GREENPEACE

More expensive, more pollution

The impact of the NEG on carbon emissions and power prices

20 July 2018

Overview

Greenpeace Australia Pacific commissioned Reputex to model the impact of the proposed National Energy Guarantee (NEG) on Australia's carbon emissions and on National Electricity Market (NEM) wholesale prices by 2030 under the government's **26 per cent** emissions reduction target and a higher **45 per cent** target.

Our research shows that the government's plan **fails on emissions and it fails on power prices.**

Malcolm Turnbull's NEG will do nothing to lower Australia's carbon emissions, and it will raise power prices by about a quarter compared to a more ambitious 45 per cent target.

Key findings

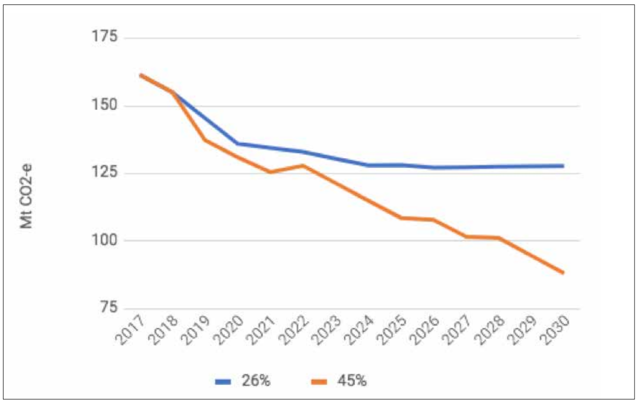
The NEG will do nothing to reduce carbon emissions.

Current policy scenario (26 per cent NEG)

- The National Electricity Market is on track to exceed a 26 per cent emissions target under current policy
- A **26 per cent NEG** will have a 'negligible impact in driving any new renewables investment' over and above current policy
- The **NEG is therefore a failure** when it comes to reducing Australia's carbon emissions.
- Under current policy, a 26 per cent reduction target for emissions from electricity (to **130 million tonnes** of CO2-e per annum) will be met by 2024
- 42 per cent of generation will be derived from renewable energy sources in 2030 under current policy, compared with the 32-36 per cent modelled by the ESB

45 per cent NEG scenario

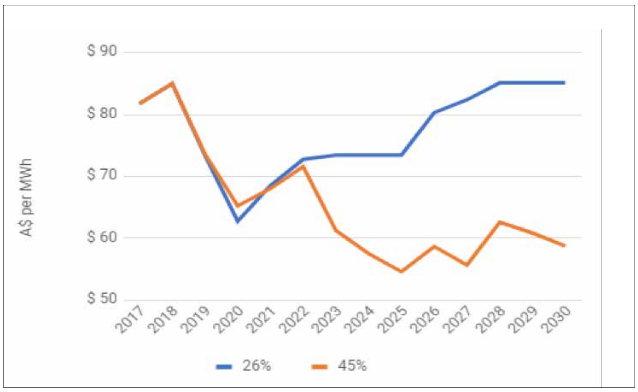
- Under a **45 per cent target**, electricity sector emissions will fall to **88 million tonnes** of CO2-e per annum by 2030
- Coal would be limited to around 40 percent of the energy mix, leading to renewable energy capacity growing to 35 GW by 2030
- This would mean that under a 45 per cent electricity emissions reduction target **50 per cent of electricity generation would come from renewables by 2030**



NEM emissions – 26% NEG target vs. 45% NEG target in 2030. Source: RepuTex Energy, 2018

The NEG will lead to higher electricity prices

- The NEG with a 26 per cent target will mean **higher wholesale electricity prices** by 2030 compared to a more ambitious 45 per cent target
- A **26 per cent NEG** will push wholesale power prices above $80 per MWh by 2030
- In contrast, a 45 per cent target will drive wholesale prices lower, to just below **$60 per MWh by 2030.** This is because a higher target will create a constraint on coal-fired emissions, bringing in more cheap solar and wind energy into the NEM



Electricity price scenarios (all regions) – 26% NEG target versus 45% NEG target
Source: RepuTex Energy, 2018

Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

For more information contact:
support.au@greenpeace.org

Greenpeace Australia Pacific
Level 2, 33 Mountain Street
Ultimo NSW 2007
Australia

Greenpeace Australia Pacific Ltd
ABN: 61 002 643 852

greenpeace.org.au

Market Study | July 2018

THE IMPACT OF THE NEG ON EMISSIONS AND ELECTRICITY PRICES BY 2030

Modelling for Greenpeace Australia Pacific

RepuTex ENERGY

ABOUT THIS REPORT

THE IMPACT OF THE NEG ON EMISSIONS AND ELECTRICITY PRICES BY 2030

Contents

BACKGROUND

The National Energy Guarantee (NEG) proposes to establish two obligations on retailers, consisting of a 'reliability guarantee' - imposing an obligation to meet a percentage of load requirements with flexible and/or dispatchable resources – and an 'emissions guarantee', imposing a requirement on retailers and large users to meet their load requirements at a specified average emissions intensity level.

In June 2018 The Commonwealth Government and the Energy Security Board (ESB) released detailed design proposals for public consultation.

The documents build on design elements set out in April 2018. The most recent updates describe how the proposed reliability and emissions requirements will each be forecast, implemented and enforced. For some elements, design is still under consideration. Comments on the merits of different design options are being sought.

ABOUT THIS REPORT

RepuTex has been engaged by Greenpeace Australia Pacific (Greenpeace) to analyse the impact of the proposed NEG by 2030. Specifically, analysis considers the impact of more ambitious emissions targets under the NEG on wholesale electricity prices.

The focus of this report is the analysis of annual average wholesale electricity price in the National Electricity Market (NEM) under the modelled NEG emissions reduction scenarios.

Analysis initially considers the impact of a 26% emissions reduction target under the NEG by 2030. Given the high levels of committed investment in renewable energy, this may be considered a Base Case view of the NEM under "current national policy" (state & federal).

Scenarios then investigate the impact of a materially different projection assuming higher emissions reduction ambition, including a 45% emissions reduction target in the electricity sector (from 2005 levels) by 2030

Part one of this report provides an introduction to our modelling approach. Part two outlines our modelling assumptions and expectations for new entrant investment and greenhouse gas emissions. Part three presents our electricity price expectations for each scenario.

EXECUTIVE SUMMARY

THE IMPACT OF THE NEG ON EMISSIONS AND ELECTRICITY PRICES BY 2030

THE NEM IS ON TRACK TO EXCEED A 26% TARGET UNDER CURRENT POLICY

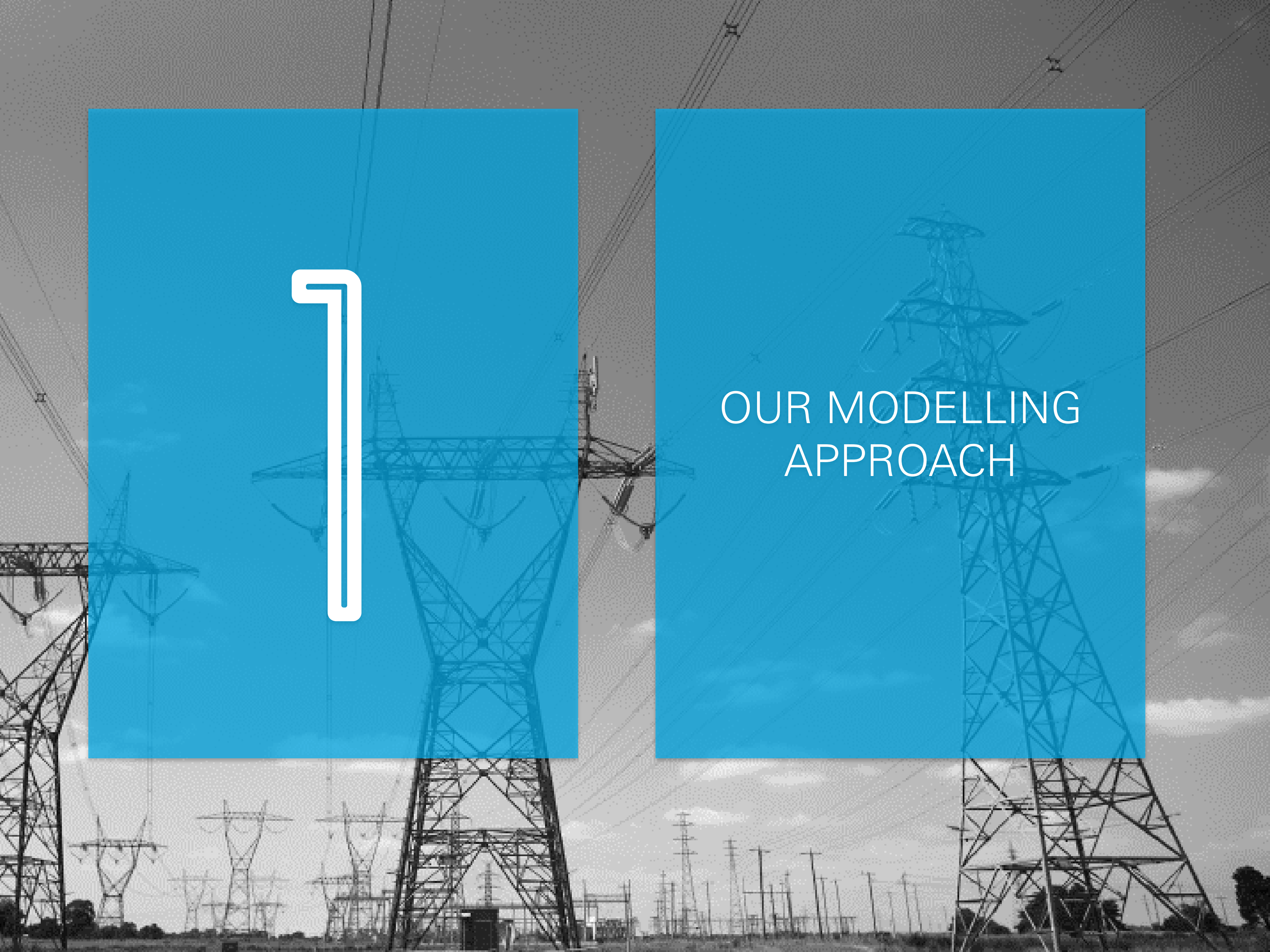
- When the full extent of current committed renewables capacity is considered, along with investment to meet renewable energy targets in Victoria, we estimate a significant increase in new renewable energy capacity in the NEM, growing to around 23 GW by 2030.
- As a result of this investment, we estimate 42 per cent of generation will be derived from renewable energy sources in 2030 under "current national policy", more than the 32-36 per cent modelled by the ESB.
- Modelling indicates that renewable energy investment, and emissions reductions, are therefore likely to more advanced under current policy than modelled by the ESB, with a 26 per cent reduction (130 Million tonnes of CO_2-e per annum or Mtpa) met by 2024, 5 years earlier than forecast by the ESB (2029).
- As a result, the NEG is modelled to have a negligible impact in driving any new renewables investment beyond this level.

