2014, p. 3.

⁴⁵ Core Energy Group, Demand, Energy and Customer Forecasts Envestra Limited – Gas Access Arrangement Review Victoria and Albury Networks (2013 to 2017), March 2012.

⁴⁶ Core Energy Group, JGN Statistics Work book_FY2014_REVISIED_AERCONFIDENTIAL, February 2015

⁴⁷ AER Draft Decision, Attachment 13 – Consumption, pp 13-10, 13-17.

⁴⁸ DAE Report, November 2014, pp 17-18.

⁴⁹ AER Draft Decision, Attachment 13 – Demand, p 13-13.

The AER's approach, when applied to increasing small business connections, gives rise to an additional 2.8% increase in small business consumption or 644,668GJ across the 2015-2020 period, when compared to Core's original forecast.

Table 3.5 Total Small Business Consumption Forecast | GJ ⁵⁰

Core Energy	22,969,726
DAE	23,614,394
Absolute Difference	644,668
Percentage Difference	2.8%

As noted above, the AER/DAE rely upon an assumption that a structural change in consumption per connection has occurred in 2008. Core assumes that the term "structural change" refers to material and sustained change in a major driver/s or explanatory variable of small business consumption per connection. Core notes that the AER/DAE do not provide detail of what particular driver or drivers they believe have changed since 2008.⁵¹

Core's approach to determining whether it was appropriate to exclude the full data from the times series was to:

- First, conduct a structural change test – which was to compare the annual average growth between the 2002-2013 series, and the 2008-2013 series to consider whether there was any material difference in the rate of growth across the two different periods; and
- Second, conduct statistical testing to determine whether the Core forecast falls within a statistically acceptable range of outcomes

The results of these tests are set out below.

3.3.2.1 Structural change testing

First, Core reviewed the annual average growth in consumption per connection, measured by the proportional change between the 2002-2013 and 2008-2013 and these results are summarised in Table 3.6. The analysis has also been extended to include 2014 data and these results are summarised in Table 3.7.

Table 3.6 Historical 2002-13 | Annual Change in Small Business Consumption and Consumption per Connection | % ⁵²

Growth Rates	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Avg 03-13	Avg 08-13
Weather Norm. Consumption	3.89%	4.48%	2.64%	2.90%	5.51%	-7.30%	-3.40%	10.71%	4.58%	-7.05%	1.86%		
Consumption / Connection	13.10%	-10.41%	-8.29%	-8.10%	-2.38%	-5.05%	-15.33%	9.00%	1.60%	-5.00%	-1.16%	-2.91%	-2.66%

Table 3.7 Historical 2002-14 | Annual Change in Small Business Consumption and Consumption per Connection | % ⁵³

Growth Rates	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg 03-14	Avg 08-14
Weather Norm. Consumption	3.90%	4.45%	2.64%	2.85%	5.54%	-7.32%	-3.42%	10.75%	4.50%	-7.04%	1.89%	3.58%		
Consumption / Connection	13.11%	-10.44%	-8.29%	-8.14%	-2.35%	-5.07%	-15.34%	9.05%	1.52%	-4.98%	-1.13%	1.03%	-2.59%	-2.13%

Note: 2003 is the first year as it includes the movement from 2002 to 2003

⁵⁰ Core Energy Group, JGN Statistics Work book_FY2014_REVISIED_AERCONFIDENTIAL, February 2015.

⁵¹ DAE Report, November 2014, p 27.

⁵² Core Energy Group, JGN GAAR Core Expert Report_Databook, February 2014. Note 2003 is the first year for which a movement is recorded for the time series - i.e. movement between 2002 and 2003.

⁵³ Core Energy Group, JGN GAAR Core Expert Report_Databook, February 2015, Tab historical Data. Note 2003 is the first year for which a movement is recorded for the time series - i.e. movement between 2002 and 2003.

As demonstrated in Table 3.6, the annual average decline in small business customer consumption is not significantly different between for the full data set (2002-2013) to the period from 2008 i.e. -2.91% vs -2.66%.

This difference does not demonstrate a structural change in small business consumption per connection. Specifically, for a potential structural change to be evident Core would expect there to be a material difference in the trend between the two periods and there clearly is not, whether or not the data series is extended to 2014.

As a result, Core does not consider there is a reasonable basis to exclude the 2002-2008 data from the time series.

3.3.2.2 Statistical testing

Core undertook statistical analysis to demonstrate that the Core forecast for small business consumption per connection falls within an acceptable range of potential outcomes. The small business consumption per connection forecast is within one standard deviation of simulated consumption per connection values. Simulated consumption per connection values were derived to demonstrate the full spectrum of possible outcomes given the historical growth rates. The detailed analysis of this statistical testing is provided in Attachment 3.

3.4. Use of alternative cross price elasticity factor

3.4.1. AER Draft Decision

DAE determined that “on balance, it may be reasonable to include an estimate of cross-price elasticity in per customer consumption forecasts”⁵⁴ The AER’s Draft Decision rejected JGN’s factor for cross-price elasticity based on DAE’s advice, reducing it from 0.1 to 0.05.⁵⁵ The reasons why DAE considered that Core’s value was too high was based on the following factors:

- ACIL Allen, in its gas forecasting work for AEMO, had not found any modelling which produced a statistically significant estimate for cross price elasticity and did not include it as a variable in its current modelling.
- DAE’s own price elasticity estimates are higher than those applied by Core Energy. To avoid double counting, DAE considers it is appropriate to have a lower cross price elasticity.
- There are likely to be mitigating effects offsetting gas price increases relative to electricity prices. These include the likely increase in price of alternative energy products including solar, as subsidies are removed.
- Core Energy’s within model estimates of cross price elasticity were not statistically significant.

For reasons set out in the next section, we do not consider that simply halving our estimated cross price elasticity factor from 0.1 to 0.05 is a reasonable basis to forecast demand taking into account that changes in relative gas and electricity prices will have an effect on demand over the forecast period.

We agree that estimating cross-price elasticity with the available data is difficult. Professional judgement needs to be taken into account in these circumstances, considering economic theory and a range of quantitative and qualitative information sources.

Core has undertaken an analysis of DAE’s cross price elasticity approach and Core’s own cross price approach to identify the differential impact. Table 3.8 highlights the difference in total residential consumption that arises from

⁵⁴ DAE Report, November 2014, p 29.

⁵⁵ AER Draft Decision, Attachment 13 – Demand, p 13-14.

applying a cross price elasticity of 0.1 and 0.05, for the forecast period 2015 to 2020. This cumulative difference in residential consumption is 0.3%.

Table 3.8 Total Residential Consumption in Forecast Period | GJ⁵⁶

Core Energy	114,556,628
DAE	114,943,187
Absolute Difference	386,559
Percentage Difference	0.3%

Note: (i) Connections used to forecast consumption is Core's submitted forecasts.

(ii) Core reported residential consumption is forecasted under the carbon price repeal scenario

Table 3.9 highlights the difference in total I&C consumption that arises from applying a revised cross price elasticity factor, for the forecast period 2015 to 2020. This cumulative difference in residential consumption is 0.68%.

Table 3.9 Total I&C Consumption in Forecast Period | GJ⁵⁷

Core Energy	36,988,528
DAE	37,239,388
Absolute Difference	250,860
Percentage Difference	0.68%

Note: (i) These values are prior to any adjustments due to Tariff switching.

3.4.2. Core's response to DAE's considerations

In Core's opinion DAE has not provided sufficiently robust evidence in support of a reduction in the cross price elasticity factor from 0.1 to 0.05. Core addresses the specific issues raised by DAE/AER below.

3.4.2.1 ACIL Allen's analysis for AEMO

Economic theory suggests that there is a relationship between gas demand and the price of alternative products such as electricity services.

Core acknowledges the difficulty in estimating cross-price elasticity using Australian data, as noted by ACIL Allen. Core examined the historical data and concluded that given there had not been a material divergence between gas and electricity price changes in the past meaning that it was challenging to establish a reliable economic relationship in the form of a cross-price elasticity assumption.

However, this is not to suggest that future divergence in the forecast price of gas and electricity will not materially impact consumption per connection. AEMO expects there to be an out-of-trend change in forecast gas consumption resulting from increasing customer choice and the changing relative price of forecast gas and electricity prices.

As noted by AEMO in its National Gas Forecasting Report:

[AEMO] does expect that changing relativity of fuel prices and increasing availability of high efficiency electric appliances will impact gas consumption over the forecast period. Such an impact may already be visible in reduced average use per consumer across all states except Tasmania.

⁵⁶ Core Energy Group, JGN Statistics Work book_FY2014_REVISSED_AERCONFIDENTIAL. February 2015 Tab Residential Forecasts.

⁵⁷ Core Energy Group, JGN Statistics Work book_FY2014_REVISSED_AERCONFIDENTIAL. February 2015 Tab I&C Forecasts.

