GENERATION EXPANSION PLAN

FOR THE 2014 NATIONAL TRANSMISSION NETWORK DEVELOPMENT PLAN

Published: **December 2014**

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Disclaimer

AEMO has made every effort to ensure the quality of the information in this publication but cannot guarantee that information, forecasts and assumptions are accurate, complete or appropriate for your circumstances. This publication does not include all of the information that an investor, participant or potential participant in the National Electricity Market might require, and does not amount to a recommendation of any investment.

Anyone proposing to use the information in this publication (including information and reports from third parties) should independently verify and check its accuracy, completeness and suitability for purpose, and obtain independent and specific advice from appropriate experts.

Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of this publication:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the information in this publication; and
- are not liable (whether by reason of negligence or otherwise) for any statements, opinions, information or other matters contained in or derived from this publication, or any omissions from it, or in respect of a person's use of the information in this publication.

CONTENTS

TABLES

FIGURES

1.1 Introduction

The Australian Energy Market Operator's (AEMO) generation expansion plan forecasts the future generation mix taking into account consumption and generation reserve requirements. The plan incorporates a least-cost expansion of large-scale generation in the National Electricity Market (NEM) over a 25-year outlook period (2014–15 to 2038–39) to ensure adequate supply to meet demand at the current NEM Reliability Standard.[1]

The plan forecasts the generation mix by fuel type, the location and timing of investments and divestments.

AEMO uses the 2014 generation expansion plan to develop the 2014 National Transmission and Network Development Plan (NTNDP).

In previous years, the generation expansion plan has been published within the NTNDP. In 2014, AEMO has published the plan independently to allow the NTNDP to focus on transmission development.

1.2 Key findings

The key generation expansion plan forecasts are:

- NEM-installed capacity is projected to decrease by 3.5% (2,379 megawatts (MW)) by 2038–39.
  - 6,756 MW of existing generation (all thermal generating units) retires.
  - 4,377 MW new generation (mainly wind) is installed.
- Although coal-fired installed capacity decreases over the outlook period, it continues to provide the bulk of energy generation throughout the outlook period. Coal-fired generation is expected to reduce from 84.9% to 79.3% of total energy generation between 2014–15 and 2038–39.

[1] Australian Energy Market Commission (AEMC). NEM Reliability Standard – Generation and Bulk Supply. Available at: http://www.aemc.gov.au. Viewed: 27 November 2014.

1.3 Methodology

AEMO's generation expansion plan provides projections of the future generation mix to 2038–39 taking into account consumption and generation reserve requirements. It models a least-cost expansion of large-scale generation in the NEM over a 25-year outlook period.

This section provides an overview of the key demand and supply assumptions used to develop the generation expansion plan.

Demand assumptions

AEMO uses the National Electricity Forecasting Report (NEFR) to provide consumption forecasts for the NEM and by region.[2] The NEFR forecasts high, medium, and low growth scenarios. This report uses the medium scenario.

Forecast maximum demand and minimum reserve levels determine the future minimum generation capacity required. Annual energy affects the generation mix that is used to meet it.

The key demand assumptions are:

- The NEFR medium scenario consumption forecast is used for maximum demand and annual energy.
- Minimum reserve levels are calculated to ensure the Reliability Standard is met, ensuring the unserved energy level is below 0.002% for each region.[3]

Supply assumptions

In determining the generation mix required in the expansion plan, AEMO uses a least-cost methodology which takes into account factors that impact the available generation choices. New generation required to meet forecast consumption is evaluated across a wide range of technologies, including renewable and non-renewable fuel types. Existing generation retires once its technical life is reached, or the cost of retirement is less than the cost of keeping the unit in operation.

The key supply assumptions are:

- New generation capital and operating costs are based on independent estimates provided to AEMO by ACIL Allen Consulting.[4]
- Carbon pricing is not included as a cost prior to 2019–2020, which reflects current policy. From 2019–20, carbon pricing is set at the projected international floating price, forecast for AEMO by Frontier Economics.[5]
- The LRET[6] policy at the time of publication remains unchanged. This requires either the surrender of a large-scale generation credit (LGC) or payment of a penalty[7] in lieu of surrendering an LGC at a nominal price of approximately $93 (post-tax). A target of 41,000 GWh of renewable generation by 2020 is modelled, with the scheme running until the end of 2029-2030.
- All existing thermal generating units are eligible for retirement from 2017–18, provided they have reached at least 80% of their technical life[8], as retired generating units are not recommissioned.

