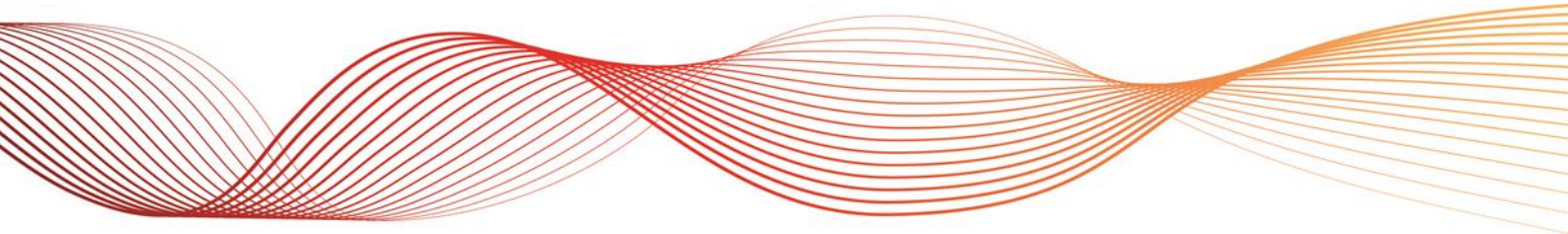




CONSULTATION PAPER

MATERIAL ISSUES AND PROPOSED INPUTS FOR THE 2016
NATIONAL TRANSMISSION NETWORK DEVELOPMENT PLAN

Published: **January 2016**





IMPORTANT NOTICE

Purpose

AEMO has prepared this document to seek feedback on the 2015 National Transmission Network Development Plan (NTNDP), and to set out proposed inputs and material issues for the 2016 NTNDP. This document has been prepared by AEMO as required by clause 5.20.1 of the National Electricity Rules.

Disclaimer

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EXECUTIVE SUMMARY

AEMO has prepared this document to:

- Seek feedback from stakeholders on the 2015 National Transmission Network Development Plan (NTNDP).
- Provide information and seek submissions on considerations for the 2016 NTNDP, including:
 - Material issues to be addressed in the planning scenarios.
 - Proposed scope, inputs and modelling methodology considerations.

AEMO is keen to continually improve its suite of planning publications to better meet stakeholder needs. AEMO respects the expertise of its stakeholders and values all feedback, which is critical in guiding meaningful progress. AEMO is committed to ensuring the NTNDP remains a transparent and valuable information resource that represents a holistic view of the south-eastern Australian electricity transmission network.

Material issues to be explored in 2016

AEMO considers the following issues to be material for the 2016 NTNDP:

- Uncertainty about the electricity industry's contribution towards emissions reduction targets, which can change the generation mix and network development in the National Electricity Market (NEM).
- A changing generation mix from large-scale synchronous generation to inverter-connected generation (both large-scale and distributed), which is leading to emerging operational challenges.
- The increasing range of both network and non-network solutions to be considered in long term planning processes to meet these emerging operational challenges.
- Changing consumer behaviour, influenced by network tariff reform and adoption of energy management technologies, which is changing both the amount and timing of electricity consumed from the grid.

AEMO intends to address the first three of these issues in the 2016 NTNDP. A program of work for 2016 and 2017 will examine how changing consumer behaviour affects energy consumption and demand. Early outcomes from this program could inform the 2016 National Electricity Forecasting Report (NEFR) and feed into the 2016 NTNDP.

2016 NTNDP scope and scenarios

The Federal Government made a commitment at the twenty-first United Nations Conference of the Parties to implement an economy-wide target to reduce greenhouse gas emissions by 26 to 28 per cent below 2005 levels by 2030 (COP 21 Commitment)¹.

AEMO intends to develop 2016 NTNDP scenarios that will examine the possible impact this commitment may have on network development over the next 20 years. This will involve an assessment of the changing generation mix, changing consumer behaviour, and operational challenges associated with the transformation to meet the emissions reduction commitment.

This Consultation seeks stakeholder feedback on the inputs and assumptions proposed in this paper.