Notably, DAE themselves say:

...it is clear there will be a non-zero demand response if, as expected, electricity become materially cheaper relative to gas.⁵⁸

Consistent with economic theory, this will affect both connections (E to G connections and disconnections) and consumption per customer (for example, as customers switch to using their reverse cycle-air-conditioners for space heating). Core has accounted for these two impacts separately as described below.

3.4.2.2 DAE conclusion that Core's analysis may involve double-counting of elasticity response

The AER's draft decision and DAE analysis seem to highlight concern relating to double-counting of the impact on Tariff V gas demand of changes in the forecast price of electricity. DAE were also asked by the AER to consider whether including cross price elasticity and marketing effectiveness is overstating the changes attributable to decreasing gas/electricity price differentials.⁵⁹ Further, the DAE report notes that its forecasts already take into account an own-price elasticity effect of 0.45 (after two years) for residential usage and 0.36 for I&C usage, which is higher than the Core assumptions.⁶⁰

Core has taken care to ensure that there has not been double-counting in its analysis of cross price elasticity.

- Core's own price elasticity calculation focuses purely on the demand response attributable to a movement in gas prices. The elasticity factors applied are conservative relative to other international studies and DAE's own estimates and are in accordance with the approach and results previously approved by the AER⁶¹
- Core's cross-price elasticity factor focuses purely on the demand response attributable to a movement in relative price of electricity and gas prices as substitute energy sources. The elasticity factor applied is conservative when considered against the full range of international studies. Further the studies used a basis for deriving the cross-price factor have been reviewed by Core to ensure they adequately address the independent impact of cross and own price elasticity factors.
- Core has focused separately on those forces impacting connections and those factors impacting consumption per connection. Issues relating to marketing effectiveness have been considered in deriving connection forecasts. We believe that JGN's marketing efforts are likely to be negatively impacted by rising wholesale gas prices and moderating electricity prices, and this has been taken into account when considering the connections forecasts.

Core considers that its approach to forecasting the cross price elasticity of gas consumption is the best approach available under the circumstances, it takes care to ensure that double counting is avoided (in large part through focused analysis and use of conservative factors) and that the DAE approach provides inadequate evidence to cause Core to revise its assumption.

3.4.2.3 DAE conclusion that there are likely to be mitigating effects offsetting gas price increases relative to electricity prices.

The AER/DAE rely upon an assumption that there are likely to be mitigating effects offsetting gas price increases relative to electricity prices, including the likely increase in price of alternative energy products including solar, as subsidies are removed.

⁵⁸ DAE, Australian Energy Regulator Gas demand forecast for Jemena's NSW network, November 2014, p 8.

⁵⁹ DAE, Australian Energy Regulator Gas demand forecast for Jemena's NSW network, November 2014, p 29.

⁶⁰ DAE, Australian Energy Regulator Gas demand forecast for Jemena's NSW network, November 2014, p 29.

⁶¹ Core Energy Group, Demand, Energy and Customer Forecasts Envestra Limited – Gas Access Arrangement Review Victoria and Albury Networks (2013 to 2017), March 2012.

Core notes that DAE/AER do not provide any source or basis for the conclusion that the price of alternative energy products is forecast to increase in NSW. Moreover, DAE/AER do not recognise the range of independent market analysis which presents scenarios of significant declines in the prices for alternative energy products.

- a range of Government and independent market experts are forecasting cost reductions in small scale solar and utility-scale solar as continued advances in manufacturing techniques lowers unit production costs (Refer Attachment 4);
- continued upfront subsidies to households and businesses installing eligible small scale solar technologies (such as solar PV and solar hot water) under the Small Scale Renewable Energy Scheme (**SRES**) – which forms part of the Australian Government’s Renewable Energy Target (**RET**) – following the Expert Panel’s review and recommendations regarding the RET (‘Warburton Review’); and
- increasing awareness of customer choice regarding alternative energy products and customer willingness to take-up these products.

Based on extensive third party analysis, Core considers that there is likely to be continuing strong growth in use of alternative energy products including small scale solar as relative costs continue to decline.

3.4.2.4 Core’s statistical results

Core is unable to adopt a statistical analysis to demonstrate a statistically significant relationship between movements in the relative price of gas and electricity to demonstrate the anticipated cross-price effect. This is because there has not been a material deviation between gas and electricity prices in recent history in NSW – and therefore there is a lack of suitable data. It is for this reason that Core believes it is appropriate to rely on other studies, which indicate the likely relationship between price movement and consumption per connection. That said Core does note a general trend in increased customer awareness and understanding of energy alternatives. As prices increase this provides an increased incentive for consumers to explore alternatives and to pursue alternatives which optimise value, evidenced by the clear trend toward solar power, including solar water heating.

Core has undertaken extensive literature research to arrive at a list of studies, which provide a useful basis for estimating the cross price effect. Core has analysed those studies which satisfied the initial selection criteria (test for quality) in further detail to ensure that they provided an appropriate basis for forecasting cross-price relationships in NSW. While each study exhibited certain differences, and noted the difficulties associated with reviewing such a relationship, Core concluded that the studies provided a reasonable guide to the cross-price elasticity effect under the circumstances. Factors which were taken into consideration in forming this review included:

- > The quality of the research - which included highly regarded universities and the US Department of Energy
- > The use of advanced statistical approaches, including an appropriate weather normalisation method
- > Consideration of extensive literature research
- > Adequately consideration of both own price and cross price elasticity factors
- > Unbiased - transparent analysis of findings.

As summarised in the Table 3.10 below, the literature review has derived a range of cross price elasticity factors between 0.1 and 0.15. Core had taken a conservative approach and elected to use the lower end of the range to derive the cross price elasticity factor used in its original forecasts.

Table 3.10 Third Party Research | Cross Price Elasticity⁶²

Date	Study	Author/Source	Cross Price Elasticity Factor
1987	Residential gas consumption	Herbert	0.1
2005	Regional differences in the price-elasticity of consumption for energy	Bernstein, Griffin	0.11
2010	Residential consumption of gas and electricity in the US	Alberini et al	0.15
2011	Residential gas Consumption	Payne, Loomis, Wilson	0.123

DAE provided no evidence or rationale to support the use of a revised cross price elasticity factor of 0.05. DAE has not identified any empirical evidence supporting a cross price elasticity below 0.1. It appears that DAE has arbitrarily halved Core's price elasticity. This is despite the fact that our estimate was conservative.

As a result, Core considers that application of a cross price elasticity factor of 0.1 continues to provide the best estimate of cross price elasticity, in circumstances where the AER and DAE have not provided a reasonable basis for their estimate.

3.5. Use of an alternative allocation between new estates and medium/high density dwellings

3.5.1. AER Draft Decision

The AER determined that "based on historical HIA data" a 44 and 56 per cent allocation respectively for new estate and M/H density connections produced a better estimate.

In rejecting Core's alternate allocation assumption of 48 per cent and 52 per cent for new estates and medium/high density connections respectively, the AER stated that Core's assumptions were based on a range of third party analysis, but Core "did not provide the details of this third party analysis".⁶³ The AER observed the following about Core's approach:⁶⁴

In reviewing Core Energy's forecast method, DAE noted that 'combining both supply side and demand side factors to arrive at estimates of new dwellings is somewhat novel...' and that '[a] more orthodox approach would simply be to use forecasts of new dwellings to determine the forecast'. DAE, however, assessed Core Energy's forecast against the latest available HIA data to determine the reasonableness of the forecast.

The AER concluded that:⁶⁵

The JGN and HIA total new dwellings data is reasonably similar over the access arrangement period. For consistency reasons, DAE submitted that the HIA data historical average of 56 per cent should be applied. Based on DAE's advice we have adopted a 56 and 44 per cent allocation respectively for medium/high density and new estate connections.

3.5.2. Core's response

Table 3.11 compares the cumulative difference in residential consumption that arises from apportioning new estates and new medium/high ("M/H") density by applying the AER/DAE approach as opposed to the JGN/Core approach.

⁶² Core Energy Group, Gas Demand and Customer Forecasts Jemena Gas Networks | NSW Gas Access Arrangement 2015-2020, April 2014, p 88.

⁶³ AER Draft Decision, Attachment 13 – Demand, p 13-16.

⁶⁴ AER Draft Decision, Attachment 13 – Demand, p 13-16.

⁶⁵ AER Draft Decision, Attachment 13 – Demand, p 13-16.