TARGET SCALE UP WILL DRIVE RENEWABLE INVESTMENT

- In contrast to a 26% NEG, a 45% emissions guarantee would imply a constraint on coal-fired emissions, which would limit coal to around 40 per cent of the energy mix by 2030.
- This would provide a signal for additional investment in clean energy, characterised by the projected build-out of low-cost clean energy facilities as more than 22 GW of solar and wind capacity is added to the NEM.
- This would result in renewable energy capacity growing to around 35 GW by 2030, or 50 per cent of generation in 2030.

INCREASED RENEWABLES CAPACITY TO DRIVE ELECTRICITY PRICES LOWER

- Under a 26% NEG, electricity prices are forecast to fall through to 2020 as more than 6 GW of renewable energy investment enters the NEM under the LRET. Increased competition will see average prices become less influenced by high priced gas, falling toward $60 MWh in 2020.
- Although some new renewable energy continues to be supported after 2020, underpinned by demand from corporate Power Purchase Agreements (PPAs) and the Victorian Renewable Energy Target (VRET), annual additions are projected to be small relative to pre-2020 levels.
- The result is the continuation of a coal-dominated market with a fairly static picture for large-scale renewables investment, as gas provides flexibility to meet evening ramp ups.
- As a result wholesale electricity prices rise above $70 per MWh after the closure of Liddell, and above $80 per MWh after the expected retirement of Yallourn in 2028.
- In contrast, a 45% emissions guarantee would imply a constraint on coal-fired emissions, while providing a signal for additional investment in clean energy. Similar to the price decline under the 26 per cent scenario prior to 2020, the competitive pressure from higher solar and wind energy is modelled to push wholesale prices lower.
- As a result wholesale electricity prices are projected to oscillate around $60 per MWh through to 2030, rather than rise above $80 per MWh as seen under the low investment scenario under a 26% NEG.



1

OUR MODELLING APPROACH

OUR ELECTRICITY MARKET MODEL

ANALYSIS OF THE NATIONAL ENERGY GUARANTEE BY 2030

OUR NEMRES ELECTRICITY MODEL

In delivering this project, we utilise our proprietary model for the National Electricity Market and renewable energy system (NEMRES), which replicates the operation of AEMO's dispatch engine by simulating market behaviour and supply-demand conditions across the NEM.

Various rules, laws and policies govern the operation of the NEM, with the key elements being supply and demand, connected by the electricity network. The supply side is comprised of fossil fuel and renewable generators which offer generation capacity based on their own economic decisions, dispatched by AEMO from the cheapest to more costly generator, subject to system conditions, to meet demand.

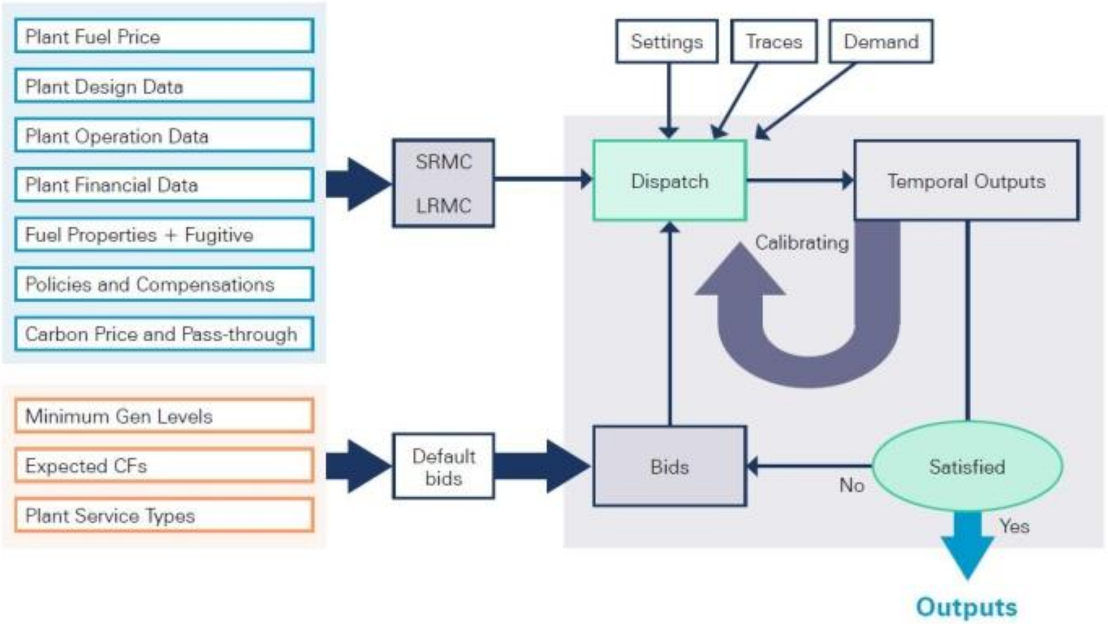
Demand is affected by a number of factors such as weather, economic activities, population, etc. Although demand for power has patterns, it remains mostly unplanned and highly inelastic over the short term. System operators rely on demand forecasting for the daily market operation and long term planning.

NEMRES simulates the NEM least cost dispatch process and supply and demand conditions in the forecast periods, modelling the resulting generation and emissions from each of the scheduled generation plants. Contracts between generators and retailers/large users impact the percentage of electricity subject to bidding behaviours and spot price revenue.

NEMRES explicitly models all scheduled power plants, while also allowing for non-market and non-scheduled plants.

Figure 1 outlines the main model components and model process flows. The central component of NEMRES is the least cost dispatch model, which dispatches the generation of plants based on default bids adjusted to each generators most recently observed patterns.

Figure 1 – RepuTex NEMRES modelling process



For each dispatch interval, bids are optimised for individual facility profitability. Hydro generation is allocated by model based on historical inflow and the proportion of run-of-river generation and storable hydro energy.

As shown, the input data preparation and model calibration are important blocks, supported by a number of criteria in checking the validity of model outputs, including cross checks against the closing facilities projected to be the least profitable, and the feasibility of new entrants in a given region.

OUR ELECTRICITY MARKET MODEL

ANALYSIS OF THE NATIONAL ENERGY GUARANTEE BY 2030

MERIT ORDER MODEL

A merit order is constructed via the bids offered by all fossil fuel plants. The algorithm orders the price bands offered by plants from the least to highest and accumulates the quantities of corresponding price bands accordingly.

BIDDING MODEL

The bidding model constructs four default price and quantity pairs. All the price and quantity pairs are in percentage of the cost and available capacity of each plant except the price in the first band, which is fixed at $0 per (MWh). The first band of a bid applies to plant-level minimum generation. The second band applies to short-run marginal cost (SRMC) and the third to long-run marginal cost (LRMC). The last band is related to the value of lost load (VOLL).

The quantity is the percentage that a plant is willing to offer to the market at above given prices. The quantity is incremental, in that the sum of the four quantity components must be 100 per cent. The quantity at the SRMC cost is related to the contract level, while the quantity at the LRMC may be allocated to the normal design level less the amount that has already been allocated in the previous price bands. The last band can be thought as opportunity or gaming bids.

There are two default bidding formats. Long-term forecasting calculates dispatch on annual demand duration curve. High precision forecasting uses half-hourly dispatch against half-hourly load..

COST MODEL

The cost of a generator depends on a number of factors: plant characteristics such as plant efficiency/heat rate, plant auxiliary usage, fuel cost, fuel combustion emission factor, variable operating & maintenance (VOM), fixed operating & maintenance cost (FOM), etc. The SRMC and LRMC are calculated by summing each cost components as shown in Figure 2.

To calculate per MWh cost of the fixed cost, a capacity factor is assumed for each plant. This may have impacts on dispatch outcomes. Bids may be adjusted based on plant profitability. Annual profit is calculated as total revenue from the sent-out energy + fixed subsidies less the variable cost associated with per MWh generation and less the annual fixed cost.

