Chapter 3

Options for the retirement of coal fired power stations

3.1 Evidence to the inquiry highlighted that Australia's coal fired power stations will need to be retired in the medium term in order to make way for lower-emissions sources of power generation. Various options could be utilised to facilitate this process, and are discussed through this chapter.

3.2 Broadly, the options for facilitating the retirement of coal fired power stations include the following:

- leave retirement decisions solely to industry and market forces (without any further changes to government policy settings);
- directly regulate closures (i.e. government directs particular power stations to shut down through regulation, with the plant owner bearing the cost of closure);
- introduce a government payment-for-closure scheme, where the government pays high emissions intensity plant operators to shut down (with the taxpayer sharing the cost of closure);
- market mechanisms introduced by regulation, creating incentives for closure (or disincentives for continued operation) with the market ultimately deciding which power stations retire and when. Possible market mechanisms include:
    - a carbon pricing mechanism, causing higher-emitting plants to incur greater costs, making them less competitive and more likely to cease operations;
    - an emissions intensity scheme, whereby the government sets a baseline emissions intensity target, with below-baseline producers rewarded and above-baseline producers penalised via a tradable permits mechanism;
    - a regulated market mechanism for closure (e.g. the Jotzo model), whereby payments are made by the industry as a whole to shut down the power stations which are the most cost effective to close.

'Barriers to exit' and need for policy certainty

3.3 Much of the policy discussion in this area focusses on whether there are 'barriers to exit' which impact on the decision-making of coal plant operators when determining if (and when) to close.

3.4 The question is not merely whether any barriers to exit exist, but whether these barriers are significant enough to prevent an 'efficient' or 'orderly' restructuring of the market to occur (with older, high-emissions plant capacity retiring first). As explained by the AEMC:

> A barrier to exit is any cost or foregone profit that a firm must bear if it leaves an industry. While these costs therefore represent barriers to exit for

individual generators they are only a problem if they are a barrier to *efficient* exit decisions.

For example, based on this definition, it will not always be efficient for generators with the highest variable cost to exit the market first. Where generators with high variable costs have high shut down costs, it can be an optimal outcome for them to exit the market after generators with low variable costs but low shut down costs.[1]

3.5 Several barriers to exit for coal fired power stations have been identified in the Australian context, which can be summarised broadly as follows:

- *First-mover disadvantage*: If one plant exits the market, the remaining plants will receive higher revenues, which acts as a disincentive to closure as every operator has an incentive to defer closure in the hope that another plant will close.[2]
- *Low operating costs of older coal plants*: Brown coal fired power stations generally carry lower short-run marginal costs of production than other power generators, meaning they may have a greater capacity to continue functioning at low cost even as they approach or exceed their expected operating lifespan.[3]
- *Closedown and site remediation costs*: The cost of shutting down a power plant permanently (even as opposed to 'mothballing' a plant or moving to seasonal rather than full-time production) is high, with site remediation costs estimated as being between $100-$300 million for Australian plants.[4]
- *Policy uncertainty*: This uncertainty has the effect of making it difficult for plant operators to predict what the cost of exiting the market will be now, as opposed to in the future. Hence, this uncertainty may cause inefficient investment and closure decisions.[5]

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1 Australian Energy Market Commission, *Advice to the COAG Energy Council: Barriers to Generators Exiting the Market*, June 2015, p. 3, available at http://www.aemc.gov.au/Markets-Reviews-Advice/Barriers-to-Generators-Exiting-the-Market# (accessed 1 November 2016).

2 Frank Jotzo and Salim Mazouz, *ANU Centre for Climate Economics and Policy*, CCEP Working Paper 1510, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, p. 3. [*Submission 4*, Attachment 1]

3 Frank Jotzo and Salim Mazouz, *ANU Centre for Climate Economics and Policy*, CCEP Working Paper 1510, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, p. 3. [*Submission 4*, Attachment 1]

4 Tim Nelson, Cameron Reid and Judith McNeill, 'Energy-only markets and renewable energy targets: complementary policy or policy collision?', *AGL Applied Economics and Policy Research Working Paper No. 43*, August 2014, p. 2.

5 Australian Energy Market Commission, *Advice to the COAG Energy Council: Barriers to Generators Exiting the Market*, June 2015, pp. 22–23; Tim Nelson, Cameron Reid and Judith McNeill, 'Energy-only markets and renewable energy targets: complementary policy or policy collision?', *AGL Applied Economics and Policy Research Working Paper No. 43*, August 2014, p. 16.