Table 3.11 Total Residential Consumption in Forecast Period | GJ ⁶⁶

Core	113,794,186
DAE	113,739,823
Absolute Difference	(54,362)
Percentage Difference	(0.05%)

Note: Core reported residential consumption is forecasted under the carbon price repeal scenario

Core referred to a number of third party research reports to derive an estimate of the split between new estates and medium/high dwellings. These included:

- BIS forecast of NSW dwellings. This report incorporates an average of almost 49% new estate and almost 51% medium/high density connections in the 2016-18 period. Further the report shows that there has been a clear upward trend in medium/high density dwellings;
- Review of analysis of NSW residential property market undertaken by NSW Government agencies and Councils⁶⁷;
- Review of analysis of Australian residential property market undertaken by the Reserve Bank of Australia⁶⁸;
- Review of analysis of NSW residential property markets by major trading banks and real estate organisations⁶⁹;

Taking the above into account, Core's approach in deriving its allocation assumptions involved:

- review of HIA data which indicates a materially higher level of multi-unit starts in the future (~5% higher) than historically⁷⁰
- review of the BIS Shrapnel indicates that higher density dwelling will fall within the range 50-52% during the forecast period⁷¹
- review of the NSW Department of Planning report "good design for medium density living" highlights the strategic imperative for higher density dwellings to meet sustainability objectives
- observation that numerous Sydney areas are recently being rezoned to allow for higher density developments
- analysis to demonstrate that the dwelling structure is materially different in the City of Sydney vs. Greater Sydney and that projections are for strong growth in City dwelling construction. In 2011, the total population of the City of Sydney was estimated to be 183,492 people. It is expected to increase by over 72,500 people to 256,032 by 2021, at an average annual growth rate of 3.39%. ⁷²

Core estimated a split of 48% to New Estate and 52% to medium/high density taking into account this range of evidence.

Table 3.13 illustrates the significant change in trend in M/H housing and Houses (new estates) based on BIS analysis for FY2013. It is of particular importance to note the trend from 2010; reaching 52% M/H density by 2018.

⁶⁶ Core Energy Group, JGN GAAR Core Expert Report_Databook, February 2015.

⁶⁷ Minister for Planning and Infrastructure, NSW Budget to Boost Housing Supply, July 2013; Premier of NSW, NSW Housing Boom: More New Homes and Infrastructure for Sydney, December 2013; Minister for Planning and Infrastructure, NSW Leading the Way in Housing Construction, July 2013.

⁶⁸ Reserve Bank of Australia, Recent Developments in the Australian Housing Markets, March 2013.

⁶⁹ Ray White, More Homes Planned for Sydney Homebuyers, January 2014; Sydney Property Finders, Apartment building activity rising in NSW, February 2014; QBE, Australian Housing Outlook 2013-2016, October 2013; AIG, The NSW Housing cycle: when and where will the next wave of business opportunities be?, October 2012; Australian Construction Industry Forum, Construction Market Report, October 2012; Urban Taskforce, Approvals for apartments and non-residential booming in NSW, February 2014.

⁷⁰ HIA Housing Forecasts, November 2013.

⁷¹ BIS Report 'Building in Australia 2013-2028.

⁷² City of Sydney Population, households and dwellings, < <http://forecast.id.com.au/sydney/population-households-dwellings>>.

Table 3.12 FY2013 Dwellings Completed | Private Dwellings in NSW⁷³

FY	Houses	Med Density	High Density	Total thousand completions	Houses %	Med & High Density
2002	21,430	7,253	5,624	34,307	62%	38%
2003	23,594	9,028	10,000	42,622	55%	45%
2004	22,149	9,591	10,612	42,352	52%	48%
2005	20,477	11,589	11,098	43,164	47%	53%
2006	18,023	9,000	8,351	35,374	51%	49%
2007	15,121	8,248	5,928	29,297	52%	48%
2008	13,359	6,334	6,031	25,724	52%	48%
2009	13,952	6,136	6,392	26,480	53%	47%
2010	14,689	4,639	4,633	23,961	61%	39%
2011	16,529	5,110	4,879	26,518	62%	38%
2012	14,764	4,812	5,656	25,232	59%	41%
2013	16,035	5,760	7,900	29,695	54%	46%
2014	17,604	6,650	10,038	34,292	51%	49%
2015	20,068	7,629	11,555	39,252	51%	49%
2016	22,290	8,715	13,178	44,183	50%	50%
2017	23,721	9,577	14,172	47,470	50%	50%
2018	21,992	9,613	13,767	45,372	48%	52%

Source: BIS Shrapnel Building in Australia 2013-2018

Since the Original submission BIS has released a FY2014 forecasts, which is set out below. The revised forecasts reflect the updated split of M/H and new estates.

Table 3.13 FY2014 Dwellings Completed | Private Dwellings in NSW⁷⁴

FY	Houses	Med Density	High Density	Total thousand completions	Houses %	Med & High Density
2014	19,284	7,175	11,263	37,722	51%	49%
2015	25,000	7,400	21,300	53,700	47%	53%
2016	27,200	8,200	21,700	57,100	48%	52%
2017	25,650	8,150	19,400	53,200	48%	52%
2018	22,900	6,650	14,500	44,050	52%	48%
2019	24,750	6,750	14,050	45,550	54%	46%
2020	25,660	7,840	19,250	52,750	49%	51%
2021	25,660	7,840	19,250	52,750	49%	51%

Source: BIS Shrapnel Building in Australia 2014-2029

Core understands that DAE's approach was to rely on a single data source, namely HIA⁷⁵.

The advantage of Core's approach compared to DAE's is that it draws upon multiple independent data sources which are not simply accepted but rather assessed in detail to determine which data series should be relied upon to provide a best estimate. In particular Core's consumption and supply analysis - described by DAE as "*somewhat novel*" – actually represents a thorough analysis of all industry and sectoral drivers of new housing. In conclusion, Core

⁷³ BIS Shrapnel Building in Australia 2013-2018.

⁷⁴ BIS Shrapnel, Building in Australia 2014-2029, Outlook for Residential Building, 2014-2029.

⁷⁵ DAE, Australian Energy Regulator Gas demand forecast for Jemena's NSW network, November 2014, p 16.

considers that our approach enabled us to compare independent "bottom up" analysis against third party analysis to derive a best estimate.

Core considers that its approach to deriving the allocation between new estates and medium/high density dwellings has a strong technical and commercial basis, and provides the best estimate available under the circumstances.

3.6. Alternative time series used to forecast small business connections

3.6.1. AER Draft Decision

The AER, relying upon DAE's analysis, applied a shorter, 2008-2013 trend series for forecasting small business connections rather than the data series available to it, and used by Core. This was a result of a perceived "structural break in the series in 2008, where there was a significant step change in the number of connections".⁷⁶

DAE's analysis looked at average growth in new connections and determined that there was a "step change" in connections that occurred around 2008.⁷⁷ DAE appears to have simply viewed the new connections data series summarised in Table 3.14 and observed that New Connections moved from approximately 260-300 connections per annum between 2003 and 2007 and increasing consistently above 400-500 connections thereafter.

DAE's analysis does not indicate the specific driver/s of the step change, and it is not apparent that they have undertaken any statistical or other analysis to support their selective use of the data time series.

3.6.2. Core's response

The following table provides the full historical data series relating to small business connections. DAE's analysis appears to have focused purely on the New connections line item and excluded consideration of movements in disconnections and balancing items to overall small business connections (for example, variations due to use of multiple reporting systems).

Table 3.14 Historical Small Business Connections | No. ⁷⁸

Connections	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Opening Connections		12,670	11,638	13,573	15,190	17,008	18,382	17,947	20,475	20,795	21,404	20,941	21,581
New connections		308	277	258	261	279	495	535	428	524	472	510	587
Disconnections		(741)	(809)	(675)	(760)	(554)	(387)	(362)	(22)	(38)	(64)	(49)	43
Balancing/ Unreconciled Items		(599)	2,467	2,034	2,317	1,649	(543)	2,355	(86)	123	(871)	179	-
Total Connections	12,670	11,638	13,573	15,190	17,008	18,382	17,947	20,475	20,795	21,404	20,941	21,581	22,125

Table 3.14 highlights that a material number of connection movements are accounted for within the Disconnections and Balancing/Unreconciled Items classification. Core considers it necessary to consider this full statistical data set to assess whether there is a structural trend in connections. Further, to the extent that any structural change is observable, after use of a complete data series, Core considers it important to explain the driver of such a change via use of appropriate analytical techniques.

⁷⁶ AER Draft Decision, Attachment 13 – Demand, p 13-10.

⁷⁷ DAE Report, November 2014, p 18.

⁷⁸ Core Energy Group, JGN Demand Forecast Model_FY2014_FINAL_AERCONFIDENTIAL, February 2015, Historical_Data Tab.

In Core's review of the complete data set for net connections, Core has been unable to observe a structural change. Core's analysis set out in 3.3 above, shows that there is no clear evidence of a structural change in average annual connections between the 2002-13 and 2008-2013. The DAE assessment does not lead Core to revise its small connections forecast method (using the full data-set).

3.7. Use of a lower estimate of residential disconnections

3.7.1. AER Draft Decision

The AER determined that Core's forecast of the number of residential disconnections was overstated as a result of the inclusion of 2002 to 2010 data, because the number of disconnections from 2011 to 2013 has been relatively more stable than the previous period.

"We consider that Core Energy's forecast of the number of residential disconnections are overstated. This is due to the inclusion of 2002 to 2010 data in estimating the historical trend in the disconnection rate. In contrast to the 2002 to 2010 period, for the three years, 2011 to 2013, the number of disconnections has been stable. Therefore, we are not satisfied that using an increasing trend over this period is appropriate. Rather, we consider that 2011-13 data provides a more reasonable basis for forecasting disconnections than the trend over the 2002-13 period."