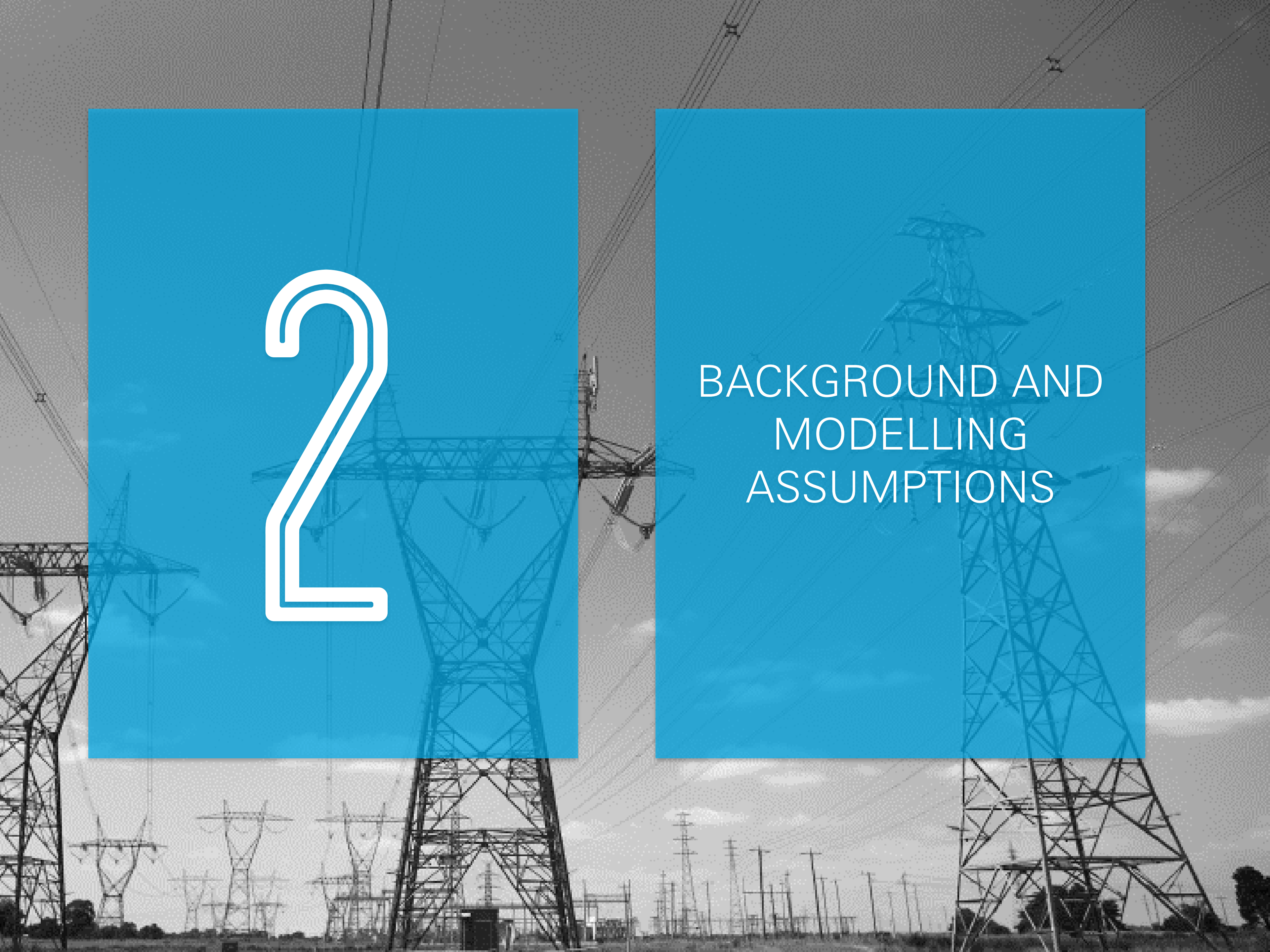
Figure 2 – Plant Level Generation Cost

	Cost Component		Factors in Cost Component
SRMC	Fuel cost	⟵	Heat rate + fuel price + CPI factor
	Fuel carbon cost	⟵	Fugitive emission pass through + permit price + CPI factor
	VOM	⟵	RepuTex data or as provided + CPI factor
	Emissions cost	⟵	Heat rate + fuel combustion emissions factor+ carbon capture + permit price
	Subsidies	⟵	
+			
Fixed cost	FOM	⟵	RepuTex data or as provided + expected capacity factor
	Capital cost	⟵	RepuTex data or as provided + expected capacity factor
	Subsidies	⟵	Free permits + permit price + expected capacity factor
=			
LRMC			

DEMAND TRACE MODEL

Annual forecast demand comes with three numbers for the NEM. One is for annual energy and the other two are for maximum load in the winter and summer seasons. Annual load is chosen to allocate forecast demand into finer time scales. RepuTex aims to mimic the operation of the NEM over 200 periods per year, equivalent to averaging demand over 1.8 days. Once the load shape in a particular historical period is chosen, the Demand Trace Generator can produce a demand trace matching the historical shape and forecasted energy target and the maximum load in the winter and summer season.

Weekends and public holidays load profiles are checked and matched as required. Forecasted demand for scheduled and semi-scheduled generation is used as only scheduled and semi-scheduled plants are modelled.



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BACKGROUND AND MODELLING ASSUMPTIONS

THE NATIONAL ENERGY GUARANTEE

RECENT UPDATES TO THE DESIGN OF THE NEG

RELIABILITY GUARANTEE

The NEG is proposed to require electricity retailers and large customers to own or contract electricity that meets separate targets for reliability and GHG emissions. These targets are intended to drive investment in generation facilities that maintains the reliability of the energy system while at the same time reducing emissions.

Retailers and large customers will be required to meet a percentage of their forecast peak load with flexible and dispatchable resources. Dispatchability may include any form of technology, generation, batteries or demand that can respond to a request by the operator to increase or decrease output over a defined period.

The amount and type contracted would be based on the system wide reliability standard as determined by the Reliability Panel (AEMC), translated by AEMO into a regional factor. This would set the minimum level and type of dispatchable capability the system requires.

At the beginning of the compliance period retailers and large users would be required to provide evidence that their contract positions meet the need for dispatchable resources, or the reliability guarantee.

The requirement for flexible capacity is proposed to be dynamic, varying over each dispatch period as the generation mix, customer demand and network situation changes.

EMISSIONS GUARANTEE

In addition to the reliability guarantee, an emissions guarantee will translate an emissions target for the electricity sector into a requirement for retailers and large users to meet their load requirements at an average emissions level.

This is proposed to be a 26 per cent reduction on 2005 levels by 2030, locked in for a period of 10 years (subject to any future legislative change).

Retailers would disclose how they have met their guarantee either through contracts with existing generators or to develop new capacity. As with the reliability guarantee, retailers and generators would enter into contracts for the supply of energy at a certain emissions level. These contracts between the retailer and generators would specify an amount of energy over a particular time and an emissions level at which that energy will be delivered.

The first 50,000 MWh of a market customer's load is proposed to be exempt from the emissions reduction requirement. All emissions intensive trade exposed (EITE) activities that are exempt from the requirements of the RET will also be eligible for exemption from the emissions reduction requirements of the NEG.

The Government is considering whether and how Australian Carbon Credit Units (ACCUs) may be used as a flexible compliance option to meet NEG emissions reduction requirements.

This may be capped to preserve any investment signal provided by the NEG and give certainty to emissions reductions the electricity sector would contribute (not purchase from other sectors).

The consultation paper suggests that this could be 5 to 10 percent of emissions reductions, with mechanisms for adjustments either annually or at the 5-yearly review of the target.

INTERACTION WITH STATE TARGETS

States and territories are able to pursue their own renewable energy targets, however these must not affect GHG emissions targets that would operate under the NEG.

In addition, state renewable energy targets that imply greater ambition out to 2030 than the proposed national emissions reduction trajectory under the NEG appear unlikely to receive credit for any 'additionality', with activity in all states contributing towards achieving the NEG emissions reduction trajectory.

This may act as a de-facto cap on the investment efforts of states (or companies and retailers) to go beyond legislated targets, however state RET schemes are expected to remain in place, notably in the ACT, Queensland and Victoria.

INITIAL ESB MODELLING OF THE NEG

MODELLING OF BUSINESS AS USUAL BY THE ESB

INITIAL MODELLING OF BUSINESS AS USUAL EMISSIONS UNDER THE NEG

In November 2017 the ESB provided the Commonwealth with initial modelling on the operation of the NEG and its impacts on the NEM.

Analysis considered emissions under business as usual (referred to as a 'do nothing' scenario), representing a "a plausible future for the electricity market, in the absence of any further reliability policies or emissions reduction policies being introduced". The objective of the modelling was to provide a reference case from which the relative performance of the NEG policy may be measured under a 26 per cent emissions target.

ESB base case input assumptions included:

» Current federal policy – i.e. the conclusion of the LRET in 2020 (33 TWh to 2030)

» The retirement of Liddell in 2022-2023 while 2 GW of Snowy 2.0 generation and pumped hydro begins in 2023-24.

» Operational demand of 185,000 GWh in 2030

» A$59-107/MWh in 2020 for wind; A$70-97/MWh for solar.

» Investment under state auctions limited to initial rounds (400MW QLD, 650MW VIC).

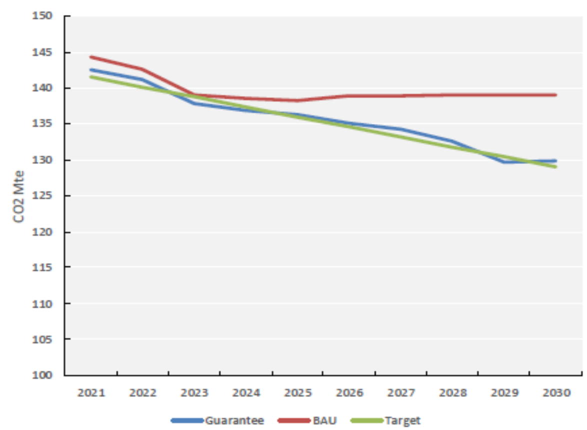
» No additional capacity was assumed to be encouraged by current state polices.

Announced state renewable energy targets in Victoria (VRET) and Queensland (QRET) were therefore assumed to include only investment committed via initial renewable energy auction rounds already undertaken, with no additional capacity to meet targets in those states.

In line with these assumptions, ESB modelling indicated that BAU emissions will fall from 144 Mt in 2021 (or 16 per cent below 2005 levels) to 139 Mt in 2030, to 19 per cent below 2005 levels, a shortfall of around 10 Mt to the 2030 target.

This outcome was driven by increasing renewables capacity under the LRET, with 31 per cent of generation projected to come from renewables in 2030 (including hydro), while 23 per cent will be derived from wind and solar.

Figure 3 (ESB): Emissions under BAU versus NEG



MODELLED IMPACT OF THE NEG

ESB modelling projected that a NEG of 26 per cent would result in 36 per cent of generation in 2030 being derived from renewables, with 28 per cent attributed to intermittent renewables, an increase of 5 per cent from BAU estimates.

ESB modelling assumed committed capacity of 8 GW - underpinned by around 5 GW of capacity under the large-scale renewable energy target (LRET), approximately 1 GW via the Queensland and Victoria renewable energy auctions and 2 GW from the Snowy 2.0 scheme.

In line with the ESB's assumptions, a 26 per cent target under the NEG was modelled to drive 3-4 GW of new renewable capacity (to meet the target). Assumptions for current committed capacity therefore drive modelling outcomes, with the NEG meeting the projected shortfall.

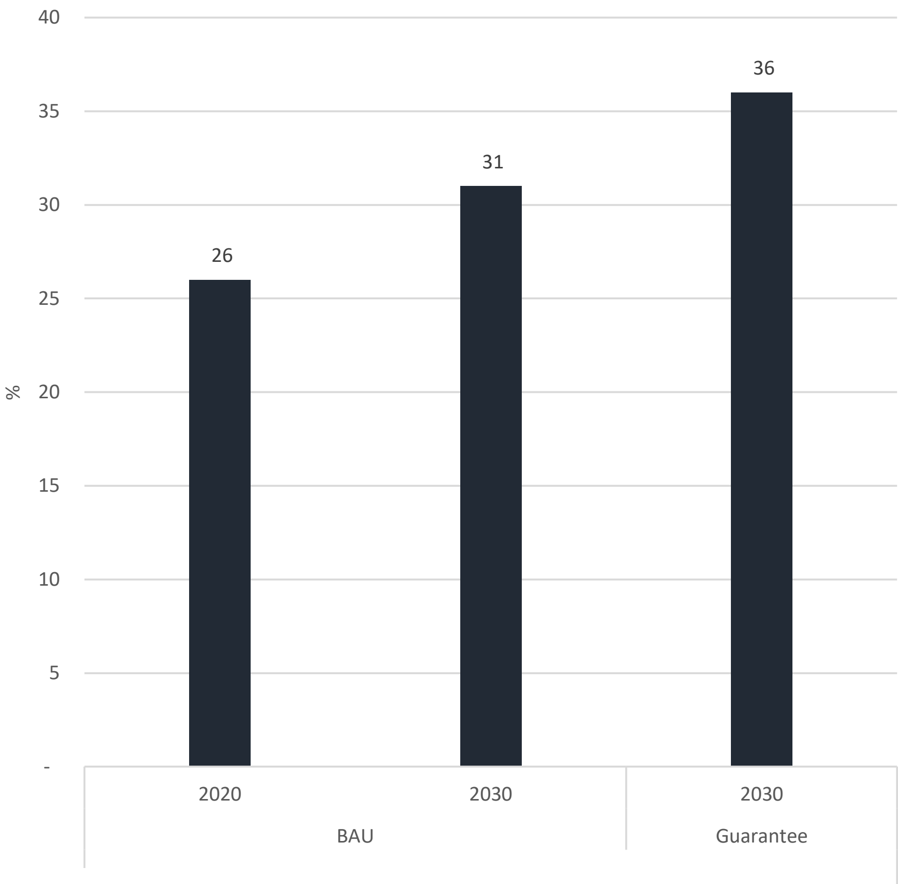
While a shortfall was modelled to exist in the reference case, this appears to understate the current investment pipeline. For example, over 6 GW of renewable projects are already committed - 3 years ahead of the ESB projection (Figure 3, over page) - while further investment is expected under S-RET schemes in Queensland and Victoria.