Appendix A lists the modelling assumptions used to develop the 2014 generation expansion plan, including any special constraints on generation, and compares these to the assumptions applied in developing the generation expansion plan included in the 2013 NTNDP. A full description of AEMO's capacity expansion modelling assumptions is also available on AEMO's website.[9]

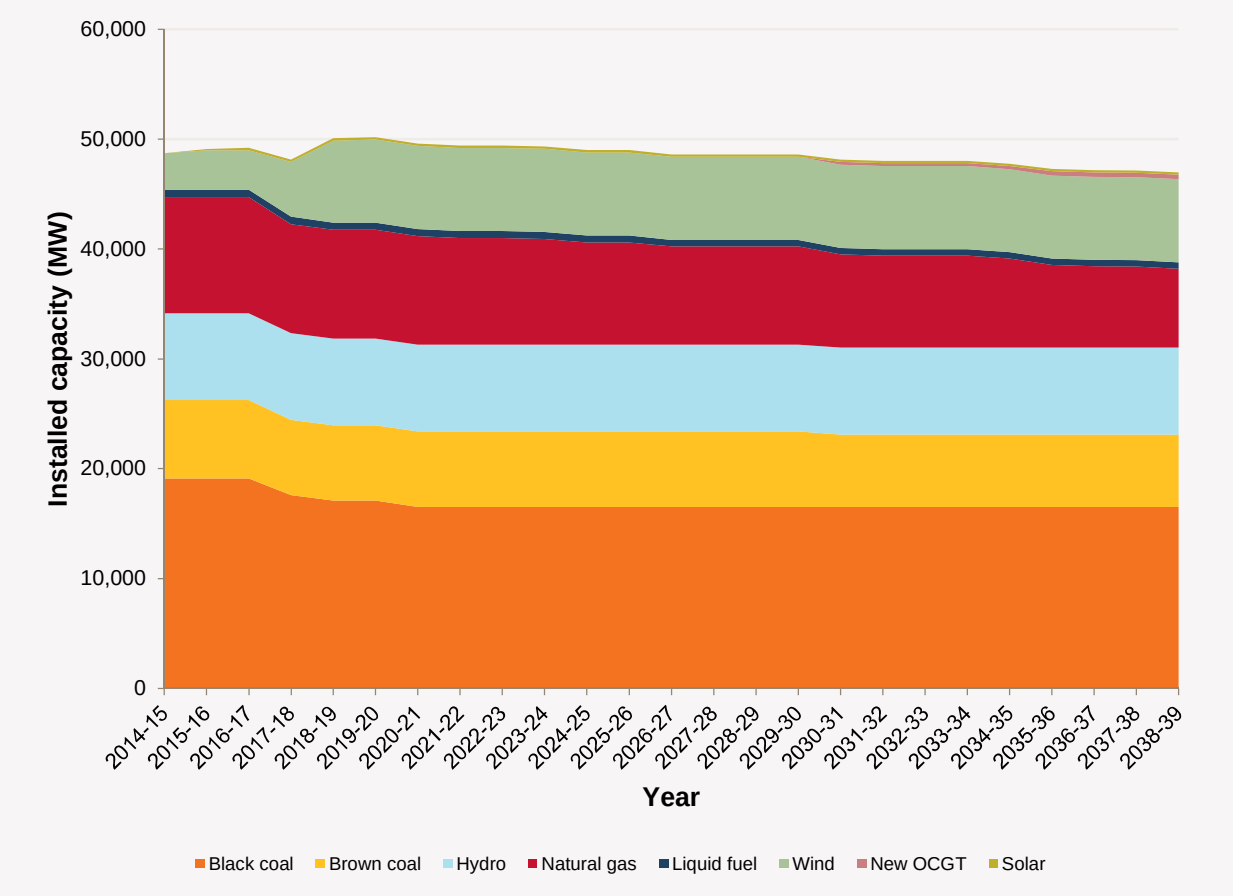
2 2014 NEFR. Available at: http://www.aemo.com.au/Electricity/Planning/Forecasting. Viewed: 27 November 2014.
3 AEMC. NEM Reliability Standard – Generation and Bulk Supply. Available at: http://www.aemc.gov.au. Viewed: 27 November 2014.
4 ACIL Allen Consulting. Fuel and Technology Cost Review. Available at: http://www.aemo.com.au/Electricity/Planning/Related-Information/Planning-Assumptions. Viewed: 27 November 2014.
5 Frontier Economics. Economic and Energy Market Forecasts. p. 11. Available at: http://www.aemo.com.au/Electricity/Planning/Forecasting/National-Electricity-Forecasting-Report/NEFR-Supplementary-Information. Viewed: 27 November 2014.
6 In developing the generation expansion plan, AEMO uses the current LRET policy in its modelling and acknowledges the uncertainty of future LRET policy settings at the time this document is published.
7 Under the LRET, liable entities surrender one LGC or a penalty for each MWh of their calculated renewable energy obligation.
8 Except for Playford B Power Station, as it is only available with a recall of 90 days.
9 AEMO Capacity Expansion Modelling and Planning Methodology and Input Assumptions. Available at: http://www.aemo.com.au/Electricity/Planning/Related-Information/Planning-Assumptions. Viewed: 20 November 2014.