3.7.2. Core's response

Table 3.15 shows the variance in total residential consumption in the forecast period that arises from different disconnection rates. The difference in cumulative residential consumption forecast is 819,910 GJ or 0.71%.

Table 3.15 Residential Consumption | Disconnection Forecast | GJ

Core	113,794,186
DAE	114,614,096
Absolute Difference	819,910
Percentage Difference	0.71%

Note: Core reported residential consumption is forecast under the carbon price repeal scenario

Core considers that the disconnections over the 2011-2013 period were abnormally low and should not be used as a basis for a future consumption forecast. Specifically, Core notes that:

- During 2011-2013, electricity prices increased at an average of 16% p.a., an increase of almost twice the corresponding increase in gas price,⁷⁹ making a gas disconnection less compelling.
- By contrast, during the 2002-2009 period electricity prices increased by an average of 4% which was similar to the rate of increase in gas prices.
- Over the next 3-5 year period electricity prices are expected to trend materially lower than gas prices, and this change in trend is expected to give rise to a disconnection rate which is in line with the longer term, 2002-2013 trend.

As a result, Core considers it appropriate that the full time series of data available to it should be used to derive a representative disconnection rate for forecasts. This also recognises the limited data-set available, and the higher threshold we believe must be met before excluding data from the analysis (particularly the vast majority of the available data).

⁷⁹ Core Energy Group, JGN Demand Forecast Model_FY2014_FINAL_AERCONFIDENTIAL, February 2015, Tab Historical_Data.

This is supported by the actual disconnection rate for the 2014 year as reported by JGN, which was 5,894 disconnections, as compared to 3,900 disconnections which was predicted from the 2011-2013 data set relied upon by DAE compared to the Core forecast (included in the original model) of 5,841. In Core's opinion, the time series used to forecast disconnection rate, as set out in the original submission to the AER forecast, represents the best estimate under the circumstances.

4. JGN's revised forecasts

This section of the report sets out Core's original forecasts and summarises the adjustments made, resulting in Core's revised forecasts over the review period.⁸⁰

4.1. Core's original forecasts

4.1.1. Tariff V consumption

Table 4.1 to Table 4.3 set out Core's original forecasts for Tariff V consumption per connection, connections and total consumption.

Table 4.1 JGN Tariff V Consumption per Connection Forecasts, as submitted to the AER on the 30 June 2014 | GJ⁸¹

	2014	2015	2016	2017	2018	2019	2020
Residential	19.84	19.07	18.45	18.07	17.68	17.39	17.15
Small Business	229.10	214.61	201.18	193.62	185.45	176.70	169.89
I&C	485.24	465.11	404.82	398.41	390.16	379.96	373.60

Source: Jemena Gas Networks (NSW) Ltd, June 2014, 2015-20 Access Arrangement Information, Appendix 5.1, Consumption forecasting report, p 30-31

Table 4.2 JGN Tariff V Connection Forecasts, as submitted to the AER on the 30 June 2014 | No.⁸²

	2014	2015	2016	2017	2018	2019	2020
Residential	1,163,815	1,192,049	1,221,754	1,253,153	1,283,259	1,312,083	1,340,626
Small Business	22,086	22,631	23,221	23,858	24,546	25,290	26,092
I&C	16,244	16,551	16,820	17,151	17,494	17,851	18,222
Total	1,202,145	1,231,231	1,261,795	1,294,162	1,325,300	1,355,224	1,384,940

Source: Jemena Gas Networks (NSW) Ltd, June 2014, 2015-20 Access Arrangement Information, Appendix 5.1, Consumption forecasting report, p 30-31

Table 4.3 JGN Tariff V Consumption Forecasts, as Submitted to the AER on 30 June 2014 | GJ⁸³

	2014	2015	2016	2017	2018	2019	2020
Residential	23,092,505	22,736,962	22,535,845	22,644,314	22,687,131	22,820,905	22,996,609
Small Business	5,059,748	4,856,832	4,671,596	4,619,335	4,552,256	4,468,591	4,432,905
I&C	7,882,384	7,698,139	6,809,061	6,832,957	6,825,440	6,782,586	6,807,666
Total	36,034,637	35,291,933	34,016,503	34,096,606	34,064,827	34,072,082	34,237,180

Source: Jemena Gas Networks (NSW) Ltd, June 2014, 2015-20 Access Arrangement Information, Appendix 5.1, Consumption forecasting report, p 30-31

4.1.2. Tariff D consumption

Table 4.4 sets out Core's original forecasts for Tariff D consumption.

Table 4.4 JGN Tariff D ACQ, MDQ and CD Forecasts, as submitted to the AER on the 30 June 2014 | GJ⁸⁴

	2014	2015	2016	2017	2018	2019	2020
ACQ	53,144,476	46,296,728	45,951,999	45,290,414	44,644,746	44,014,608	43,399,622
MDQ	291,580	263,885	262,397	259,881	256,632	254,228	254,228
CD	291,580	263,885	262,397	259,881	256,632	254,228	254,228

4.2. Summary of Core's revised Tariff V forecasts

⁸⁰ This section should be read in conjunction with supporting Excel files listed in the Contents (Attachments) above.

⁸¹ Core Energy Group, Gas Demand and Customer Forecasts Jemena Gas Networks | NSW Gas Access Arrangement 2015-2020, April 2014.

⁸² Ibid.

⁸³ Ibid.

⁸⁴ Ibid.

4.2.1. Tariff V consumption

Table 4.5 to Table 4.7 summarise Core's revised forecasts for JGN's Tariff V gas consumption per connection, connections and total consumption. Section 5.1 set out the total net differences between the original forecasts and the revised forecasts. In cumulative terms, Tariff V consumption has been revised upward by 1,728,415 GJ between 30 June 2015 and 30 June 2020.

Table 4.5 Core Energy JGN Tariff V Consumption per Connection Forecast | GJ⁸⁵

Tariff V Customer	2014	2015	2016	2017	2018	2019	2020
Residential	20.08	19.18	18.47	18.03	17.57	17.19	16.85
Small Business	246.36	204.53	193.50	186.24	177.85	168.87	161.73
I&C	455.88	466.65	411.75	403.49	392.08	378.69	369.15

Table 4.6 Core Energy JGN Tariff V Connection Forecast | No.⁸⁶

Tariff V Customer	2014	2015	2016	2017	2018	2019	2020
Residential	1,172,432	1,208,251	1,242,767	1,274,694	1,304,049	1,330,847	1,355,105
Small Business	22,125	22,710	23,343	24,025	24,762	25,556	26,413
I&C	16,827	17,183	17,498	17,871	18,259	18,662	19,080
Total	1,211,384	1,248,145	1,283,607	1,316,590	1,347,070	1,375,065	1,400,598

Table 4.7 Core Energy JGN Tariff V Consumption Forecast | GJ⁸⁷

Tariff V Customer	2014	2015	2016	2017	2018	2019	2020
Residential	23,540,485	23,173,501	22,948,822	22,980,146	22,905,968	22,876,170	22,836,669
Small Business	5,450,558	4,644,979	4,516,814	4,474,594	4,403,912	4,315,646	4,271,818
I&C	7,671,044	8,018,319	7,204,775	7,210,884	7,159,007	7,066,912	7,043,476
Total	36,662,086	35,836,800	34,670,411	34,665,624	34,468,887	34,258,728	34,151,962

Changes in consumption per connection have arisen from:

- updates for FY2014 actual data in relation to consumption per connection for Tariff V customers;
- the repeal of the Clean Energy Act; and
- updated forecasts of retail electricity prices to reflect most recent and available data, as published by the AEMC.
- updates to the forecasts of New Estate and M/H Density housing to account for revised forecasts from independent data sources including BIS Shrapnel.

Changes in Tariff V connections have arisen from:

- updates for FY2014 actual data for connections; and
- updates to the forecasts for dwelling completions and residential connections to account for revised forecasts from independent data sources including BIS Shrapnel and HIA.

Core sets out in Section 5 further detail about the rationale, and incremental effect, of each of the above changes.

⁸⁵ Core Energy Group, Core Energy Group, JGN Demand Forecast Model_FY2014_FINAL_AERCONFIDENTIAL, February 2015, Tab Summary.

⁸⁶ Ibid.

⁸⁷ Ibid.

4.2.2. Tariff D consumption

The table below sets out Core Energy's revised forecast of JGN gas consumption for Tariff D customers. Section 5.1 set out the total net differences in Tariff D consumption. In summary, Tariff D maximum daily demand/contract demand (MDQ/CD) has been revised upward by 64,872 GJ over the review period.