This is expected to fill any shortfall to the 26 per cent target, suggesting a business as usual pathway will result in emissions falling below the proposed sectoral target for the NEG.

INITIAL ESB MODELLING OF THE NEG

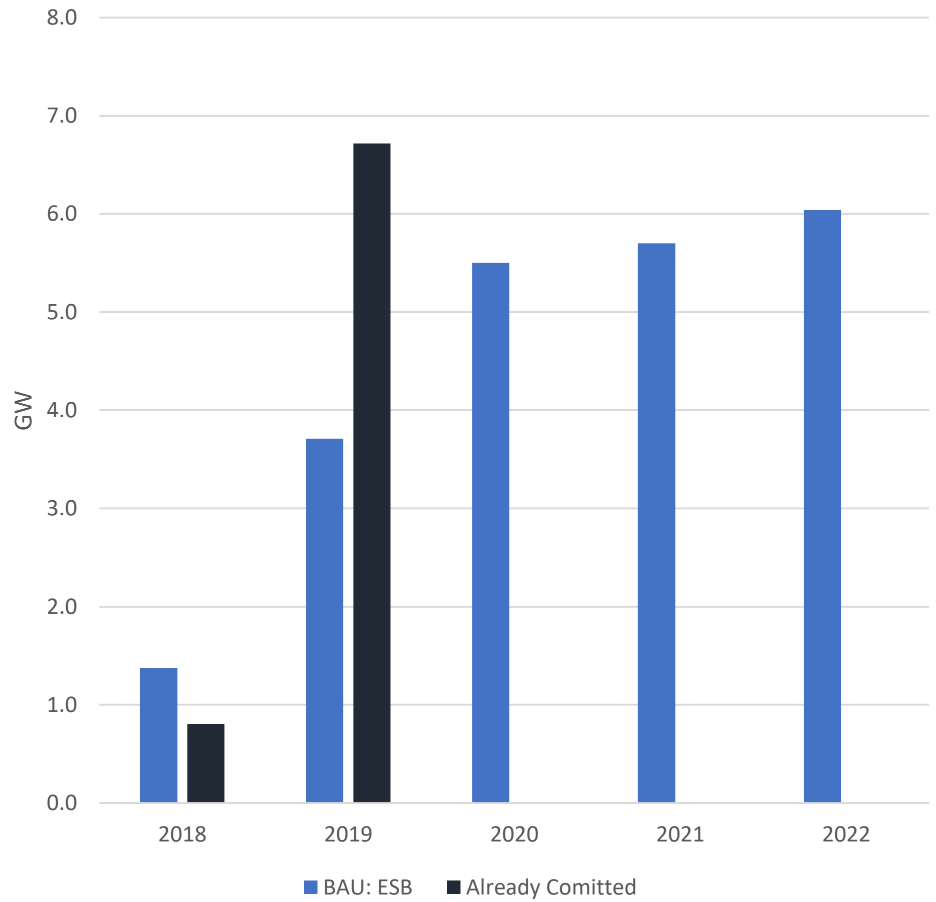
ASSUMED COMMITTED RENEWABLE ENERGY CAPACITY

Figure 4: Percentage penetration of renewable energy by 2030 (ESB)



Source: ESB, 2017

Figure 5: Entry of Cumulative Renewable Generation Capacity by Year



Source: ESB, 2017, RepuTex Energy, 2018

MODELLING ASSUMPTIONS

THE IMPACT OF THE NEG ON EMISSIONS AND ELECTRICITY PRICES BY 2030

MODELLING SCOPE

The scope of this research is the analysis of the impact of more ambitious emissions targets under the NEG on greenhouse gas emissions reductions and wholesale electricity prices.

The focus of this report is the analysis of annual weighted average wholesale electricity price for all states under proposed NEG emissions reduction, with discussion of GHG emissions implications.

Analysis initially considers the impact of a 26% emissions reduction target under the NEG by 2030. Given the high levels of committed investment in renewable energy, this may be considered a Base Case view of the NEM under "current national policy" (state & federal).

Specifically, analysis considers two different emissions reductions scenarios:

1. A 26% emissions reduction target in the electricity sector from 2005 levels by 2030;
2. A 45% emissions reduction target in the electricity sector form 2005 levels by 2030;

KEY ASSUMPTIONS

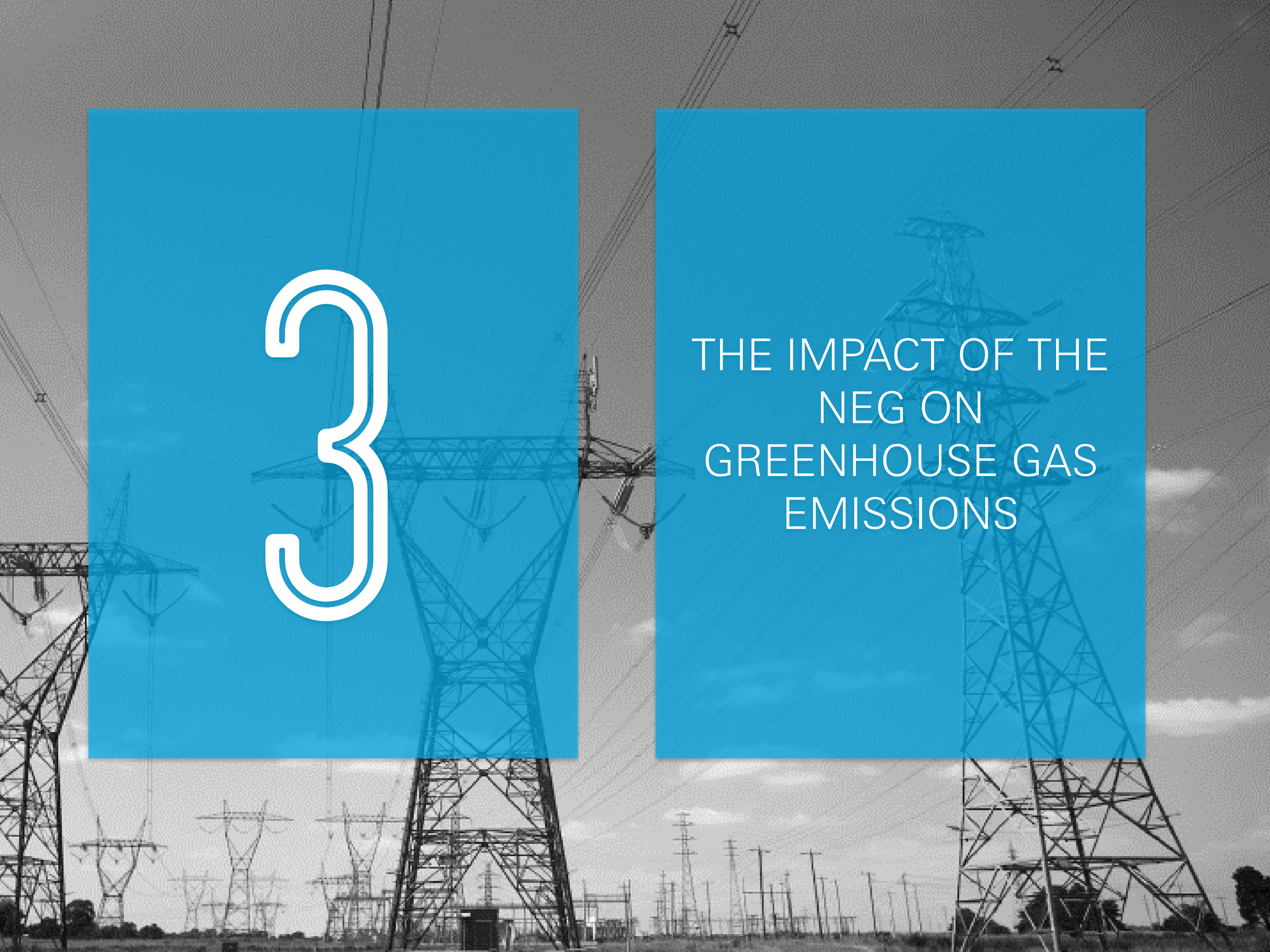
Given the ESB did not consider the full extent of current committed capacity, or further investment to meet the Victorian renewable energy target, we consider these assumptions within our analysis. This provides an alternate Base Case to earlier ESB analysis, which we believe is more reflective of current national policy (state and federal). Key assumptions include:

- AEMO Electricity Forecasting Insights – March 2018 update: Neutral annual consumption scenario, released in March 2018.
- Announced generation retirements, e.g. Liddell is assumed to retire by 2023.
- Reliability is assumed to be maintained under the NEG reliability guarantee if the energy only market cannot be relied on to ensure enough supply to prevent unserved energy risk exceeding standards.
- Current federal policy – i.e. the conclusion of growth in the LRET in 2020 (33 TWh to 2030)
- Analysis includes state renewable energy auctions, based on contracted investment under state auctions held in 2018 (400MW QLD, 650MW VIC).
- In addition, the Victorian VRET scheme is assumed to be met, in line with current legislation.

NEG ASSUMPTIONS

Emissions targets are assumed to apply to the NEM as a whole, and not individual states. Key modelling assumptions include:

- The emissions target trajectory is based on an emissions budget derived from the maximum level of emissions from financial year 2021 to 2030, established by following a trajectory from business-as-usual level emissions in 2020 to a point in 2030 equal to the modelled target.
- NEG modelling first seeks to optimise dispatch for emissions by introducing a shadow carbon price up to the level of fuel switching between black and brown coal. If this is insufficient, the model builds the most economic low emissions generator.
- The emissions budget is used to set the electricity emissions target trajectory such that the emissions budget equals the sum of the electricity emissions targets multiplied by projected electricity demand for the period 2021 to 2030.