1.4 Capacity outlook

Installed capacity by fuel type

Figure 1 shows that NEM-installed capacity is forecast to decrease 3.5% by 2038–39, largely as a result of changes in NEFR maximum demand forecasts.[10]

Figure 1 Total NEM installed generation capacity by fuel type



As a proportion of total NEM-installed capacity:

- Wind generation increases by 129% until 2019–20.
- Gas-powered generation (GPG) decreases by 32% by 2038–39.
- Liquid fuel decreases by 14% by 2038–39.
- Black coal-fired generation decreases by 13% by 2038–39.
- Brown coal-fired generation decreases by 8% by 2038–39.

Renewable generation installed capacity is not expected to increase beyond 2019–20. Grid-connected solar photovoltaic (PV) contributes 211 MW by 2017–18. Residential PV is excluded from the expansion model but is considered in the NEFR to be negative consumption.

[10] Available at: http://www.aemo.com.au/Electricity/Planning/Forecasting. Viewed: 23 November 2014.

Capacity changes and forecast investments

Figure 2 illustrates forecast NEM generation capacity additions, reductions and timing over the 25-year outlook period. The forecast net reduction in generation capacity is 2,379 MW by 2038–39, comprising 4,377 MW new generation additions and 6,756 MW existing generation retirement.

Key observations are:

- 3,977 MW of wind investment is completed by 2019–20.
- 3,395 MW of natural gas generation capacity retires between 2017–18 and 2038–39.
- 2,575 MW of black coal-fired capacity retires between 2014–15 and 2020–21.
- 786 MW of brown coal-fired capacity retires between 2017–18 and 2038–39.
- New open-cycle gas turbine (OCGT) investments are required from 2030–31 in order to meet minimum reserve levels.

Total projected new generation investment is $11 billion in real 2014–15 dollars, compared to $25 billion reported in the 2013 NTNDP.[11]

Figure 2 NEM generation capacity additions and reductions

Note: Liquid fuel remains unchanged.

Regional capacity changes by fuel type

Table 1 provides the location of generation capacity additions, reductions and their anticipated timing over the 25-year outlook period. A map identifying the location of projected generation additions and reductions to 2038–39 is provided in Appendix B.

[11] Available at: http://www.aemo.com.au/Electricity/Planning. Viewed: 27 November 2014.