¹ Australian Government, August 2015. *Australia's intended nationally determined contribution to a new climate change agreement*. Available: <http://www4.unfccc.int/submissions/INDC/Published%20Documents/Australia/1/Australias%20Intended%20Nationally%20Determined%20Contribution%20to%20a%20new%20Climate%20Change%20Agreement%20-%20August%202015.pdf>



Methodology considerations for the 2016 NTNDP

AEMO continues to refine the modelling methodologies for both the generation outlook and the transmission outlook. Current focus areas include:

- Generation outlook – better representing wind and solar generation uncertainty, and examining how to incorporate battery storage into market modelling.
- Transmission outlook – broadening the analysis to examine additional constraint equations that represent emerging operational challenges, and increasing the range of network and non-network options considered to address network limitations and operational challenges. This outlook may also include a high level analysis of the costs and benefits associated with increased interconnection between Victoria and both South Australia and Tasmania.

Stakeholder feedback and workshop

AEMO plans to hold a stakeholder workshop **on 25 February 2016** to discuss this Consultation in more detail. Please email planning@aemo.com.au **by 19 February 2016** if you would like to take part in this workshop.

A short online survey is available for you to provide brief feedback on the 2015 NTNDP, at <https://www.surveymonkey.com/r/GDSW5MK>, **until 18 March 2016**.

AEMO invites written submissions on the statement of material issues and the proposed inputs for the 2016 NTNDP **by Friday 18 March 2016**. Please email submissions to planning@aemo.com.au, or post to Network Planning Group, AEMO, GPO Box 2008, Melbourne, VIC 3000.

Stakeholders who have any additional suggestions on ways AEMO can improve its 2016 NTNDP, other than the topics outlined in this document, should also include these ideas in submissions.



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1. STAKEHOLDER CONSULTATION

The 2015 NTNDP²:

- Reflected on current network investment trends and how these are evolving.
- Examined the adequacy of transmission flow paths between significant generation and load centres in the NEM.
- Identified transmission network limitations for the outlook period of 20 years.
- Discussed factors impacting power system security, such as levels of inertia and the proportion of total generation managed through the dispatch process.
- Identified network support and control ancillary service (NSCAS) gaps which could occur in the next five years. These are services that may be needed to manage the security and reliability of the NEM in the near term.

AEMO is seeking feedback on the 2015 NTNDP through an online survey that should take no more than 10 minutes to complete. This feedback will help us understand how to improve future NTNDPs to deliver valuable information that supports our stakeholders in operating their business. This survey will close on **18 March 2016** and can be found at:

<https://www.surveymonkey.com/r/GDSW5MK>

This paper focuses on the following consultation questions to help scope the 2016 NTNDP:

- 1. What do you think are the material issues facing the electricity industry that the 2016 NTNDP should address?**
- 2. What scenarios/sensitivities would you like to see examined in the 2016 NTNDP?**
- 3. Is the proposed approach to modelling the impact of the COP 21 Commitment reasonable?**
- 4. What do you think are the key challenges/opportunities for network development in the future, particularly highlighting any that were not identified in the 2015 NTNDP?**
- 5. Do you have any suggestions on how to improve the generation outlook or transmission outlook methodologies for the 2016 NTNDP?**
- 6. Are the proposed 2016 NTNDP input assumptions appropriate, and would you recommend any additions/changes to these assumptions?**

Please see chapters 2–5 below for expanded comments on each question.

AEMO invites stakeholders to provide written feedback on these questions, or any other comments, by **Friday 18 March 2016**. Please email written submissions to planning@aemo.com.au, or post to:

- Network Planning Group
AEMO
GPO Box 2008
Melbourne, VIC 3000.

AEMO also plans to hold a stakeholder workshop **on 25 February 2016** to discuss this Consultation Document in more detail. Please email planning@aemo.com.au **by 19 February 2016** if you would like to take part in this workshop.

² AEMO. 2015 National Transmission Network Development Plan. Available: <http://www.aemo.com.au/Electricity/Planning/National-Transmission-Network-Development-Plan>.

2. STATEMENT OF MATERIAL ISSUES

PLEASE CONSIDER:

1. What do you think are the material issues facing the electricity industry that the 2016 NTNDP should address?

AEMO prepares the NTNDP each year to consider and assess an appropriate course for the efficient development of the national transmission grid over the next 20 years. In doing so, AEMO must consider any material issue that could impact transmission grid development in that time horizon.

For the 2016 NTNDP, AEMO considers the following issues as material:

- **Uncertainty about the electricity industry's contribution to emissions reduction targets:**

Mechanisms to help achieve the COP 21 Commitment have not yet been announced yet the choice of policy mechanism will influence how the generation mix changes over time. This Consultation Document outlines AEMO's proposed approach to modelling this commitment in the absence of any specific mechanism (see section 3.1.2).