3

THE IMPACT OF THE NEG ON GREENHOUSE GAS EMISSIONS

26% TARGET – NEW CAPACITY

THE IMPACT OF THE NEG ON GREENHOUSE GAS EMISSIONS

LRET & STATE POLICY WILL DRIVE BASE CASE RENEWABLE INVESTMENT

When the full extent of current committed capacity is considered (dark blue bars in Figure 5), along with investment to meet renewable energy targets in Victoria, we estimate a significant increase in renewable energy capacity in the NEM, growing to almost 30 GW by 2030, as shown in Figure 4 (over page).

Around 0.8 GW of utility-scale renewables has already been commissioned in 2018, with 6 GW estimated to be completed in the next 12 months. Together this represents 6.8 GW of renewables capacity added to the NEM by the end of 2018.

In addition, the legislated Victorian renewable energy target calls for approximately 1.5 GW of additional investment in large-scale renewable energy capacity. The announced target in Queensland (not legislated or binding) is not considered beyond its initial auction round.

Including other capacity for managing reliability (up to 4 GW), this would represent over 12 GW of new capacity investments under current policy, prior to the introduction of the NEG, suggesting that clean energy investment is unlikely to stagnate over the longer term, as favourable economics continue to provide a robust signal for investment.

Should small-scale technologies be included in the analysis, we estimate an additional 14 GW of capacity may be added to the market by 2030.

As a result of this investment, we estimate 42 per cent of generation will be derived from renewable energy sources in 2030 (Figure 7), derived from current national policy, more than the 32-36 per cent modelled by the ESB.

Given this pipeline, a 26% NEG is modelled to have no impact in driving any new renewables investment beyond this level (refer to slide 16).

IMPACT ON CAPACITY BUILT

Immediate investment to 2020 is predominantly constructed to meet the existing large-scale renewable energy target (LRET).

Committed projects suggest the addition of around 4 GW of wind capacity and almost 3 GW of solar capacity by 2020, driven by continued investment in South Australia and Victoria, with increasing consumption supporting strong wind and solar investment in Queensland.

Up to 5 GW of gas generation capacity is forecast to be built ahead of the planned closure of Liddell by 2022. This is supported by the need to replace both the bulk energy generation and dispatchable capacity of Liddell. Although a mix of renewables, battery storage and demand response (coupled with an efficiency upgrade at Bayswater power station) are developed, modelling suggests that high-efficiency gas remains the least-cost way to provide firm power prior to 2022.

In this scenario, the construction of 'Snowy 2.0' is not required to meet the 26% NEG target.

Small-scale PV capacity grows by more than 10 per cent annually adding the equivalent of 5 GW of capacity by 2024, and continuing to grow to 14 GW of new capacity by 2030.

1.4 GW of wind capacity is added in Victoria by 2025, and continues to add another 0.8 GW in other regions by 2030.

RETIREMENTS

Merit order pressure from new investment in low-cost wind and solar generation is expected to trigger retirements within Australia's aging coal fired fleet. This is modelled to result in more than 3.5 GW of coal retiring by 2030, modelled as Liddell and Yallourn facilities. Liddell's closure is assumed to occur as announced by 2023, while Yallourn is modelled to retire due to increased competition after 2025.

Another 2 GW of excess capacity from non-coal plants results in a net gain of approximately 3 GW of gas capacity by 2030.

Almost all of forecast growth in gross electricity demand is expected to be met by increasing small-scale PV generation, with retiring coal plants replaced by a combination of dispatchable gas, solar and wind, made possible by an increase in capacity from demand response and other flexible storage liked batterie and pumped hydro.

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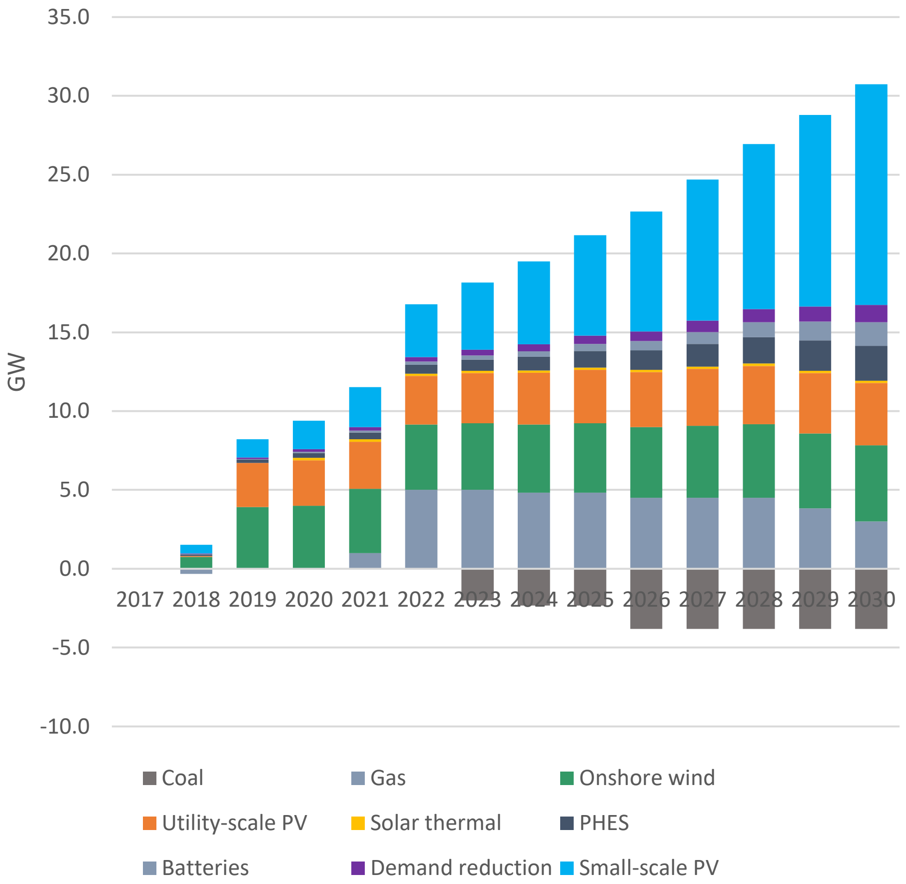
26% TARGET – NEW CAPACITY

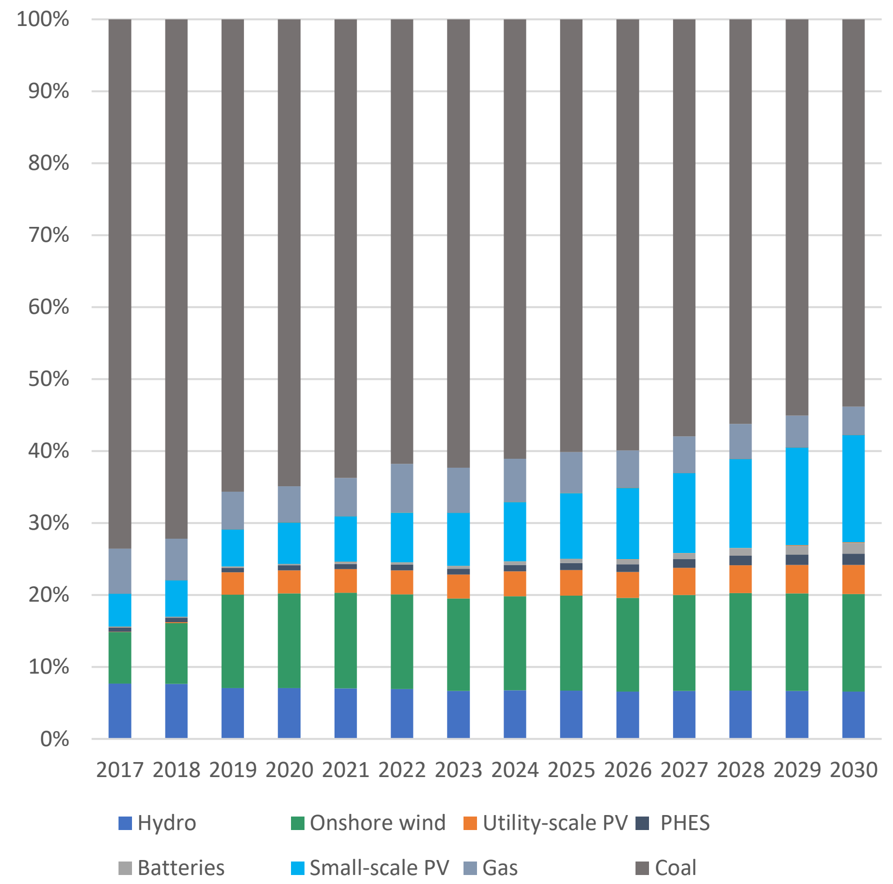
THE IMPACT OF THE NEG ON GREENHOUSE GAS EMISSIONS