Table 4.8 Core Energy JGN Tariff D ACQ, MDQ and CD Forecast | GJ⁸⁸

Tariff D	2014	2015	2016	2017	2018	2019	2020
ACQ	55,156,511	48,622,030	48,465,714	47,627,204	46,947,725	46,284,667	45,637,630
MDQ	337,070	278,995	276,777	272,291	269,306	266,932	266,932
CD	348,512	278,995	276,777	272,291	269,306	266,932	266,932

The movement in Tariff D consumption forecasts is attributed to new information provided by JGN relating to FY 2014 actual consumption, new connections and disconnections.

⁸⁸ Core Energy Group, Core Energy Group, JGN Demand Forecast Model_FY2014_FINAL_AERCONFIDENTIAL, February 2015, Tab Summary.

5. Explanation of movements since original forecasts

This section of the report addresses each factor which has contributed to the revised forecasts.

5.1. Summary of Movements

Table 5.1 to Table 5.3 highlights the movement in consumption per connection, connections and total consumption from the original forecasts. Subsequent sections address the change due to driving factors in isolation⁸⁹. Table 5.4 summarises movements in ACQ, MDQ and CD for the Tariff D market due to revisions.

Table 5.1 Incremental difference in JGN Tariff V Consumption per Connection Forecasts | GJ⁹⁰

	2014	2015	2016	2017	2018	2019	2020
Residential	0.24	0.11	0.02	-0.04	-0.11	-0.20	-0.30
Small Business	17.26	-10.08	-7.68	-7.37	-7.60	-7.83	-8.16
I&C	-29.36	1.54	6.94	5.08	1.93	-1.27	-4.45

Table 5.2 Incremental difference in JGN Tariff V Connection Forecasts | No.⁹¹

	2014	2015	2016	2017	2018	2019	2020	Total (2016-2020)
Residential	8,617	16,202	21,012	21,541	20,789	18,764	14,479	96,586
Small Business	39	79	122	167	215	266	321	1,092
I&C	583	631	678	721	765	811	858	3,832
Total	9,239	16,913	21,812	22,429	21,770	19,842	15,658	101,510

Table 5.3 Incremental difference in JGN Tariff V Consumption Forecasts | GJ⁹²

	2014	2015	2016	2017	2018	2019	2020	Total (2016-2020)
Residential	447,979	436,538	412,976	335,831	218,836	55,265	-159,940	862,969
Small Business	390,809	-211,852	-154,783	-144,740	-148,344	-152,944	-161,087	-761,898
I&C	-211,340	320,180	395,714	377,928	333,567	284,325	235,810	1,627,343
Total	627,449	544,866	653,908	569,019	404,060	186,646	-85,217	1,728,415

Table 5.4 Incremental difference in JGN Tariff D ACQ, MDQ and CD Forecasts | GJ⁹³

	2014	2015	2016	2017	2018	2019	2020	Total (2016-2020)
ACQ	2,012,035	2,325,303	2,513,715	2,336,790	2,302,979	2,270,059	2,238,008	11,661,550
MDQ	45,490	15,110	14,380	12,410	12,674	12,704	12,704	64,872
CD	56,932	15,110	14,380	12,410	12,674	12,704	12,704	64,872

⁸⁹ Please note that the impact of the individual driving factors applied in isolation is not equal to the impact when all the driving factors are applied in combination.

⁹⁰ Core Energy Group, JGN GAAR Core Expert Report_Databook.xlsx, February 2015, Tab Demand Forecast Comparison.

⁹¹ Ibid.

⁹² Ibid.

⁹³ Ibid.

5.2. 2014 actual data updates

Core was provided with FY2014 actual data to update its demand forecasting model. It is important that forecasts are as accurate as is possible, requiring the most up-to-date information which is reasonably available.

5.2.1.1 Consumption per connection

Specifically JGN provided Core with the following information to update its forecasts for consumption per connection:

- 2014 actual consumption per connection for each customer segment; and
- 2014 first year consumption for new connections.

The incremental impact of the above updates on the original forecasts is set out in the table below.

Table 5.5 Incremental difference in JGN Tariff V Consumption per Connection Forecasts | GJ⁹⁴

	2014	2015	2016	2017	2018	2019	2020
Residential	0.24	0.26	0.25	0.25	0.25	0.26	0.26
Small Business	17.26	-8.58	-7.98	-7.53	-7.04	-6.55	-6.15
I&C	-29.36	4.75	6.57	5.06	3.52	2.01	0.65

The original submission used the actual FY2013 result as a basis for forecast projection, rather than the historical trend point. A consequential effect of the inclusion of the 2014 actual data is we have refined our approach to forecasts consumption per connection from the historical trend (as adjusted for the inclusion of the FY2014 data point), rather than rebasing the forecast so that its starting point is the most recent historical data point.

5.2.1.1 Connections

Specifically JGN provided Core with the following information to update its forecasts for connections.

- 2014 actual connections per customer segment; and
- 2014 disconnections.

The incremental impact of the above updates on the original forecasts is set out in Table 5.5 below.

Table 5.6 Incremental difference in JGN Tariff V Connection Forecasts | No⁹⁵

	2014	2015	2016	2017	2018	2019	2020	Total (2016-2020)
Residential	8,617	16,202	21,012	21,541	20,789	18,764	14,479	96,586
Small Business	39	79	122	167	215	266	321	1,092
I&C	583	631	678	721	765	811	858	3,832
Total	9,239	16,913	21,812	22,429	21,770	19,842	15,658	101,510

5.2.1.1 Tariff V Consumption

The resultant movement in Tariff V consumption is summarised in Table 6.6.

⁹⁴ Core Energy Group, JGN GAAR Core Expert Report_Databook.xlsx, February 2015, Tab Demand Forecast Comparison.

⁹⁵ Ibid.

Table 5.7 Incremental difference in JGN Tariff V Consumption Forecasts | GJ⁹⁶

	2014	2015	2016	2017	2018	2019	2020	Total (2016-2020)
Residential	447,979	627,114	700,303	709,874	696,619	666,264	603,244	3,376,304
Small Business	390,809	-177,926	-161,558	-148,126	-134,050	-119,937	-107,531	-671,201
I&C	-211,340	374,207	392,296	380,986	365,858	348,524	335,908	1,823,572
Total	627,449	823,395	931,041	942,735	928,428	894,851	831,621	4,528,676

In summary, updating the consumption forecast model for FY2014 actual data results in a net increase in Tariff consumption of 4,528,676 GJ. This is largely due to a higher actual consumption per connection for FY2014 when compared against the forecast consumption per connection for FY2014 in the original submission as highlighted in Table 6.5.

In addition, Core updated its connections forecasts for updated third party forecasts by BIS Shrapnel, December 2014 data, as well as HIA Housing forecasts up until November 2014 by type. This resulted in increased new dwelling residential connections of over 15,000 between 2016 and 2020.

5.3. Carbon tax repeal

The forecast of consumption per connection presented in Core's original forecast included a carbon price impact. Since our original forecast, and in light of the AER's Draft Decision, the Clean Energy Act has been repealed. As a consequence, Core has removed the impact of carbon price in its revised forecast.

The movements which relate to the carbon tax repeal relating to Tariff V consumption per connection is set out in the Table 5.8 and Table 5.9 below. Tariff D demand forecast is unaffected by the legislative repeal.

Table 5.8 Incremental difference in JGN Tariff V Consumption per Connection Forecasts | GJ⁹⁷

	2015	2016	2017	2018	2019	2020
Residential	-0.05	0.01	0.02	0.02	0.02	0.01
Small Business	-0.8	2.03	2.23	1.88	1.62	1.44
I&C	-1.65	4.31	4.83	4.15	3.66	3.33

Table 5.9 Incremental difference in JGN Tariff V Consumption Forecasts | GJ⁹⁸

	2015	2016	2017	2018	2019	2020	Total
Residential	-64,561	11,733	25,108	29,421	24,110	19,009	109,380
Small Business	-18,082	47,253	53,237	46,092	40,891	37,571	225,044
I&C	-27,296	72,479	82,835	72,681	65,289	60,665	353,950
Total	-109,939	131,465	161,180	148,194	130,290	117,245	688,374

5.4. AEMC electricity price update

Core revised the forecast of retail electricity prices used in the analysis of price elasticity of consumption to account for independent updated forecasts published by the AEMC. Specifically, the percentage change in average residential price by Retailer was obtained from AEMC's Residential Price outlook. In consultation with JGN, the weighted average change in retail electricity prices was derived based on JGN's analysis of gas load by local

⁹⁶ Core Energy Group, JGN GAAR Core Expert Report_Databook.xlsx, February 2015, Tab Demand Forecast Comparison.

⁹⁷ Ibid.

⁹⁸ Ibid.

government area (**LGA**). LGA's were categorised by electricity Retailer to determine the percentage of JGN gas load within a given electricity network.

The AEMC has forecast a further decrease in electricity prices, as shown in Table 5.10 when compared against the change in electricity price sourced from IPART⁹⁹, on a carbon cost exclusive basis. In FY2015 and FY2016, the change in retail electricity prices is forecast to drop a further 3.04% and 4.34%, respectively, when compared against FY2013 forecast figures. In FY2017, retail electricity prices are forecast to fall by -0.42%.