AEMO will continue to engage with government and industry stakeholders to derive the most appropriate assumptions to use in the 2016 NTNDP scenarios, while policy decisions are being made by responsible bodies.

- **Changing generation mix:** The mix of generation sources across the NEM is changing, with withdrawal of thermal synchronous generation (such as coal and gas-fired generation) and increasing proportions of:

- Small, distributed generation sources.
- Large-scale inverter-connected renewable generation sources.

As discussed in the 2015 NTNDP, operational challenges are emerging as a result of this changing generation mix, for example:

- Less dispatchable generation, making it more difficult to balance supply and demand in real time.
- More rapid and greater frequency deviations following disturbances, resulting from lower inertia levels as synchronous generators withdraw from service.
- Larger fluctuations in voltage as synchronous generators withdraw from service.
- Increased dependence on interconnection between regions to share network support services.

AEMO continues to evaluate how to maintain power system security and reliability as the generation mix evolves, and this will be discussed further in the 2016 NTNDP.

- **Options to manage network challenges:** As operational challenges arise, possible options to maintain security and reliability in consumers' long term interests need to be investigated, such as:

- Network augmentation.
- Non-network development options, including demand management or behind-the-meter technology adoption that can affect consumer demand.
- Emerging network technologies, such as grid scale electricity storage.
- Network tariff reform to incentivise changes in consumer behaviour.

In the 2016 NTNDP, AEMO intends to explore possible network and non-network options that could efficiently manage the long-term operational challenges identified in the 2015 NTNDP.

- **Changing consumer behaviour:** Changing consumer attitudes and preferences regarding energy services and energy management technologies (such as appliance timers or electricity storage)



are changing the way electricity is consumed. This can affect both the amount and timing of electricity consumed from the grid.

AEMO intends to commence a program of work for 2016 and 2017 that will examine how changing consumer behaviour affects energy consumption and demand. Early outcomes from this program could inform the 2016 NEFR and feed into the 2016 NTNDP.

3. SCOPE AND SCENARIOS OF THE 2016 NTNDP

PLEASE CONSIDER:

2. What scenarios/sensitivities would you like to see examined in the 2016 NTNDP?
3. Is the proposed approach to modelling the impact of the COP 21 Commitment reasonable?

3.1 Scenario development

Each year the NTNDP assesses the need for transmission development under a range of credible scenarios over a 20-year period. The scenarios reflect pertinent issues and policy settings at the time of each NTNDP.

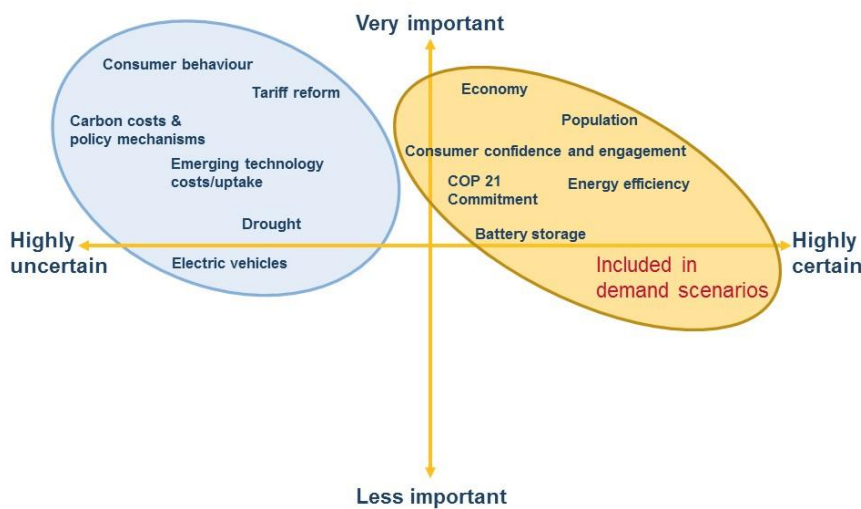
3.1.1 Demand side considerations

AEMO has historically formed a Scenario Working Group (SWG) every two years to develop demand scenarios. The latest working group convened on 17 December 2015. The SWG helps develop these scenarios to be used in the NEFR and Electricity Statement of Opportunities (ESOO), which are then used as inputs for other planning publications such as the NTNDP.