Figure 6: Entry and Exit of Cumulative Capacity by Technology Type and Year



Source: RepuTex Energy, 2018

Figure 7: NEM Output of Generation by Technology Type and by Year



Source: RepuTex Energy, 2018

26% TARGET – EMISSIONS

THE IMPACT OF THE NEG ON GREENHOUSE GAS EMISSIONS

IMPACT ON EMISSIONS

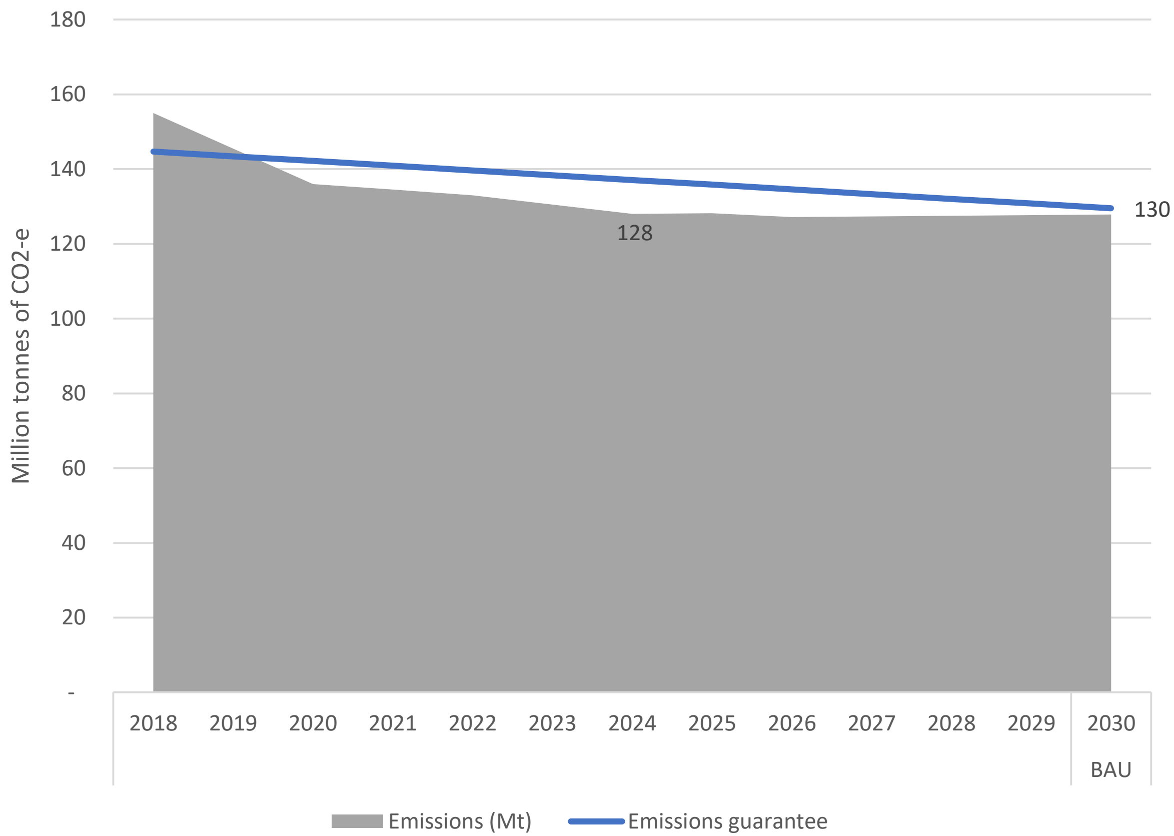
Modelling indicates that renewable energy investment, and emissions reductions, are likely to be far more advanced under current policy than otherwise modelled by the ESB.

As shown in Figure 8, we project NEM emissions will fall to 128 Mt by 2024, or around 27% below 2005 emissions levels. This exceeds the announced emissions target for the NEM of 129.5 Mt CO2-e, or 26% below NEM emissions in 2005 (175.0 Mt).

Given that the level of renewable energy investment is projected to already exceeds the government's 26% target, the NEG is therefore not modelled to drive any new investment in renewable capacity.

While modelling is highly sensitive to assumptions about electricity consumption, which are uncertain, on a pound for pound basis against ESB modelling, analysis indicates that current committed wind and solar capacity and new investment under the VRET will drive enough emissions reductions to exceed the government's target, prior to the implementation of the NEG.

Figure 8: NEM emissions projection – Base Case versus 26% target



Source: RepuTex Energy, 2018

45% NEG TARGET SCENARIO

THE IMPACT OF A SCALED UP TARGET ON NEM EMISSIONS

IMPACT OF A 45% TARGET

Should the emissions guarantee under the NEG be scaled to up to a 45% emissions reduction target (96 Mtpa by 2030), combined with the full extent of current committed capacity and investment to meet the VRET, we estimate a significant increase in new clean power capacity in the NEM, growing to around 35 GW by 2030 (Figure 9 over page). 2030 emissions are projected to fall to 88 Mtpa, which is about 50% below 2005 levels.

The majority of the new capacity in this scenario – 23 GW - is modelled to come from large-scale renewables. As outlined in the 26% scenario, around 0.8 GW of utility-scale renewables has already been commissioned in 2018, with about 6 GW estimated to be completed in the next 12 months. Together this represents 6.8 GW of renewables capacity added to the NEM by the end of the year. In addition, the VRET will call for approximately 1.5 GW of additional investment in renewable energy capacity additions.

Including the net addition of 3 GW of gas, we estimate there could be 26 GW of new net energy capacity under this scenario. With another 7.5 GW of demand response and energy storage. Total supply-side capacity additions may net 33.5 GW.

Should small-scale technologies like PV be included in the analysis, we estimate an additional 12 GW of capacity may be added to the market by 2030 for a total of 45.5 GW of new capacity.

On an energy basis, we estimate 50 per cent of generation will be derived from renewable energy sources in 2030 under this scenario.

IMPACT ON CAPACITY BUILT

In line with a 26% target, immediate investment to 2020 is predominantly constructed to meet the existing large-scale renewable energy target (LRET). Committed projects suggests the addition of around 4 GW of wind capacity and 3 GW of solar capacity by 2020, driven by continued investment in South Australia and Victoria, with increasing consumption supporting strong wind and solar investment in Queensland.

In addition, up to 5 GW of gas generation is forecast to be built ahead of the planned closure of Liddell by 2023, with the construction of 'Snowy 2.0' also assumed to occur.

Demand for more clean energy allows for the addition of more utility-scale PV to be added. Due to its falling costs throughout the decade, almost 14 GW of large-scale PV is added by 2030 in addition to the 12 GW of small-scale PV.

Wind energy also sees major capacity additions with 9 GW of wind capacity is added by 2030, 2 GW of which are modelled to come from offshore wind developments.

RETIREMENTS

Merit order pressure from new investments in low-cost wind and solar generation is again expected to trigger retirements within Australia's aging coal fired fleet. Modelling results in more than 6,600 MW of coal retiring by 2030. Specifically, these include Liddell, Yallourn, Tarong and Vales Point. Liddell's closure is assumed to occur as announced by 2022. Yallourn, Tarong and Vales Point retire due to increasing competition by 2030.

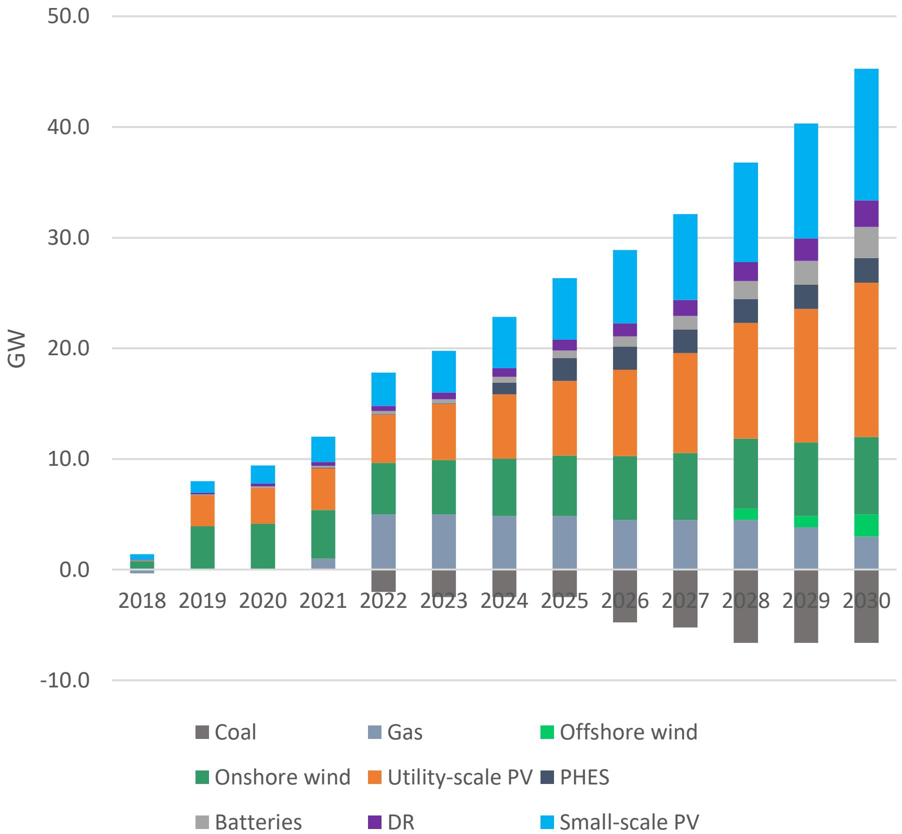
Elsewhere another 2 GW of excess capacity from non-coal plants results in a net gain of approximately 3 GW of gas capacity by 2030.

Almost all of forecast growth in gross electricity demand is expected to be met by increasing small-scale PV generation, with retiring coal plants replaced by a combination of dispatchable gas, solar and wind, made possible by an increase in capacity from demand response and other flexible storage liked batterie and pumped hydro.

45% NEG TARGET SCENARIO

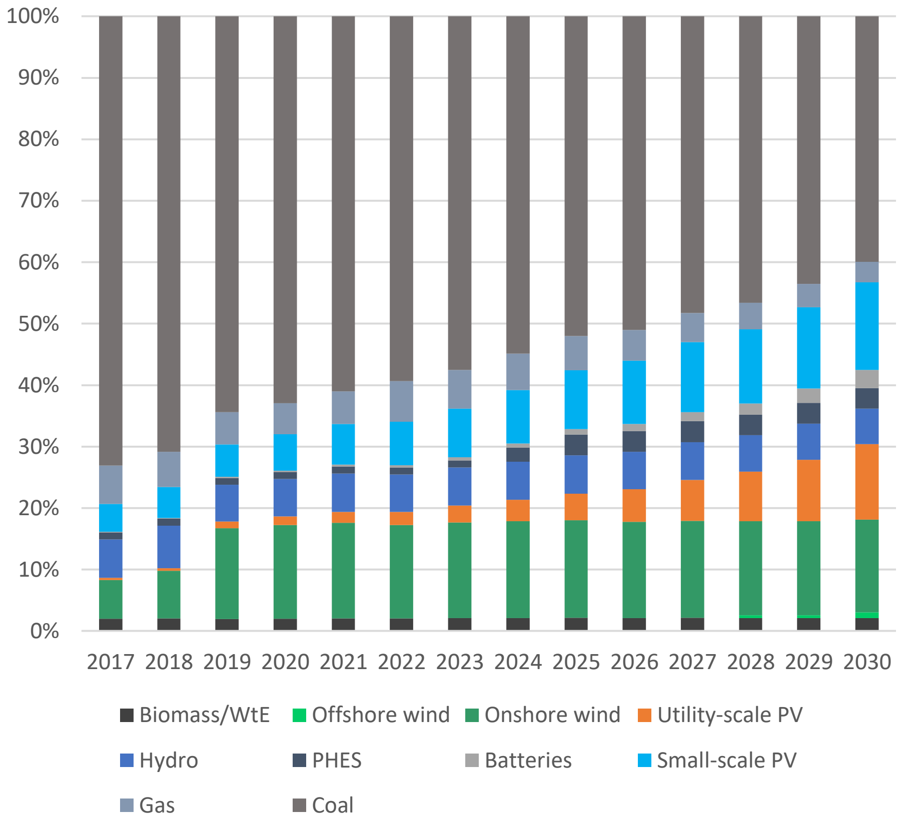
THE IMPACT OF A SCALED UP TARGET ON NEM EMISSIONS

Figure 9: Entry and Exit of Cumulative Generation by Technology Type and Year – 45% NEG target scenario