Table 5.10 Forecast Change in Retail Electricity Prices | %¹⁰⁰

	2015	2016	2017	2018	2019	2020
IPART 2013 Original Submission ¹⁰¹	-0.77%	-9.56%	-	-	-	-
IPART 2013 Carbon Cost Exclusive ¹⁰²	-9.55%	-7.24%	-	-	-	-
AEMC 2014	-12.59%	-11.58%	-0.42%	-	-	-
Difference	-3.04%	-4.34%	-0.42%	-	-	-

In making these updates, Core has also revisited how it applied step changes from the extrapolated trend for price effects (including both own and cross price elasticity). In particular, Core applied the price differential, derived from finding the difference between the forecast impact of price and the historical impact of price¹⁰³, to the forecast of demand per connection.

The movement attributed to updating electricity price with most recent AEMC data, and the refinement to deriving the step change in energy prices, is set out below. The total fall in forecast gas consumption for Tariff V is 3,502,574GJ

Table 5.11 Incremental difference in JGN Tariff V Consumption per Connection Forecasts | GJ¹⁰⁴

	2015	2016	2017	2018	2019	2020
Residential	-0.03	-0.13	-0.26	-0.33	-0.41	-0.49
Small Business	0.16	-0.58	-1.67	-2.03	-2.41	-2.88
I&C	0.32	-1.20	-3.53	-4.39	-5.33	-6.53

Table 5.12 Incremental difference in JGN Tariff V Consumption Forecasts | GJ¹⁰⁵

	2015	2016	2017	2018	2019	2020	Total (2016-2020)
Residential	-32,177	-153,990	-320,937	-417,911	-522,868	-647,818	-2,702,430
Small Business	3,469	-13,158	-38,744	-48,362	-59,144	-72,945	-309,649
I&C	5,149	-19,861	-59,419	-75,242	-93,266	-116,480	-490,495
Total	-23,559	-187,009	-419,100	-541,515	-675,277	-837,243	-3,502,574

⁹⁹ IPART, Final review of Regulated Retail Prices and Charges for Electricity From 1 July 2013 to 30 June 2016, June 2013.

¹⁰⁰ Core Energy Group, JGN GAAR Core Expert Report_Databook, AEMC Electricity Prices Tab, February 2015.

¹⁰¹ The Original Submission was based on IPART forecasts of change in electricity prices that were inclusive of carbon cost.

¹⁰² An estimate of the electricity price change adjusted for carbon based on IPART changes in cost allowances and using a weighted average of three retailers.

¹⁰³ Core Energy Group, JGN Demand Forecast Model_FY2014_FINAL_AERCONFIDENTIAL, Tab Residential, Row 230 – 242, February 2015.

¹⁰⁴ Core Energy Group, JGN GAAR Core Expert Report_Databook.xlsx, February 2015, Tab Demand Forecast Comparison.

¹⁰⁵ Ibid.

5.5. Tariff D consumption revisions

5.5.1.2014 updates

JGN provided Core with the following information, including FY2014 actual data, to revise its forecasts for Tariff D consumption:

- changes to assumed disconnections;
- new connections and associated gas consumption;
- known changes in future gas consumption; and
- transfers between Tariff V and Tariff D.

The incremental movement attributed to these updates is set out below.

Table 5.13 Incremental difference in JGN Tariff D ACQ, MDQ and CD Forecasts | GJ ¹⁰⁶

	2014	2015	2016	2017	2018	2019	2020	Total (2016-2020)
ACQ	2,012,035	2,325,303	2,513,715	2,336,790	2,302,979	2,270,059	2,238,008	11,661,550
MDQ	45,490	15,110	14,380	12,410	12,674	12,704	12,704	64,872
CD	56,932	15,110	14,380	12,410	12,674	12,704	12,704	64,872

Specifically, the FY2014 update has resulted in an increase in Tariff D consumption of 11,661,550GJ p.a. in Annual Contract Quantity (**ACQ**) and 64,872GJ p.a. in CD/MDQ.

5.5.2. Other considerations

The review indicated that there was no additional information which would cause Core to revise its Tariff D forecast. In coming to this conclusion Core completed a broad based literature search, including review of relevant third party public releases, including but not limited to:

- ABS;
- AEMC;
- AEMO (various including NGFR);
- BIS (public releases and select data available through subscription);
- E3 Program;
- Federal Government Treasury;
- HIA;
- NSW Government releases, web sites;
- NSW Treasury;
- Reserve Bank;
- Internet for general information relating to gas consumption including growth of solar and reverse cycle air conditioning.

¹⁰⁶Core Energy Group, JGN GAAR Core Expert Report_Databook.xlsx, February 2015, Tab Demand Forecast Comparison.

Attachment 1 | Terms of Reference

20 January 2014

Paul Taliangis
Chief Executive Officer
Core Energy Group Pty Limited
Level 10, 81 Flinders Street
Adelaide SA 5000
pt@coreenergy.com.au

Dear Paul

Jemena Gas Networks (NSW) Ltd 2015-20 Access Arrangement: request for report on demand forecast

We have been instructed to seek a report and revised demand forecasts from Core Energy to assist Jemena Gas Network (**JGN**) in responding to the AER's draft decision on JGN's access arrangement (**AA**) proposal for the period 1 July 2014 to 30 June 2020.

Core Energy prepared JGN's demand forecasts (**Core's initial forecasts**) and an accompanying report as part of JGN's AA proposal submitted to the AER on 30 June 2014.

The AER engaged Deloitte Access Economics (**DAE**) to advise on Core's initial forecasts. Relying on DAE's advice, the AER did not approve aspects of Core's initial forecasts for gas consumption of Tariff V customers. DAE agreed with JGN's proposed Tariff D consumption forecasts, which was accepted by the AER.

Core Energy is requested to prepare a report, for submission to the AER, which:

- a) reviews the AER's departures from Core's initial forecasts and determines whether, on the basis of the AER's draft decision and the accompanying DAE analysis, it leads Core Energy to change its approach in preparing revised demand forecasts; and
- b) sets out Core's approach to revising Tariff V and Tariff D demand forecasts taking into account:
 - i. any relevant matters under paragraph (a) (i.e. changes it has made to its forecasts to take into account matters raised in the AER's draft decision); and
 - ii. relevant information which has become available since the submission of Core's initial forecasts to the AER.

In preparing such a report, Core Energy is required to:

- where appropriate, undertake additional analysis in order to support its conclusions – particularly, in relation to paragraph (a) above; and
- provide a revised forecast model for both Tariff V and Tariff D demand (including, providing all relevant documents which form the basis of the revised forecasts).

The work is to be performed in accordance with the Consultancy Agreement between Jemena Limited and Core Energy dated 27 June 2013.

Yours sincerely

Gilbert + Telen

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Attachment 2 | Statistical testing of GSP and SFD

Specifically, Core's statistical testing looks at:

- The p-value which is a function used for testing a statistical hypothesis. If the p-value is equal to or smaller than the significance level ($\alpha = 5\%$), it suggests that the variable is statistically significant.
- The Variance Inflation Factor (VIF) test is used to assess the degree of collinearity amongst two or more explanatory variables. Collinearity makes the estimated coefficients unreliable.
- Breusch-Pagan (BP) test for heteroskedasticity. Heteroskedasticity occurs when the errors are non-constant. Heteroskedasticity will not make the estimates biased but will make the t-stat and inference testing unreliable.
- The Breusch-Godfrey (BG) and Durbin Watson (DW) are used to test for autocorrelation. If autocorrelation is present the standard errors and statistical tests are no longer valid, resulting in unreliable significance values.
- The Ramsey-Reset (R-Reset) test is used to test for functional misspecification and intends to provide an indicator of non-linearity. Essentially it tests if the model has omitted any non-linear explanatory variables.
- Comparing different regression by R-Squared, Adjusted R-Squared for overall explanatory power, and the AIC (Akaike's Information Criterion) which measures the relative quality of different models.
- The signs of all variables are checked so they make economic sense
- A causation test which demonstrates through quantitative and/or qualitative analysis that a particular hypothesis or assumed relationship is logical and supported by real world observation.

Statistical significance testing – residential consumption per connection

In this section we discuss the statistical tests for the DAE regression, Core's 2002-2013 regression and Core's 2002-2014, updated regression.

Table 5.14 Statistical Tests – Residential¹⁰⁷

Regression Model	P-Value	R2	BP	DW	BG	VIF	R-Reset	AIC
DAE (2002-2010)	0.014	0.90	0.5744	2.2279	0.3740	10	0.1226	(50.4000)
CORE (2002-2013)	0.0078	0.94	0.7831	2.3454	0.4492	6.5	0.0249	(70.1440)
CORE (2002-2014)	0.148	0.85	N/A	1.4868	N/A	10.8	0.0799	(65.4821)

- The p-value for SFD appears to be rapidly increasing with marginal increases in sample size. When the full data-set is used there is no statistically significant relationship between SFD and residential demand per connection. In Core's opinion this renders the regression coefficients unsuitable for forecasting purposes
- Although, models with lagged variables often have some degree of collinearity, the VIFs for these models are very high and above acceptable levels of 10. The signs and magnitudes of the coefficients in these models are incorrect and unreliable, especially the own price variables. The statistical significance of the individual variables in the model could be misleading.
- There does not appear to be any degree of heteroskedasticity in the DAE regression or Core's 2002-2013 regression, as demonstrated by a Breusch-Pagan test. There is a degree of heteroskedasticity when the 2014 time series is used, but this is corrected for using the White consistent standard errors.