3.6 This final factor, policy uncertainty, was identified by numerous stakeholders to the inquiry as a key issue creating instability in industry decisions—along with the corollary observation that introducing more policy stability in this area would promote better outcomes for investors and market participants. For example, Associate Professor Frank Jotzo argued:

> Australia's energy sector has been exposed to significant investment uncertainty due to pervasive policy uncertainty and climate policy reversals for over a decade. Such uncertainty has detrimental effects on the investment climate and potentially on the cost effectiveness of investment…For an effective and efficient low-carbon transition, stable and predictable policy settings are needed.[6]

3.7 The Australian Energy Council argued similarly:

> A benefit of the market is that it can discover what the real economic life of a power station is and when it is worthwhile to invest in refurbishing a plant to extend its operating life. Stable carbon policy is needed to inform this investment decision making, and potentially signal that coal-fired power station emissions intensity may lead them to close earlier than without a carbon policy.[7]

3.8 AGL Energy submitted:

> The transition to a decarbonised and modernised generation sector requires large scale investment, recent AGL analysis estimates this at $23 billion in renewables alone to achieve an emission reduction consistent with a 27% reduction in [greenhouse gas] emissions by 2030.
>
> Such investment will be supported by policy that provides macro level certainty as to the timeframe and operating life of incumbent plant.
>
> Such certainty has the potential to benefit a range of factors contributing to the efficient transition including new investments, management of existing capital stock, policy development, community transition and energy market development.[8]

Leaving retirement decisions solely to industry and market forces

3.9 The status quo approach would leave any retirement decisions on the closure of coal fired power stations up to the plant owners themselves, with no external changes in government policy settings to assist this process. This approach was endorsed by the COAG Energy Council in December 2014, which stated:

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6 *Submission 4*, p. 4. See also: Clean Energy Finance Corporation, *Submission 64*, p. 7; Clean Energy Council, *Submission 13*, p. 1.

7 *Submission 44*, p. 6.

8 *Submission 12*, p. 3.

> The Council considers it is for the market to provide signals for investment and de-investment for generation, and opposes the transferral of the costs of retiring assets onto consumers or taxpayers.[9]

3.10 Advocates for this position argue that plant operators will choose to cease operations as necessary, in accordance with existing market conditions, and that there are no barriers to exit that are significant enough to warrant government intervention. The AEMC undertook work in 2015 to identify barriers to generators exiting the NEM, and found that 'there is nothing in the National Electricity Law or Rules which would constitute a barrier to efficient exit decisions by generators'.[10]

3.11 The AEMC stated that recent experience shows that generators are not being prevented from leaving the market under current policy settings:

> While it is possible the uncertainty around exit costs is creating a barrier to efficient exit, a number of generators have announced exit decisions in recent years. The evidence suggests that any barriers to exit have not deterred generators from commencing various stages of exit or the full retirement of plant. This would support leaving it to the market to determine which plant should exit.[11]

3.12 In particular, the AEMC pointed to the closure in May 2016 of the Northern and Playford B coal power stations in South Australia and the announced closure of the Hazelwood plant as examples of generator exit without further policy intervention.[12]

3.13 The AEMC stated further in its submission to the inquiry:

> The decision of a generator to retire should be a commercial decision.
>
> Investment and divestment decisions are based on a range of factors. A decision to retire a generator can take a number of years and requires intimate knowledge of the commercial and operating structures of that generator as well as clear expectations about future revenues and costs. Generators are best placed to manage the risk of their own investment or divestment decisions. The added benefit of this approach is that the risks of poor investment decisions are borne by generators rather than taxpayers or electricity consumers (as would be the case if a government were to intervene).[13]

3.14 Other stakeholders have maintained that existing barriers to exit do risk distorting the process of market transition, arguing that additional policy intervention may be required in order to facilitate the phased closures of older, higher-emissions

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9 COAG Energy Council, *Meeting Communiqué*, Adelaide, 11 December 2014.

10 Australian Energy Market Commission, *Advice to the COAG Energy Council: Barriers to Generators Exiting the Market*, June 2015, p. 3.

11 Australian Energy Market Commission, *Advice to the COAG Energy Council: Barriers to Generators Exiting the Market*, June 2015, p. 24.

12 *Submission 76*, p. 3.