For 2016, these scenarios are structured to define the most probable pathway for demand in the NEM, providing a baseline against which a range of key uncertainties can be explored. This year’s demand scenarios assume a “Strong/Neutral/Weak” structure, referring to the economic conditions affecting energy consumers and focusing on underlying consumption³.

The “Neutral” scenario in 2016 is comparable to the “Medium” scenario used by AEMO in previous years. Unlike previous years when the High and Low scenarios sought to address a range of uncertainties impacting on consumption from the transmission network, the 2016 Strong and Weak scenarios are more like sensitivities, providing narrower analysis on factors such as population, consumer confidence and engagement, and business conditions in the Australian economy. The change in approach recognises the range of uncertainties facing the industry – too many to address within three demand scenarios. Some of these uncertainties, and the factors to be included in the demand scenarios, are depicted in Figure 1 below.

Figure 1 Factors included in scenario development



³ Underlying consumption refers to everything consumed on site, and can be provided by localised generation from rooftop photovoltaics (PV) and embedded generators, or by the electricity grid.

AEMO will monitor factors that are highly uncertain and will include them in future demand scenarios as they become more likely.

An assumption in the demand scenarios for 2016 is the achievement of Australia’s COP 21 Commitment, and a summary of key assumptions in the demand scenarios is shown in Appendix A.

3.1.2 Planning considerations

Planning scenarios, such as those used in the NTNDP, build a picture of possible future demand and supply characteristics that can then be used to prepare network development strategies. Planning scenarios may examine the credible extreme cases of supply and demand, in order to identify when operational challenges could emerge.

Consequently, planning scenarios may consider the demand scenarios used in the NEFR/ESOO as a starting point, but adjust them according to the focus of the planning analysis and stakeholder feedback. Adjustments may include further consideration of emerging technologies or energy efficiency.

The 2016 NTNDP will consider how Australia’s COP 21 Commitment might be achieved. Rather than assuming particular abatement policies, the analysis will presume that the NEM achieves a proportionate share of emissions reduction to 2030.

AEMO has conducted preliminary studies, using the least cost modelling methodology applied in the 2015 NTNDP Generation Outlook, to analyse potential changes in the generation mix resulting from the COP 21 Commitment. These studies indicate that, in addition to strengthening energy efficiency measures, the following coal generation may need to withdraw from the NEM by 2030 to meet the COP 21 Commitment:

- About 40% of coal-fired generation in Victoria (about 2,700 MW of generation capacity).
- About 30% of coal-fired generation in New South Wales (about 3,300 MW of generation capacity⁴).
- About 30% of coal-fired generation in Queensland (about 2,700 MW of generation capacity).

Additionally, AGL and Origin have publically announced that they do not expect to run the following coal-fired generators beyond their operating lives.^{5,6}

Table 1 Coal-fired generation not expected to run beyond its operating life

Asset owner	Generation plant	Generation capacity / MW	Commissioned
AGL Energy Limited	Bayswater	2,640	1985
AGL Energy Limited	Loy Yang A	2,180	1984 - 1988
Origin Energy Limited	Eraring	2,880	1982 - 1984

Assuming a 50-year operating life for these power stations, AEMO proposes to withdraw these generators in the Generation Outlook modelling between 2030 and 2040. This would therefore be in addition to the coal-fired generation withdrawals assumed to meet the COP 21 Commitment reflecting the likelihood that further abatement targets will be set beyond 2030. AEMO is seeking feedback from stakeholders on this proposed approach.

3.2 2016 NTNDP expansion of scope

In the 2015 NTNDP, AEMO stated that an intended focus area for the 2016 report will be to identify potential network and non-network options to manage system security across the national transmission network, addressing the emerging challenges identified in the 2015 report. This will require an expansion of scope for the transmission outlook methodology, which is discussed further in section 4.2.

⁴ This is in addition to the announced closure of the 2000 MW Liddell power station.

⁵ AGL. Available: <https://www.agl.com.au/about-agl/media-centre/article-list/2015/april/agl-policy-to-provide-pathway-to-decarbonisation-of-electricity-generation>.

⁶ Origin. Available: <https://www.originenergy.com.au/blog/big-picture/paris-climate-change-deal-makes-history.html>.