¹⁰⁷Core Energy Group, JGN Statistics Work book_FY2014_REVISIED_AERCONFIDENTIAL, February 2015, Tab Deloitte – SFD Regression and Statistical Test – RDC.

- The Durbin-Watson and Breusch-Godfrey tests demonstrate that none of the models suffer from autocorrelation.
- The Ramsay-Reset tests are generally quite low and below 0.05 for 2002-2013, which provides some evidence that the model has an incorrect function form. At least one of the variables appears to have a non-linear relationship with consumption per connection.
- The AIC and BIC show that Core's models are significantly closer to the actual true relationship than DAE. This supports the Core model that finds that SFD should have a small impact and has an insignificant relationship with residential demand.

Core has also undertaken a series of regressions that included, SFD, GSP or Household expenditure with own price elasticity and the lag of own price elasticity. These models performed poorly.

Based on these results there is no statistical evidence for the inclusion of a broad economic variable.

In addition to the multivariate regression analysis, Core examined the univariate regressions between consumption per connection for Tariff V residential and various economic variables, including GSP, SFD and HH component of the SFD. Univariate regression analysis enables Core to assess the explanatory power of a single variable on forecast consumption per connection.

In isolation, Core observed that Changes in GSP and SFD do not have a statistically significant relationship with the change in consumption per connection for Tariff V residential and there is a low degree explanatory power. This was observed by looking at the R-square. When the actual (untransformed)¹⁰⁸ SFD and GSP are regressed against residential consumption per connection, the relationship is statistically significant but appears to be negative.

Statistical significance testing – GSP and I&C consumption per connection

Table 5.15 Statistical Tests ¹⁰⁹

Regression Model	P-Value GSP	R2	BP	DW	BG	VIF	R-Reset	AIC
DAE (2002-2010)	0.1744	0.5395	0.8400	1.6086	0.8400	1.0300	0.9173	(39.2200)
CORE (2002-2013)	0.0860	0.8052	0.8537	2.1600	0.7725	1.1400	0.7947	(54.0054)
CORE (2002-2014)	0.0260	0.9054	0.7912	2.2564	0.5814	1.0500	0.8780	(59.4831)

- The p-values appear to be getting lower and as the sample size increases there does appear to be a higher degree of statistical significance.
- There does not appear to be any degree of heteroskedasticity in the DAE regression or Core's regressions, as demonstrated by a Breusch-Pagan test.
- The Durbin-Watson and Breusch-Godfrey tests demonstrate that none of the models suffer from autocorrelation.

¹⁰⁸ Ibid.

¹⁰⁹ Core Energy Group, JGN Statistics Work book_FY2014_REVISSED_AERCONFIDENTIAL, February 2015, Tab Statistical Test – CDC.

- The Core models have a higher explanatory power as demonstrated by the R-Square, and lower AIC and BIC values. On this basis the 2014 model is preferred.
- The Ramsey-reset test shows that none of the models have non-optimal functional form.
- The VIF factors are very low and there does not seem to be any collinearity problems with the models.

Attachment 3 | Alternative Time Series of Small Business Consumption per Connection Statistical Testing

Core has undertaken statistical analysis to demonstrate that the Core forecast for small business consumption per connection falls within an acceptable range of potential outcomes.

In order to test this, Core undertook the following steps:

- Developed simulation analysis, as follows:
 1. Calculated the average annual year on year growth rate of demand per connection
 2. Calculated the standard deviation of the annual year on year growth rate of demand per connection
 3. Used the assumption of Normality (a normal distribution of growth) to apply a normal distribution (with a mean of x and standard deviation of y)
 4. Randomly generated growth rates for each of the forward years
 5. Applied growth rates to the starting year to simulate future demand
 6. Repeated Steps 4 and 5 many times
 7. Sorted the minimum, max, standard deviations, average etc. from the simulated projections

These simulations use the distribution of historical growth rates to generate a series of projections. When normality (a Gaussian distribution) is assumed, it is implied that the distribution of sample means (across independent samples) is normal. In order to use the same procedures for different sample sizes, we assumed the data within each sample was normal, not just the means across samples. A histogram was used to test for normality, and to assess whether the distribution is even. The aforementioned assumptions are valid given the data is in percentage terms and there are a range of values close to zero.

- Derived a range of forecasts of demand per connection based on the assumption of normality and using the average (-2.9%) and standard deviation (8.4%) of the annual growth rate in demand per connections from 2002-2013. These assumptions were applied against the actual 2013 consumption per connection result.
- Generated a table 5.16 which demonstrates that the Core forecast (included in the original submission) falls within a one standard deviation range of the mean which is widely accepted in economic analysis circles as a reasonable outcome.

Table 5.16 Simulated small business consumption per connection and trend forecasts | GJ

Forecast	2013	2014	2015	2016	2017	2018	2019	2020
Minimum*	244.22	201.65	187.22	167.92	162.52	141.74	121.20	116.57
Std (-1)*	244.22	215.04	203.38	196.57	193.20	176.32	168.20	161.10
Avg (2002-2013)*	244.22	233.08	228.87	227.62	224.06	212.23	206.55	199.09
Std (+1)*	244.22	251.12	254.36	258.67	254.91	248.13	244.90	237.07
Max*	244.22	276.09	283.52	298.21	283.20	281.14	277.75	267.40
Historical Trend	223.10	210.05	197.01	183.96	170.92	157.87	144.83	131.78
Core Forecast (original)	244.22	229.10	214.61	201.18	193.62	185.45	176.70	169.89

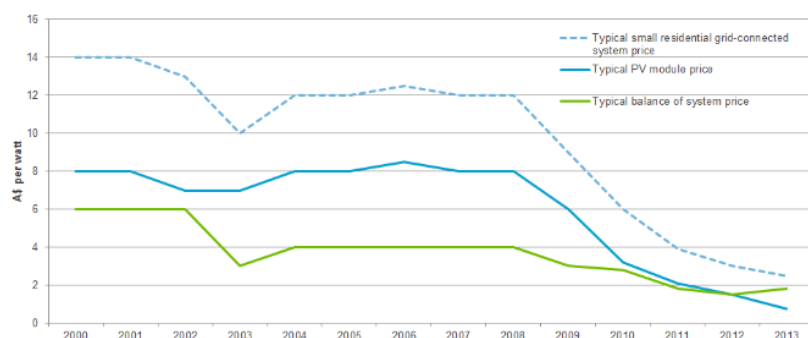
*Represents forecasts simulated using the 2002-2013 mean and standard deviation

Attachment 4 | Trend in Price of Alternative Energy Products

Australia

Australian Government Climate Change Authority, Renewable Energy Target Review, December 2014

FIGURE 12 TRENDS IN AUSTRALIAN PV SYSTEM COSTS, 2000–2013



Note: Prices are prior to any assistance under the SRES and are in nominal dollars.

Source: Climate Change Authority based on Australian PV Institute 2013

Solar PV Forecast for AEMO 2012 – 2022 Considerations for the Australian Energy Market Operator

The fundamental drivers of increasingly favourable financial returns for solar power are the ever increasing residential electricity price and the ever-decreasing price of solar power systems. Figure 4 demonstrates the financial returns available from a 5kW system (assumed to export 50% of its power), under a range of electricity price forecasts. The reduction in solar multiplier and anticipated end to feed-in tariffs notwithstanding, solar power is clearly attractive to the end user.

AEMC, Impact of the enhanced Renewable Energy Target on energy markets, November 2011

Installations of small generating units (i.e. solar PV) are projected to increase significantly under a carbon emissions price over the outlook period, as a result of higher retail electricity prices and falling solar PV costs which are expected to increase the financial payback associated with installation.

Climate Commission, The Critical Decade: Australia' Future – Solar Energy', 2013

Solar photovoltaic (PV) systems have become more and more affordable. As prices have fallen, ordinary Australians have been quietly driving a solar revolution.

For Australian households the price of an average solar PV system has fallen to the point where solar is now competitive in some areas with daytime retail electricity prices.

The cost of buying a solar PV system today is less than a quarter of the price a decade ago.

Over 1 million rooftop solar PV systems have been installed in Australia, up from 8,000 in 2007. About 2.6 million people, 11% of our population, now use the sun for their electricity needs.

Queensland has the largest number of solar PV installations of any state, followed by New South Wales and Victoria. Australian households in outer metropolitan suburbs with high concentrations of home mortgages have a higher proportion of rooftops with solar PV than other suburbs.