13 *Submission 76*, p. 3.

generators. The imperative to reduce Australia's carbon emissions in line with our international commitments is also cited as a reason for implementing policies that would have the effect of curbing emissions in the electricity sector, even if a consequent result of such policies is to force coal powered generators to close sooner than they otherwise would have.[14]

3.15 In its submission, AGL Energy stated:

> There is a role for governments to establish policy that facilitates 'orderly' rather than 'disorderly' exit of emissions intensive aged power stations. Such policy could be based upon age (e.g. Canadian rule which requires power stations to be closed or retrofitted with carbon capture and storage when they turn 50), emissions intensity or a market mechanism (as proposed by Jotzo and Mazouz). Ultimately, policy makers should view such a closure policy as not only an important means of securing energy supplies from modern generation equipment; but also an effective way of systemically reducing greenhouse gas emissions and providing communities the certainty they deserve to plan for such a transition.[15]

3.16 Mr Andrew Stock of the Climate Council told the committee that without a coordinated closures policy, it is difficult for generators to properly plan and announce plant retirement decisions:

> Planning for closure is actually quite problematic at an individual operator level for some quite difficult commercial reasons—that is, the electricity market operates much like another financial market would in that people selling electricity not only trade in the physical product on a day-to-day basis where they dispatch but they also trade financially in the futures market to support their physical retail contract positions. So when a decision for closure is made, it is very hard to telegraph that because if you are doing that you are trading with inside information potentially. This is one of the reasons why closure announcements come in the current market in the way they do. If the owners of power stations make a final decision before they announce that decision to the market, they are potentially trading with inside information, and that has quite serious consequences.[16]

3.17 Various policy mechanisms have been discussed as potentially aiding the transition away from coal fired power generation and towards lower emissions generation. These approaches are discussed further below. Several of these proposed mechanisms have been investigated by the Climate Change Authority (CCA) as part of its Special Review of Australia's climate action, initiated in 2014 and completed in August 2016.[17] As part of this special review, the CCA commissioned two sets of

14 See, for example: Clean Energy Finance Corporation, *Submission 64,* p. 8.

15 *Submission 12*, p. 2.

16 *Committee Hansard*, 9 November 2016, p. 4.

17 See: Climate Change Authority, 'Special Review', http://climatechangeauthority.gov.au/reviews/special-review (accessed 4 November 2016).

modelling on the effects of different carbon pricing policy options on the electricity sector.

Policy mechanisms based on direct regulation

3.18 Policy options based on direct regulatory responses by government (as opposed to market-based mechanisms implemented by government) considered by stakeholders to the inquiry included payment-for-closure schemes and several other models for regulating the closure or ongoing operations of coal power stations.

Payment-for-closure schemes

3.19 Under this model, governments agree to pay certain power station owners to close, encouraging an orderly exit of older and high-emission coal power stations from the market. The Australian Government previously announced a 'contracts for closure' scheme in 2011, as part of its clean energy package that also included the introduction of a carbon price.[18] Dr Jenny Riesz summarised the outcome of the proposed scheme as follows:

> This scheme aimed to permanently close around 2000 MW of highly emissions intensive generation capacity by 2020 via payments to particular plant owners from the Federal Government. The amount paid was to be determined by negotiation…
>
> Closure proposals were received by the Government from all eligible generators in early 2012. Negotiations ceased on 5 September 2012 with the announcement that no agreement had been reached. Again, there were differing views on the reason for this outcome. However, the expectation of a low carbon price, high gas price and high black coal price appear to have pushed up the asking price of brown coal generators beyond that which the Government was prepared to pay.[19]

3.20 A variant of this kind of scheme to retire brown coal power stations is due to be implemented in Germany: starting from October 2016, a capacity of 2.7GW of power from three brown coal plant operators will be taken out of production, with payments of 230 million euros per year made to the operators over a seven year period. The cost of these payments is borne by electricity consumers (increasing costs to consumers by 0.05 euro cents per kilowatt hour).[20]

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18 Department of Resources, Energy and Tourism, *Contracts for Closure: Program Administrative Guidelines*, 30 September 2011. Available at http://webcache.googleusercontent.com/search?q=cache:y34kDVBKYJ8J:www.industry.gov.au/Energy/Documents/cei/CFC/Program-Administrative-Guidelines.doc+&cd=1&hl=en&ct=clnk&gl=au (accessed 7 November 2016).

19 Dr Jenny Riesz, Mr Ben Noone and Associate Professor Iain MacGill, 'Payments for closure: Should Direct Action include payments for closure of high emission coal-fired power plants?', Centre for Energy and Environmental Markets, Working Paper, October 2013, p. 9.