Table 1 Projected generation capacity to 2038–39

Region	Fuel type	Generation capacity addition (MW)	Generation capacity reduction (MW)	Net change (MW)	Anticipated timing
New South Wales	Wind	2,000	-	-	By 2020–21
	Black coal	-	-2,015	-	By 2018–19
	Gas	-	-178	-	By 2021–22
	Total change	2,000	-2,193	-193	
Queensland	Wind	568	-	-	By 2018–19
	Black coal	-	-560	-	By 2020–21
	Gas	-	-946	-	By 2038–39
	Total change	568	-1,506	-938	
Victoria	Wind	223	-		By 2018–19
	Gas	-	-1,399		By 2035–36
	Total change	223	-1,399	-1,176	
South Australia	Wind	796	-	-	By 2018–19
	OCGT	400	-	-	By 2035–36
	Brown coal	-	-786	-	By 2030–31
	Gas	-	-486	-	By 2038–39
	Total change	1,196	-1,272	-76	
Tasmania	Wind	391	-	-	By 2017–18
	Gas	-	-386	-	By 2034–35
	Total change	391	-386	5	-
NEM total	**-**	**4,377**	**-6,756**	**-2,379**	**-**

Note: Adding the sub-total of each region results in total NEM generation capacity additions of 4,378 MW. The net change is -2,378 MW due to rounding.

Annual energy by fuel type

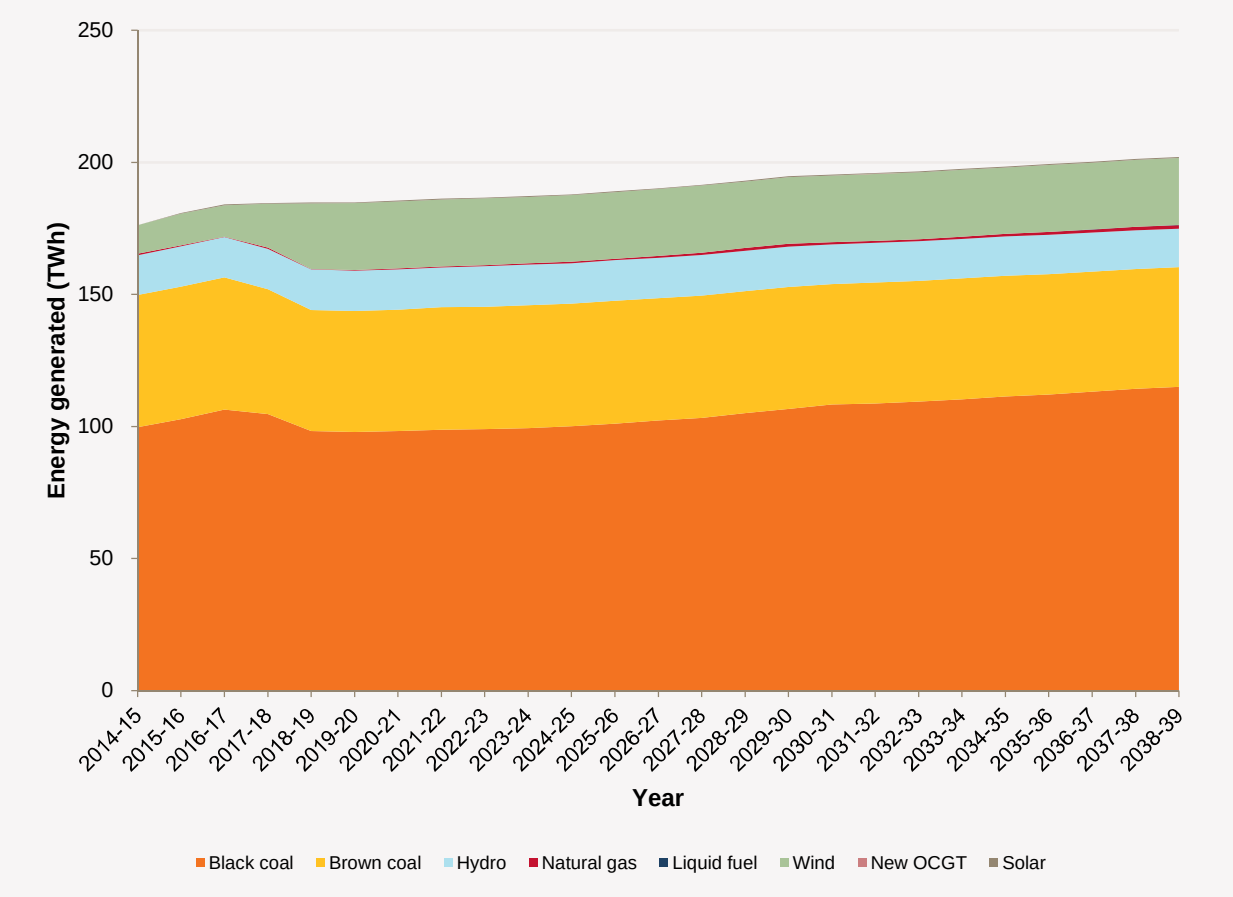
Figure 3 illustrates forecast NEM energy generated by fuel type over the 25-year outlook period. While the NEFR medium scenario consumption forecast increases over the outlook period, the current installed capacity is still more than is needed under least-cost modelling. Key observations are:

- While black coal-fired generation installed capacity is projected to decrease over the outlook period, its contribution to annual energy increases from 99.7 terawatt hours (TWh) to 114.9 TWh between 2014–15 and 2038–39. This is a result of expected higher future utilisation of existing generating units, as the current oversupply begins to be eroded.
- Wind generation is projected to increase as a proportion of annual energy generated, from around 10.8 TWh to 25.3 TWh between 2014–15 and 2018–19 as the LRET interim targets increase. Wind generation annual energy remains static from 2019–20 to 2038–39 due to there being no new wind capacity installed beyond 2020–21.

Coal continues to provide the bulk of total annual energy generated in the NEM throughout this period, reducing from 84.9% in 2014–15 to 79.3% in 2038–39.[12]

[12] Grid connected generation only, excluding all embedded generation such as residential solar PV.

Figure 3 NEM annual energy generated by fuel type



APPENDIX A. COMPARISON WITH 2013 ASSUMPTIONS

Table 2 Comparison of 2013 and 2014 generation expansion plan modelling assumptions

Key modelling assumptions	2014	2013	Reason and impact
Capacity factors	Generating systems' maximum capacity factor is limited by maintenance outages assumed to occur less than 10% of each year.	Generators allowed to reach 100% capacity factor.	This is a more realistic modelling assumption that reflects the need to annually take generating units out of service for maintenance.
Carbon pricing	The 2014 NEFR medium energy consumption scenario was used.[13]	Treasury Core scenario was used.	The 2014 NEFR medium energy consumption scenario was updated to reflect changes in climate change policies, for example, the removal of carbon pricing in the near term.
Fuel and technology costs	Fuel and technology costs were based on values reported in the 2014 Fuel and Technology Cost Review by ACIL Allen.	Fuel and technology costs were based on fuel cost projections by ACIL Tasman in 2012.	The use of updated costs improves the accuracy of the model.
Generation	New generation is built after two years, from 2017–18 to the end of the forecast period.	New generation built after three years (from 2017–18).	New committed generation projects are brought forward by one year to reflect that generators seek to maximise profit before the LRET expires in 2030. The impact is that significant wind generation is built in the first eligible year 2017–18.
	In the initial three years, only Playford Power Station (PS) retires (it is currently available on a 90-day recall basis).[14]	In the initial three years, there are no retirements.	Unchanged except for the Playford PS retirement. The impact of this change is immaterial due to the on-call status of Playford PS and limited generation.
	Thermal generating units are eligible to retire after two years (from 2016–17) and after 80% of their technical life.	Coal generating units can retire at any time.	There is no need to differentiate between thermal generating units that reach 80% of their technical life. All thermal generating units are allowed to retire in response to reduced consumption.
	Retirement costs assumed as estimated by ACIL Allen.[15]	No retirement costs.	Inclusion of retirement cost data improves the model by better reflecting the expected costs associated with retiring generating units.
	Wallerawang Unit 7 retired from service.	Wallerawang generating Unit 7 in service.	Wallerawang Unit 7 is retired from service and is not modelled. This improves modelling accuracy.
LRET	41,000 GWh LRET target and interim targets as currently legislated, terminating in 2030. No LRET after 2030.	From 2015-16, the LRET increases until it reaches 41,000 GWh in 2020-21. The model reflected that the target would continue perpetually.	This reflects the current LRET and improves modelling accuracy.[16] The impact is that less wind generation is forecast and existing generation meets a larger proportion of consumption.