4. METHODOLOGY CONSIDERATIONS

PLEASE CONSIDER:

4. What do you think are the key challenges/opportunities for network development in the future, particularly highlighting any that were not identified in the 2015 NTNDP?
5. Do you have any suggestions on how to improve the generation outlook or transmission outlook methodologies for the 2016 NTNDP?

The NTNDP co-optimises two key modelling outlooks:

- The **generation outlook**, which projects the location and timing of new generation additions and withdrawals for each scenario. This outlook focuses on efficient development to meet forecast demand, minimising both total generation and network investment costs over the 20-year planning horizon.
- The **transmission outlook**, which identifies likely congestion points on the main transmission flow paths over the 20-year outlook. These congestion points are heavily influenced by the generation outlook.

AEMO continues to refine the methodologies for both outlooks each year, and welcomes feedback on the methodology considerations for the 2016 NTNDP below.

4.1 Generation outlook methodology

AEMO continually develops its methodology to analyse the outlook for existing and new generation. The current methodology is described in the Capacity Expansion Model paper on the Planning Assumptions webpage.⁷ Current focus areas for improvement include:

- **Development of a new reference year approach:** AEMO intends to move from a deterministic to a stochastic approach to developing demand, wind and solar traces. The current methodology uses a single reference year to maintain the correlation between weather and demand. AEMO is examining the merits of using up to six reference years (2009–10 to 2014–15) to represent the future weather/demand distribution while keeping the correlation between weather and peak demand.
- **Battery storage:** AEMO is examining how best to include both grid-scale and behind-the-meter battery storage in the market modelling methodology. For example, this work may consider whether grid-scale battery storage may become competitive with gas peaking plant in the next 20 years.

4.2 Transmission outlook methodology

In the 2015 NTNDP, AEMO said it intended to present, in the 2016 NTNDP, network and non-network solutions to emerging challenges identified.

In 2016, a new set of planning scenarios will be examined. The 2016 NTNDP will again identify both the network limitations and other operational challenges associated with the changing generation mix presented in the 2016 generation outlook. The transmission outlook will then identify both network and non-network solutions to address these network limitations and other operational challenges.

The transmission outlook analysis primarily assesses the adequacy of the national transmission grid to reliably support major power transfers between supply and demand centres.

⁷ AEMO, Planning Assumptions webpage. Available: <http://www.aemo.com.au/Electricity/Planning/Related-Information/Planning-Assumptions>.



Two types of limitations are considered in this analysis to highlight congestion in the network that should be addressed:

- **Reliability limitations** occur if, at the time of regional maximum operational demand, the network does not have enough capacity to meet demand.
- **Economic limitations** are where more expensive generation is dispatched ahead of cheaper generation in order to avoid network overloads.

AEMO intends to continue analysing limitations in this way, and to broaden the 2016 transmission outlook methodology to examine:

- Additional constraint equations in the market modelling to represent operational challenges associated with frequency and voltage volatility.
- Increasing the range of network and non-network options considered to address network limitations and operational challenges. For example, further options could include a range of technologies to address frequency and voltage stability challenges.
- A high level assessment of the costs and benefits of further interconnection between Victoria and South Australia, and between Victoria and Tasmania. This is considered relevant in light of recent islanding events in both regions.

AEMO continues to consult with industry experts through the NTNDP working group, with the next meeting on **25 February 2016**. Please email planning@aemo.com.au by **19 February 2016** if you would like to attend this workshop, to be held by video conference at AEMO offices across the NEM.

5. PROPOSED 2016 NTNDP INPUTS

PLEASE CONSIDER:

- 6. Are the proposed 2016 NTNDP inputs appropriate, and would you recommend any additions/changes to these assumptions?**

The input data files and assumptions applied in the 2015 NTNDP are included in the NTNDP Database on the Planning Assumptions page of AEMO's website.⁸ Many of the inputs and assumptions in the NTNDP Database will also apply to the 2016 NTNDP.

Some key inputs and updated assumptions for the 2016 NTNDP are proposed below.

5.1 Scenarios

Please refer to section 3 above.

5.2 Forecasts

The 2016 NTNDP demand trace development will start with the 2016 NEFR forecasts for electricity consumption and maximum demand, which will also include a projection of residential storage uptake. These may then be adjusted according to the focus of the NTNDP scenarios. For example, adjustments may include increasing the levels of energy efficiency or rooftop PV and battery storage penetrations.