20 *Deutsche Welle*, 'The end of lignite coal for power in Germany', 27 October 2015. Available at: http://www.dw.com/en/the-end-of-lignite-coal-for-power-in-germany/a-18806081 (accessed 2 November 2016).

3.21 Direct payment-for-closure schemes have been criticised for a number of reasons in the Australian context. Professor Frank Jotzo and Mr Salim Mazouz argued in their 2015 paper on the retirement of coal fired power stations:

> …payments-for-closure schemes can lead to unhealthy expectations of future industry subsidies from government and therefore a deferral of plant closure decisions with associated emissions.
>
> Secondly, the politics of paying significant sums of taxpayers' money to the owners of old, highly emissions intensive power stations would be highly problematic. It also does not fit the narrative of the present Emissions Reduction Fund (ERF) mechanisms, which is one of subsidising businesses taking positive actions to move to cleaner production processes, not of compensation payments to sunset industries.[21]

3.22 The COAG Energy Council expressed the view in December 2014 that it does not support assistance to generators to exit the market.[22]

3.23 Alinta Energy, which closed its Flinders coal mine and power station in South Australia in May 2016, submitted that no government payments or incentives to close are required. It argued that the market 'understand[s] and price[s] the cost of closure into the long term planning', and ultimately the public purse should not pay for private closure.[23]

Direct regulation of power station closures and operations

3.24 Another set of options available to government would be to introduce regulatory measures that directly police the emissions performance of power stations, or mandate the retirement of coal fired power stations based on specified criteria. Direct regulatory responses could include:

- introducing standards for the emissions performance of new or existing power stations, creating industry-wide standards;
- facility-level absolute emissions baselines for high-emission generators (i.e. where each plant has a baseline for their total emissions that they must not exceed); and
- mandated closure of power stations over time, on the basis of age or emissions intensity.[24]

3.25 The Australian Energy Council commented on regulatory closure options in its submission:

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21 Frank Jotzo and Salim Mazouz, *ANU Centre for Climate Economics and Policy*, CCEP Working Paper 1510, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, p. 7. [*Submission 4*, Attachment 1]

22 COAG Energy Council, *Meeting Communiqué*, Adelaide, 11 December 2014, p. 1.

23 *Submission 27*, pp 4-5.

24 Climate Change Authority, *Policy Options for Australia's Electricity Supply Sector: Special Review Research Report*, August 2016, p. 32.

> Regulatory closure, or even the requirement to give an extended closure notice, may prejudice both financing arrangements and supply contracts of power plants. This may then precipitate a disorderly closure if loans are called in early or suppliers terminate contracts. However, all of this depends on the type of regulatory closure.[25]

Emissions standards for power generators

3.26 Mandating emissions performance standards for any new power generators would prevent any new high-emitting coal fired stations from being built.

3.27 Canada has implemented an emissions standard for new and existing coal fired generators, meaning that no new coal fired power stations can be built without carbon capture and storage (CCS) technology.[26]

3.28 Similar to Canada, the United States has adopted emissions standards for new coal generators, which effectively require CCS to be implemented in any new projects.[27]

3.29 Emissions standards of this type have been considered by the Australian and state governments in the past, and have been implemented only to be subsequently withdrawn in some Australian jurisdictions.[28]

Absolute emissions baselines for generators

3.30 This model would set a baseline constraint on emissions output of each incumbent generating facility, without any market-based certificate trading between generators.[29] The emissions baselines for each plant can be decreased over time to steadily increase the level of emissions reductions required and force generators to adopt low emissions technology (e.g. implementing CCS retrofit for coal plants) or exit the market.

3.31 The potential impact of a version of this policy in Australia was modelled by Jacobs Group (Jacobs) in 2016 for the Climate Change Authority, which found that its introduction would cause significant electricity price increases in the 2020s, more so than other policy options.[30]

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25 *Submission 44*, p. 7.

26 Climate Change Authority, *Policy Options for Australia's Electricity Supply Sector: Special Review Research Report*, August 2016, p. 65.

27 Climate Change Authority, *Policy Options for Australia's Electricity Supply Sector: Special Review Research Report*, August 2016, p. 65.

28 Climate Change Authority, *Policy Options for Australia's Electricity Supply Sector: Special Review Research Report*, August 2016, p. 66.

29 Jacobs, *Consultation Paper: Modelling illustrative electricity sector emissions reduction policies*, 29 May 2015, p. 93.