Source: RepuTex Energy, 2018

Figure 10: NEM Output of Generation by Technology Type and by Year

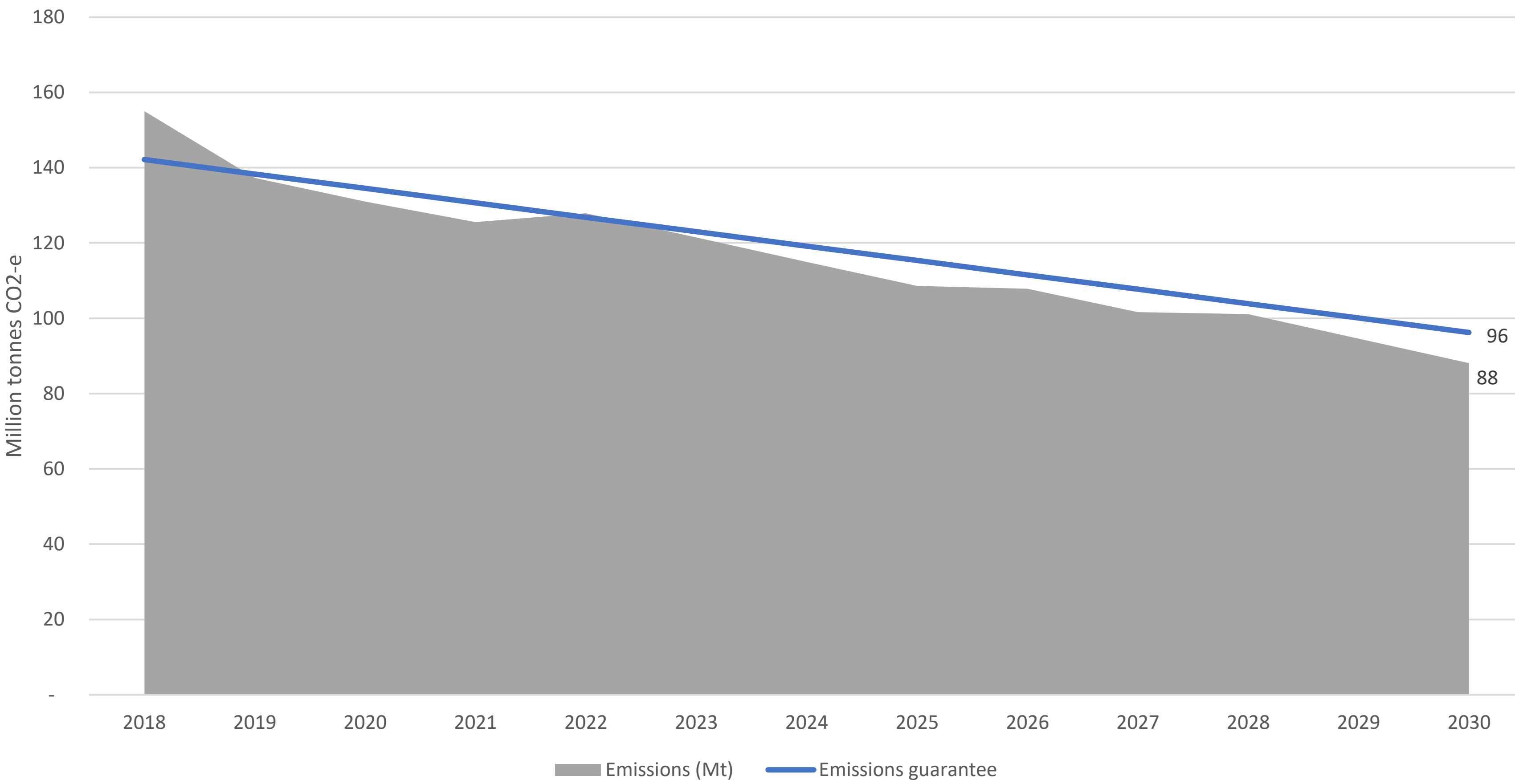


Source: RepuTex Energy, 2018

45% NEG TARGET SCENARIO

THE IMPACT OF A SCALED UP TARGET ON NEM EMISSIONS

Figure 11: NEM emissions under a 45% NEG target by 2030



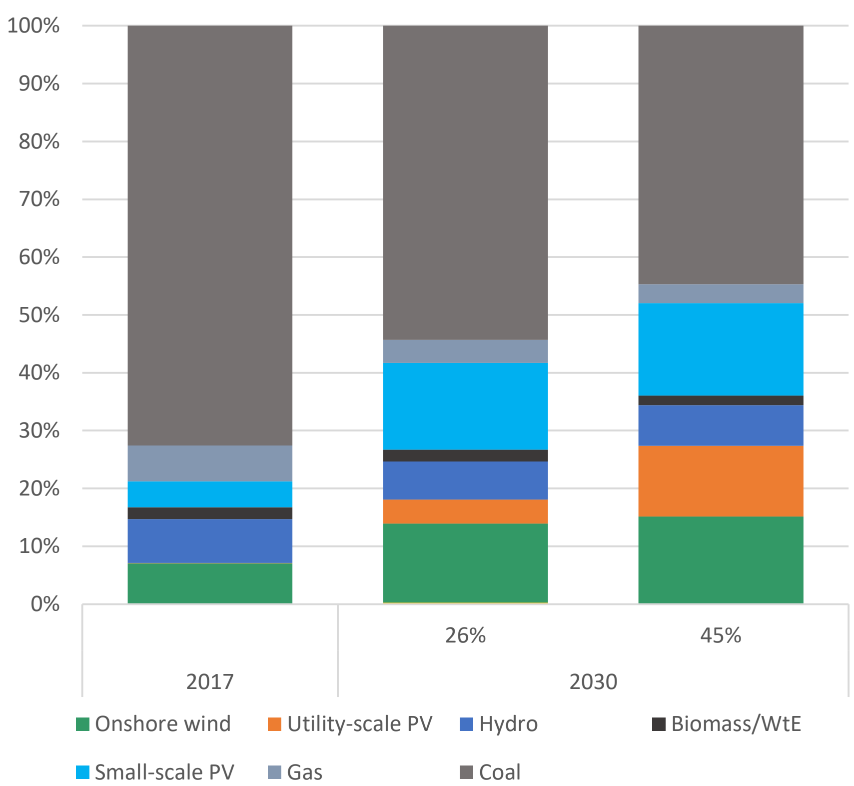
Source: RepuTex Energy, 2018

Source: RepuTex Energy, 2018

ALL SCENARIOS

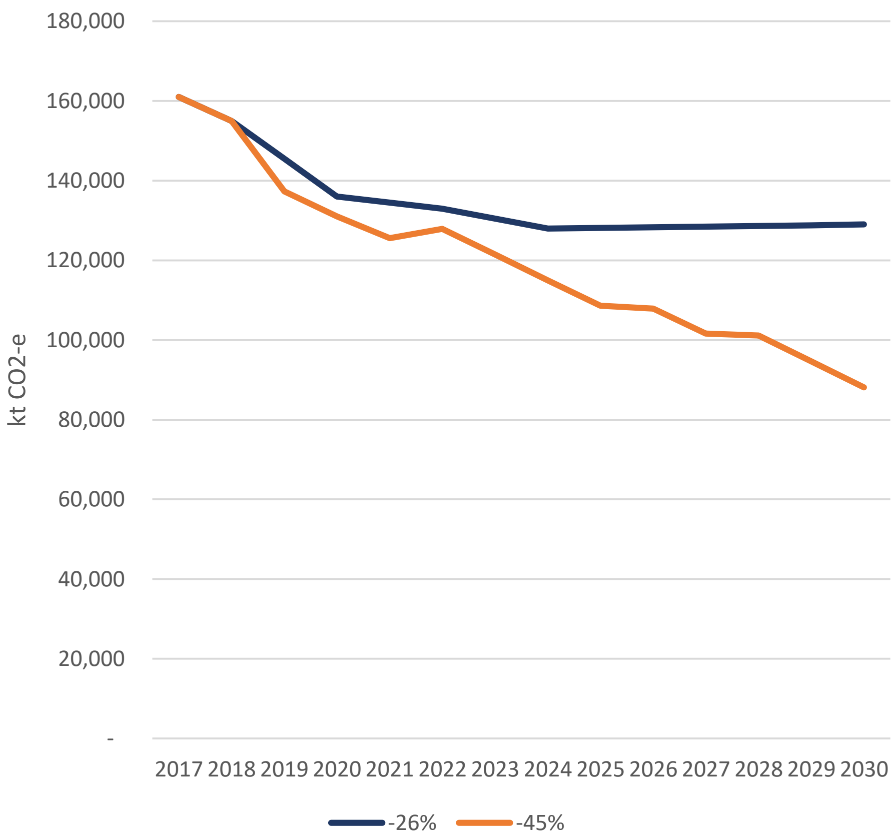
THE IMPACT OF ALL SCENARIOS ON NEM EMISSIONS