Households are motivated to install solar PV or solar hot water systems to reduce their energy bills, to control their energy generation and to make a positive difference to the environment.

AGL, AGL embraces disruptive technologies to meet changing consumer needs' November 2014

To help achieve this AGL will invest in the growing suite of empowering technologies including launching a digital metering business next year as well as expanding its solar business, including offering more flexible methods of financing and paying for solar. AGL will also explore more 'in home' energy services such as energy/battery storage and electric vehicles.

AGL estimates by the late 2020's up to one third of Australian households will be partially or fully off-grid.

"We will see a co-existence of the existing grid and disruptive technologies such as batteries, digital meters and solar PV. Consumers will increasingly have multiple options to choose from when sourcing their energy and AGL plans to play a leading role in this evolving energy market," said Mr England.

International

Mckinsey&Company, McKinsey Quarterly: The disruptive potential of solar power, April 2014

The price US residential consumers pay to install rooftop solar PV (photovoltaic) systems has plummeted from nearly \$7 per watt peak of best-in-class system capacity in 2008 to \$4 or less in 2013.¹ Most of this decline has been the result of steep reductions in upstream (or "hard") costs, chiefly equipment. Module costs, for example, fell by nearly 30 percent a year between 2008 and 2013, while cumulative installations soared from 1.7 gigawatts in 2009 to an estimated 11 gigawatts by the end of 2013, according to GTM Research.

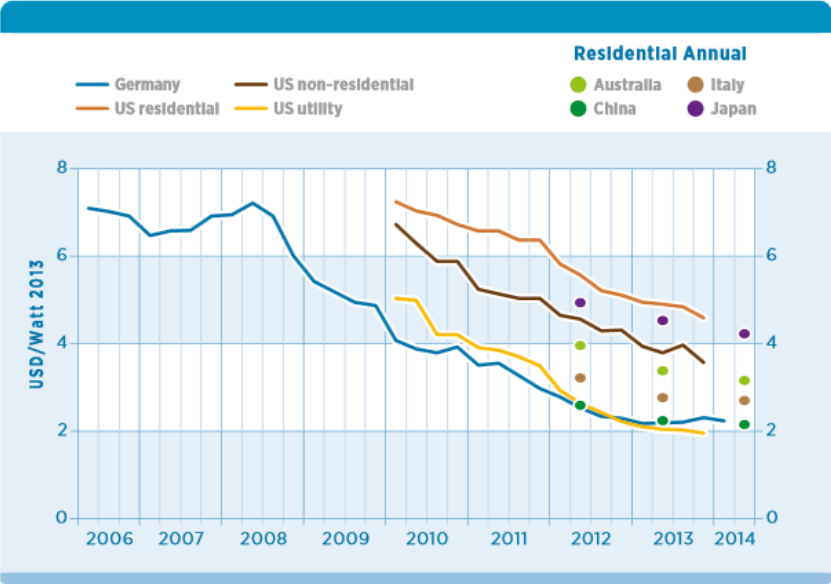
While module costs should continue to fall, even bigger opportunities lurk in the downstream (or "soft") costs associated with installation and service. Financing, customer acquisition, regulatory incentives, and approvals collectively represent about half the expense of installing residential systems in the United States. Our research suggests that as they become cheaper, the overall costs to consumers are poised to fall to \$2.30 by 2015 and to \$1.60 by 2020

Citigroup, Energy 2020: The Revolution Will Not be Televised as Disruptors Multiply, August 2014

We believe global solar growth will be driven by economics, fuel diversity and emerging financing vehicles as well as some country specific legislative overlay

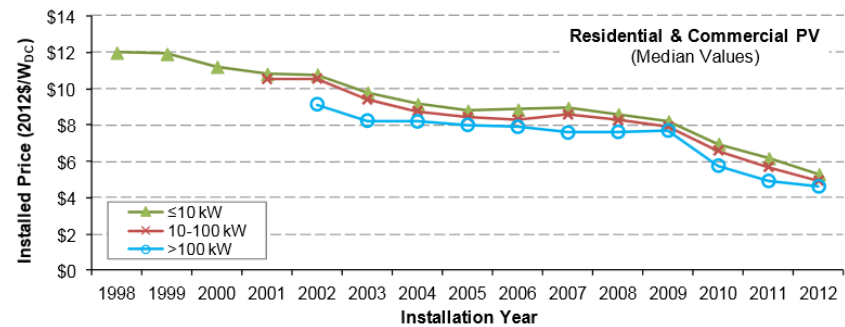
Moreover, this growth looks set to continue for the long term, as solar takes an ever greater share of energy generation, helped by improving economics against fossil fuels.

Figure 10: Solar PV system costs by country (2010-2014)



Source: IRENA Costing Alliance (n.d.)

U.S Department of Energy, Tracking the Sun VI, July 2013



Notes: See Table 1 and Table B-2 for residential and commercial PV sample sizes by installation year. Median installed prices are shown only if 15 or more observations are available for the individual size range.

Attachment 5 | Expert Credentials

The following is a summary of the relevant training, study or experience by which Paul Taliangis has gained specialised knowledge.

Tertiary Qualifications

- Bachelor of Economics
- Post graduate Diploma in Accounting
- Member Institute of Chartered Accountants in Australia
- Various national and international intensive management development courses

General Professional Experience

In excess of 30 years of commercial/ business experience focused primarily in the areas of Corporate Finance and Energy, at a national and international level.

- Chartered Accounting – 6 years experience with Price Waterhouse – Australia and New Zealand
- Banking – 3 years experience with State Bank Group
- Management Consulting – 3 years experience with Ernst and Young Consulting
- Gas Industry – 8 years experience with Santos Limited – Australia, UK and USA
- Energy Advisory – 11 years as CEO and owner of Core Energy Group

Core Competencies

Core competencies include:

- Research and analysis across all major segments of the Australian energy value chain
- Strategic analysis of Australian gas markets - Western, Northern and Eastern Australia and LNG
- Corporate strategy formulation and execution
- Demand forecasting and scenario analysis – at macro and micro levels
- Valuation of assets and companies
- Mergers, Acquisitions and Divestitures
- Investment decisions
- Portfolio Management

Overview of Gas Sector Experience

Introduction

In excess of 20 years' experience in the Australian and international gas sector:

- Manager of Corporate Development, Santos Limited – responsibility for decision-making support relating to large scale investment projects including gas assets, gas companies, joint venture interests – covering Australia (west north and east), PNG, Asia, USA, UK.
- Manager Corporate Planning, Santos Limited – responsibility for group-wide planning including industry analysis (full value chain), strategy, competitor analysis, portfolio management and valuation.

Founder and Chief Executive of Core Energy Group – a niche energy advisory firm with a particular focus on the Australian and international gas and LNG sectors. Service areas include strategic analysis, corporate finance and transactions.

Relevant Specific Experience

Focus Area	Experience
Independent Expert/Witness	<p>A variety of independent expert roles covering:</p> <ul style="list-style-type: none"> > Gas contract disputes > Gas price reviews – east and western Australia > Gas demand – electricity, industrial, distribution, transmission > Drilling activity (LNG) > Gas processing plants > Gas transmission pipelines > Gas storage > International LNG
Demand forecasting, modelling and scenario analysis	<p>Development of models and analytical tools, forecasts and demand scenarios along the gas sector value chain:</p> <ul style="list-style-type: none"> > Exploration and production; > Transmission; > Distribution; > Electricity generation; > Retailing; and > Liquefaction (LNG) <p>The following paragraphs address these areas in further detail</p>
Gas Distribution	<p>Access Arrangements</p> <ul style="list-style-type: none"> > WA – ATCO > NSW – Jemena > VIC – Envestra > SA – Envestra > ACT – Actew <p>General</p> <ul style="list-style-type: none"> > Demand forecasting, modeling and scenario analysis covering all Australian networks > Valuation of the majority of gas distribution companies and assets in Australia for a variety of purposes including acquisition evaluation, equity investment and takeover defence > Acquisition of Wagga Gas Network from NSW Government
Gas Transmission	<p>Development of gas demand scenarios for major transmission systems:</p> <ul style="list-style-type: none"> > South West Queensland > Roma Brisbane > Moomba Sydney > EGP > Moomba Adelaide > SEAGas > Tasmania > QCLNG transmission line
Gas Exploration and Production	<p>Development of contracted and potential demand and supply scenarios:</p> <ul style="list-style-type: none"> > Cooper Basin: SA and SWQ JV; unconventional gas (shale, coal seam, tight gas) > Gippsland Basin: Gippsland Basin JV > Otway Basin: Minerva, Thylacine-Geographe, Casino > Surat/Bowen Basins: all major Queensland coal seam gas fields > WA Basins: NWS Domgas, John Brookes, Gorgon, Wheatstone, Pluto > LNG – NWS JV, Gorgon, Pluto, Ichthys, Wheatstone, GLNG, APLNG, QCLNG, Darwin LNG

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