30 Jacobs, *Consultation Paper: Modelling illustrative electricity sector emissions reduction policies*, 29 May 2015, p. 94.

Regulated closures of coal fired power stations over time

3.32 This policy option involves the regulated closures of coal stations over time, either on the basis of age or on the basis of emissions intensity. As explained by Jacobs:

> [These schemes] would close existing coal capacity in roughly linear fashion starting with the oldest or most emissions intensive, with the order of plant closure publicly announced at the time the policy is introduced. Each plant identified for closure would be legally required to either close or CCS retrofit by its closure date.[31]

3.33 Modelling conducted for the CCA by Jacobs in 2016 investigated the option of government mandating the regulated closures of all remaining coal fired power stations operating in Australia by 2030 on the basis of age. Under this scenario, coal generators that do not undergo a retrofit to incorporate CCS technology would be closed on the basis of age, and no new coal capacity could be built without CCS technology.[32]

3.34 This scenario modelling found that pursuing this policy would lead to less overall emissions reductions by 2050 than other policies modelled (which are discussed further below).[33] The CCA also found that regulated closures would be a more expensive means of reducing carbon emissions than market-based mechanisms:

> [The CCA's] analysis of regulated closure indicates that using it to achieve a large post-2020 emissions reduction goal in the absence of other measures in the electricity sector would entail higher costs than other policies and would not offer a direct incentive for new low-emissions plant to be built.[34]

3.35 Choosing plant age as the basis for progressive power station closure under this model may also not produce the most efficient outcomes. Jotzo and Mazouz argue that the information asymmetry between governments and plant owners is a significant drawback to the directly regulated closures model:

> Direct regulation suffers from government not having sufficient information about business cost structures, and therefore it would be difficult for the regulator to identify which plant would be the most cost-effective to close

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31 Jacobs, *Consultation Paper: Modelling illustrative electricity sector emissions reduction policies*, 29 May 2015, p. 9.

32 Climate Change Authority, *Policy Options for Australia's Electricity Supply Sector: Special Review Research Report*, August 2016, p. 73.

33 Climate Change Authority, *Policy Options for Australia's Electricity Supply Sector: Special Review Research Report*, August 2016, p. 76.

34 Climate Change Authority, *Policy Options for Australia's Electricity Supply Sector: Special Review Research Report*, August 2016, p. 63.

> and how much to offer in compensation if such compensation was offered.[35]

3.36 Further, they argue that in Australia's current political context 'it appears unlikely that a government would choose a pure regulatory approach that singles out power stations and imposes the full cost of early closure on the owners of that station'.[36]

3.37 Associate Professor Jotzo commented further at a public hearing:

> The regulated approach, according to a timetable, age or emissions intensity would obviously give great predictability of the schedule of exit. In my view, it has the disadvantage of not being the least-cost pathway. Almost by definition, the least-cost pathway of exit will deviate from 45 years out or whatever it may be. If a government wanted to go down the regulatory closure pathway, you would want to combine that with flexibility instruments such as tradeable operation rights.[37]

3.38 Doctors for the Environment recommended that the degree of pollution and its danger to local communities should be a major factor in deciding priority for closure and in advising community and workers of the need for closure. It noted that several states in Australia already impose pollution licensing fees on power plant operators that could in theory drive the closure of heavily-polluting plants, but argued that these schemes 'have been ineffective due to the inadequate scale of fees imposed'.[38]

Market-based mechanisms

3.39 The CCA concluded in a research paper in August 2016 as part of its Special Review that a market-based mechanism to reduce carbon emissions should be implemented in the Australian electricity supply sector:

> A market mechanism in the sector would allow Australia to meet its targets at a lower cost to the community than would be possible without such a policy in the toolkit. The sector's characteristics (measurable emissions, relatively small number of large emissions sources, sophisticated profit-seeking investors operating in generally competitive generation markets) suggest market mechanisms will be feasible and more cost-effective than the alternatives. In addition, market mechanisms can be scaled to achieve

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35 Frank Jotzo and Salim Mazouz, ANU Centre for Climate Economics and Policy, *CCEP Working Paper 1510*, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, p. 17. [*Submission 4*, Attachment 1].

36 Frank Jotzo and Salim Mazouz, *ANU Centre for Climate Economics and Policy*, CCEP Working Paper 1510, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, p. 6. [*Submission 4*, Attachment 1].

37 *Committee Hansard*, 9 November 2016, p. 18.