5.3 Generation

The 2016 NTNDP will consider the existing generation capacity located in the NEM, as listed on the AEMO Generation Information page.⁹ It will include partial availability, publically-announced withdrawals, and committed and proposed generation projects, all of which are listed on the Generation Information page.

There will be a cut-off date for the generation information considered in the NTNDP modelling. The cut-off date in 2015 was 31 August, and the 2016 cut-off date will be stated clearly in the published report.

5.4 Renewable energy target and carbon price

The legislated Federal Large-scale Renewable Energy Target (LRET) will be applied in the generation outlook model. The model will select the most efficient expansion from existing capacity, new generation, and LRET penalty as legislated. Excess large-scale generation certificates (LGCs) already banked will be used in the market modelling.

The standard lead time for generation projects applied in the generation outlook methodology is three years, but AEMO intends to allow for publically-announced wind generation projects to be built within two years, taking into account the advanced stage of planning that these projects are in before reaching committed status.

The 2016 NTNDP modelling will incorporate implicit carbon price projections consistent with the 2016 NEFR scenarios (to achieve the COP 21 Commitment), but will adjust these assumptions if required to be consistent with alternative NTNDP scenario narratives.

⁸ AEMO. Planning Assumptions webpage. Available: <http://www.aemo.com.au/Electricity/Planning/Related-Information/Planning-Assumptions>.

⁹ AEMO. Generation Information webpage. Available: <http://www.aemo.com.au/Electricity/Planning/Related-Information/Generation-Information>.



5.5 Fuel and technology costs

The 2016 NTNDP will use fuel and technology cost data for both existing and new generation as provided by the 2015 Australian Power Generation Technology Report.¹⁰ This report provides a range of generation technology costs and fuel conversion factors out to 2030, and has been developed in consultation with leaders from industry, government, consumer groups and industry associations. These costs, and any updates or additional data considered necessary for the 2016 NTNDP, will be published in the 2016 NTNDP database.

Gas price assumptions will be consistent with assumptions used for AEMO's 2016 National Gas Forecasting Report (NGFR). Stakeholders are invited to provide comment on the assumptions used in AEMO's 2015 NGFR for future consideration.¹¹

5.6 Transmission network

The 2016 NTNDP modelling will incorporate existing and committed regional transmission network assets as advised by transmission network service providers for each region of the NEM in their 2016 Transmission Annual Planning Reports.

AEMO will continue to engage with non-network service providers to understand how non-network solutions can address the emerging challenges highlighted in the 2015 NTNDP.

¹⁰ *Australian Power Generation Technology Report*, 2015. Available: http://www.co2crc.com.au/dls/Reports/LCOE_Report_final_web.pdf.

¹¹ AEMO, *National Gas Forecasting Report Methodology Information Paper*. Available: <http://www.aemo.com.au/Gas/Planning/Forecasting/National-Gas-Forecasting-Report>.



APPENDIX A. DEMAND SCENARIO ASSUMPTIONS

Table 2 Overview of some proposed assumptions to be applied in the 2016 NEFR scenarios

Key assumption	Impact area	Application across sensitivities	Neutral case (most probable path)
Climate Policy	Energy prices, plant shut-downs.	Fixed	Assume achievement of Australia's COP 21 Commitment.
Climate Policy	Energy prices	Fixed	Scenario assumes most abatement cost is passed through to industry. Implicit carbon price of \$25/tonne assumed in 2020 rising to \$50/tonne by 2030. Emissions Intensive Trade Exposed Industry pays only 20% of this cost in 2020, rising to 100% in 2030.
Climate Policy	Plant-shut-downs and generation replacement.	Fixed	Coal-fired generation shut-down list reflects supply side impact of COP 21 Commitment.
Electricity Demand	Electricity Prices.	Variable	Based on underlying demand, translated back to consumption from the transmission network.
Technology uptake	End use and energy efficiency.	Variable	Neutral consumer, neutral economy.
Energy Efficiency	End use and energy efficiency.	Variable	Policy measures deliver medium uptake of energy efficiency.
Tariff structure	Electricity Prices.	Fixed	Current tariff structures continue.
Oil Prices/ Gas Prices	Oil/Gas Price.	Variable	USD 60/barrel with pricing affecting the industry as existing contracts expire.