[13] Further information is available in Section 5.1 of the 2014 Planning and Forecasting Scenarios. Available on AEMO's website at: http://www.aemo.com.au/Electricity/Planning/~/media/Files/Other/forecasting/2014_Planning_and_Forecasting_Scenarios.ashx. Viewed: 20 November 2014.

[14] Further information is available at: http://www.aemo.com.au/Electricity/Planning/Related-Information/Generation-Information. Viewed: 20 November 2014.

[15] Further information is available at: http://www.aemo.com.au/Electricity/Planning. Viewed: 20 November 2014.

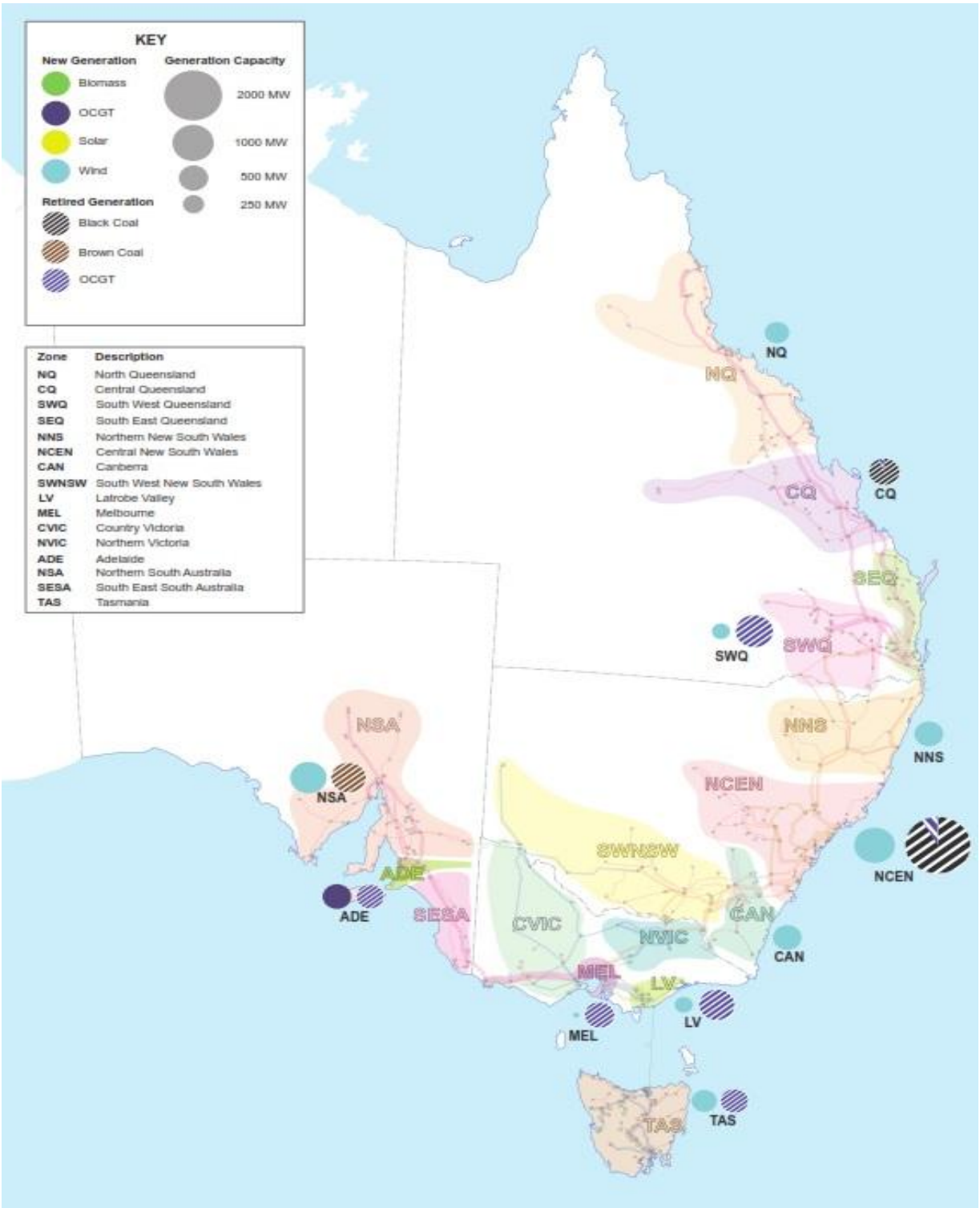
[16] Further information is available at: https://retreview.dpmc.gov.au. Viewed: 5 November 2014.