Figure 15: NEM generation mix –26% NEG target vs. 45% NEG in 2030

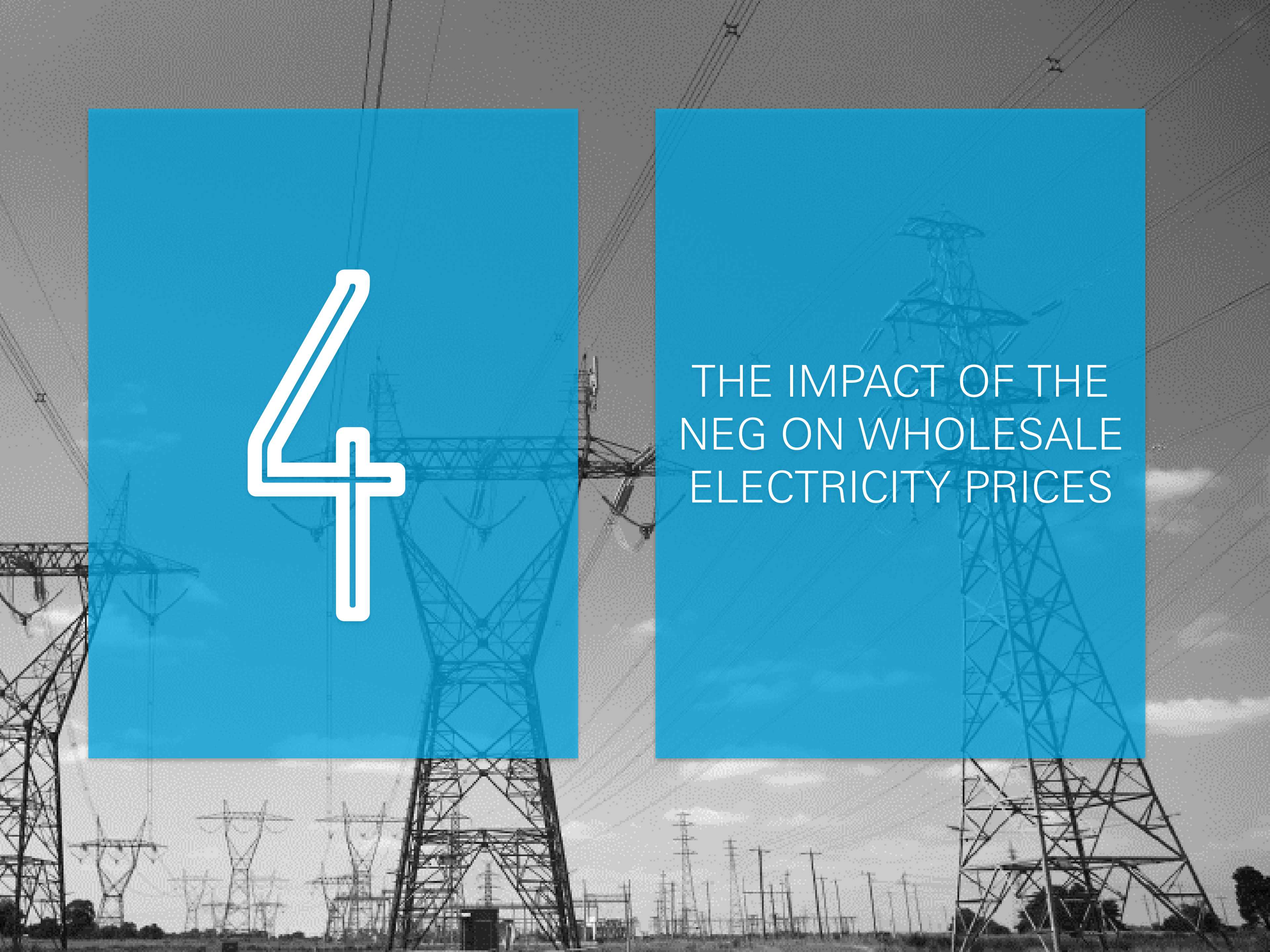


Source: RepuTex Energy, 2018

Figure 16: NEM emissions – 26% NEG target vs. 45% NEG target in 2030



Source: RepuTex Energy, 2018



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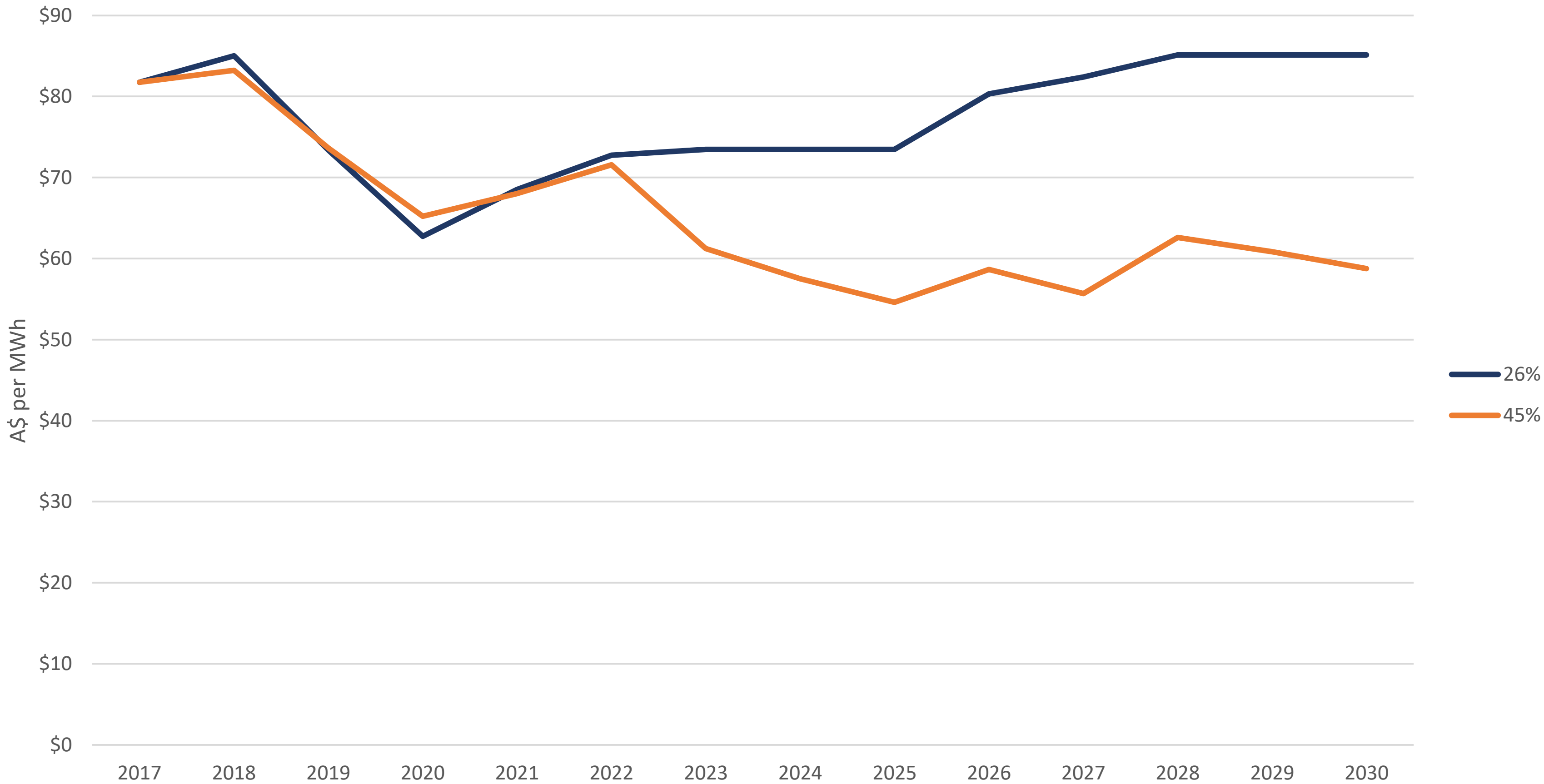
THE IMPACT OF THE NEG ON WHOLESALE ELECTRICITY PRICES

ELECTRICITY PRICE SCENARIOS

THE IMPACT OF EMISSIONS TARGET ON ELECTRICITY PRICES

Figure 17: Electricity price scenarios (all regions) – 26% NEG target versus 45% NEG target



Source: RepuTex Energy, 2018

ELECTRICITY PRICE SCENARIOS

THE IMPACT OF EMISSIONS TARGET ON ELECTRICITY PRICES

26% NEG TARGET SCENARIO

As shown in Figure 15, electricity prices are forecast to fall through to 2020 as more than 6 GW of renewable energy investments enters the NEM under LRET. This is largely due to incentives for renewable capacity under the LRET via the creation of Large-scale Generation Certificates (LGCs), and price signals attributed to the closure of the Hazelwood power station in March 2017.

The increase in low cost solar and wind generation will see the electricity supply steadily become more competitive, with average prices are less influenced by high priced gas, and subsequently falling toward $60 MWh in 2020.

Although some new renewable energy continues to be supported after 2020, underpinned by demand from corporate power purchase agreements and the VRET scheme, these annual additions are projected to be small relative to the significant build before 2020. In addition, the impact of the reliability guarantee is expected to support new gas to meet reserve capacity margins, replacing retiring coal, while meeting peak demand in competition to battery storage and demand response.

The result is the continuation of a coal-dominated market with a fairly static picture for large-scale renewables investment, with gas providing flexibility to meet evening ramp ups. As a result wholesale prices rise above $70 per MWh after the closure of Liddell, and $80 per MWh after the expected retirement of Yallourn in 2028.

45% NEG TARGET SCENARIO

In contrast to a 26% NEG, a 45% emissions guarantee would imply a constraint on coal-fired emissions, which would limit coal to around 40 per cent of the energy mix by 2030. This would subsequently provide a signal for additional investment in clean energy, characterised by the projected build-out of low-cost clean energy facilities as more than 22 GW of solar and wind capacity is added to the NEM.

Similar to the price decline under the 26 per cent scenario prior to 2020, the competitive pressure from higher solar and wind energy is modelled to push wholesale prices lower, eventually resulting in the closure of excess coal capacity. These are modelled as Liddell, Yallourn, Tarong and Vales Point, with Liddell's closure is assumed to occur as announced in 2022, while the remainder occur closer to 2030 due to a combination of high emissions intensity, high fuel costs and technical constraints. Elsewhere another 3 GW of excess capacity from non-coal plants results in approximately 9 GW of closures by 2030.

As intermittent renewable investment occurs, this low cost generation also displaces some dispatch of gas-generation during the day, and increases the opportunity for energy storage of excess renewable energy.

As a result wholesale electricity prices oscillate around $60 per MWh through to 2030, rather than rise above $80 per MWh as seen under the low investment scenario under a 26% NEG.

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APPENDIX

ABOUT REPUTEX

PRICING INSIGHTS FOR THE AUSTRALIAN ENERGY MARKET

COMPANY OVERVIEW

» RepuTex is a leading provider of independent analysis and pricing insights for the Australian renewable energy, power and emissions markets.

» We have worked with over 150 customers across Australia and the Asia-Pacific, including large energy users and emitters, offtakers and project developers, financials and government departments & agencies.

» Since 1999, our insights have become a key reference point for the market, providing our customers with an advanced perspective on the impact of new forces – such as renewable penetration, new energy storage technology and emissions contracting – on price formation and market development.

» Our focus is on data-driven insights: In doing so, we draw on our proprietary advanced analytics models to provide our customers with a deeper perspective on evolving market risk and pricing patterns.

» We have offices in Melbourne and Hong Kong, supported by a team of analysts with backgrounds in econometrics, statistics, commodities & policy.

» The company is a winner of the China Light and Power-Australia China Business Award for research across Asia-Pacific.

To learn more, please visit www.reputex.com

RESEARCH LEADS

Hugh Grossman
Executive Director
T: (+61 3) 9600 0990
E: hugh.grossman@reputex.com

Bret Harper
Associate Director, Research
T: (+61 3) 9600 0990
E: bret.harper@reputex.com

CONTACT US

RepuTex Australia
Level 2, 443 Little Collins Street,
Melbourne Victoria 3000
Tel: (613) 9600 0990
Fax: (613) 9600 3143

RepuTex Hong Kong
303 Commercial House
35 Queen's Road Central
Hong Kong
Tel: (852) 2537-1821
Fax: (852) 2537-1828

CLIENT SERVICES

Australia: +61 3 9600 0990
Asia: +852 2899 2418
Email: subscriptions@reputex.com

RepuTex CARBON