Key modelling assumptions	2014	2013	Reason and impact
	The LGC banked surplus was included. This was 29,553,111 on 1 September 2014. The model assumes the banked surplus is used in the next six years, that is, by the end of 2019–20.	In the model, the LRET commenced from 2015–16. From 2012–13 to 2014–15, the LRET did not have an impact.	This improves modelling accuracy since it is more realistic to take into account the impact any LGC surplus might have on deferring renewable generation investment.
	Until 2029–30, REC penalties are paid for shortfalls at a nominal price of $93 (2014–15 dollars and post-tax), AEMO derived real term prices using a consumer price index of 2.2%.	The REC target could not be violated, that is, liable entities would purchase LGCs to meet their annual requirement irrespective of the penalty price.	Changing market dynamics, such as lower spot prices and a relatively low LGC market price, are expected to contribute to some liable entities deciding to pay penalties instead of purchasing LGCs. Given this, the model includes REC penalties until 2030 when LRET expires.
	A low scenario was used for GreenPower[17] and no desalination trace included.	A medium scenario was used for GreenPower and a desalination trace used.	The change is based on market information on GreenPower sales. The total renewable energy target (including GreenPower sales) is about 3,000 GWh less in 2014 compared to 2013.
	First model year is 2015–16.	First model year is 2014–15.	No need for retrospective modelling of generation expansion.
Special constraint limits	New South Wales, there was a 400 MW generation expansion limit in 2018–19. Beyond 2018–19 no limits were applied.	Not applicable.	This is applied in New South Wales to reflect publicly-announced projects. This ensured New South Wales generation expansion was realistic given lead times on projects
	Queensland, unchanged in the South East Queensland zone.	In the South East Queensland zone, a limit of 1,200 MW is imposed on all new generation. In the North Queensland zone, an 800 MW limit is imposed on OCGT generation.	This limits the amount of generation the model seeks to build within this region.
	Victoria, none.	500 MW limit for GPG in the Melbourne zone.	Not applicable.
	No constraints applied in South Australia.	1,350 MW limit for wind generation expansion in South Australia and a constraint that ensures a minimum of 500 MW GPG is always available.	Not applicable.

[17] Further information is available at: http://www.greenpower.gov.au. Viewed: 28 November 2014.

APPENDIX B. LOCATION OF NEW AND RETIRED GENERATION

Figure 4 New and retired NEM generation by 2038–39



MEASURES AND ABBREVIATIONS

Units of measure

Abbreviation	Unit of measure
$	Dollar
GWh	Gigawatt hour
MW	Megawatt
MWh	Megawatt hour
TWh	Terawatt hour

Abbreviations

Abbreviation	Expanded name
AEMO	Australian Energy Market Operator
GPG	Gas-powered generation
GSOO	Gas Statement of Opportunities
LGC	Large-scale generation credit
LRET	Large-scale Renewable Energy Target
NEM	National Electricity Market
NEFR	National Electricity Forecasting Report
NER	National Electricity Rules
NTNDP	National Transmission Network Development Plan
OCGT	Open-cycle gas turbine
PV	Photovoltaic