38 *Submission 53*, p. 15.

> deep emission cuts, and are flexible to changing market and technology conditions.[39]

3.40 The market-based policies considered as part of the CCA's review included: a cap and trade scheme; an emissions intensity scheme; a carbon tax; and a baseline and credit scheme.

3.41 Under all the policy scenarios modelled as part of the CCA's review (including the direct-regulation models discussed above), coal fired generation would decline significantly in Australia in the medium term. As Jacobs stated in its final modelling report, all the policy scenarios modelled involve the entire brown coal fleet and two-thirds of the black coal fleet being decommissioned by 2030.[40]

Emissions intensity schemes

3.42 The CCA ultimately recommended the introduction of an emissions intensity scheme for the electricity supply sector in Australia.[41] Jacobs gives an overview of how such a scheme would operate in its modelling report undertaken for the CCA:

> An emission intensity baseline is set for the electricity supply sector as a whole (based on tonnes of carbon dioxide equivalent per megawatt hour sent out). All generators are allocated permits (representing one tonne of carbon dioxide equivalent) equal to their own generation multiplied by the baseline. At the end of the compliance period all generators surrender permits for each tonne of carbon dioxide equivalent emitted. This effectively means that generators with intensity below the baseline have surplus permits to sell (so receive a subsidy) and generators with intensity above the baseline need to buy additional permits (so incur an extra cost). Emissions permits can also be banked indefinitely for future use or borrowed in limited quantities.
>
> Demand for permits available in each year creates an explicit carbon price, and the relative price of electricity made from more emissions-intensive sources increases. In contrast to a conventional cap and trade scheme, there is no absolute emissions cap, so in practice overall sectoral emissions will vary depending on electricity demand.[42]

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39 Climate Change Authority, *Policy Options for Australia's Electricity Supply Sector: Special Review Research Report*, August 2016, p. 52.

40 Jacobs, *Modelling illustrative electricity sector emissions reduction policies: Final Report*, 25 August 2016, p. 4. The full list of policy scenarios modelled by Jacobs for the CCA's review are: carbon pricing via a carbon tax or cap and trade scheme; an emissions intensity target scheme; a new large-scale renewable energy target; a low emissions target with wider eligibility than the RET; a feed-in-tariff scheme incorporating contracts for differences; regulated closures of high-emissions generators; and an absolute baselines scheme applied to individual facilities.

41 Climate Change Authority, *Towards a climate policy toolkit: special review on Australia's climate goals and policies*, August 2016, p. 7.

42 Jacobs, *Modelling illustrative electricity sector emissions reduction policies: Final Report*, 25 August 2016, pp 24–25.

3.43 Jacobs' modelling on this policy scenario predicts that during the first decade of implementation (that is, 2020–2030) all coal fired power stations are shut-down as a result of the imposed policy, with mostly wind generators and combined cycle gas turbines replacing the retired capacity.[43] The generation mix for electricity supply in Australia to 2050 under this scenario is shown in Figure 3.1.

3.44 Origin Energy stated its support for a mechanism like this to manage the transition to a low-carbon electricity sector:

> Origin supports the progressive decarbonisation of the electricity sector in Australia and an eventual goal of net zero emissions by 2050 or earlier. We believe the introduction of a well-designed cost of carbon abatement for the electricity sector, such as an emissions intensity scheme, is the key to managing this transition.[44]

Jotzo model for regulated closure of brown coal power stations

3.45 Jotzo and Mazouz advocate for a different type of market-based mechanism to drive the closure of the most emissions-intensive brown coal station(s) in Australia.[45] They argue that in the absence of any policy intervention, the economics of Australia's fleet of coal fired power stations is such that black coal stations may close operations first, before the more emissions-intensive brown coal fired stations.[46] This would lead to poorer environmental outcomes in terms of overall carbon emissions and air pollutants than if brown coal capacity was closed earlier and black coal generation capacity remained online.

3.46 Their suggested model is in effect a hybrid market-based regulated closures model. It is summarised as follows:

> The principle of the proposed mechanism is that government offer power plants the opportunity to bid for the closure of some amount of capacity, leaving it to the bidding process to determine which plant(s) will close and what the magnitude of the payment to the closing plant is. The remaining plants are then mandated by government to make financial transfers to the plant that exits the market, in line with their emissions.[47]

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43 Jacobs, *Modelling illustrative electricity sector emissions reduction policies: Final Report*, 25 August 2016, p. 59.

44 *Submission 39*, p. 1.

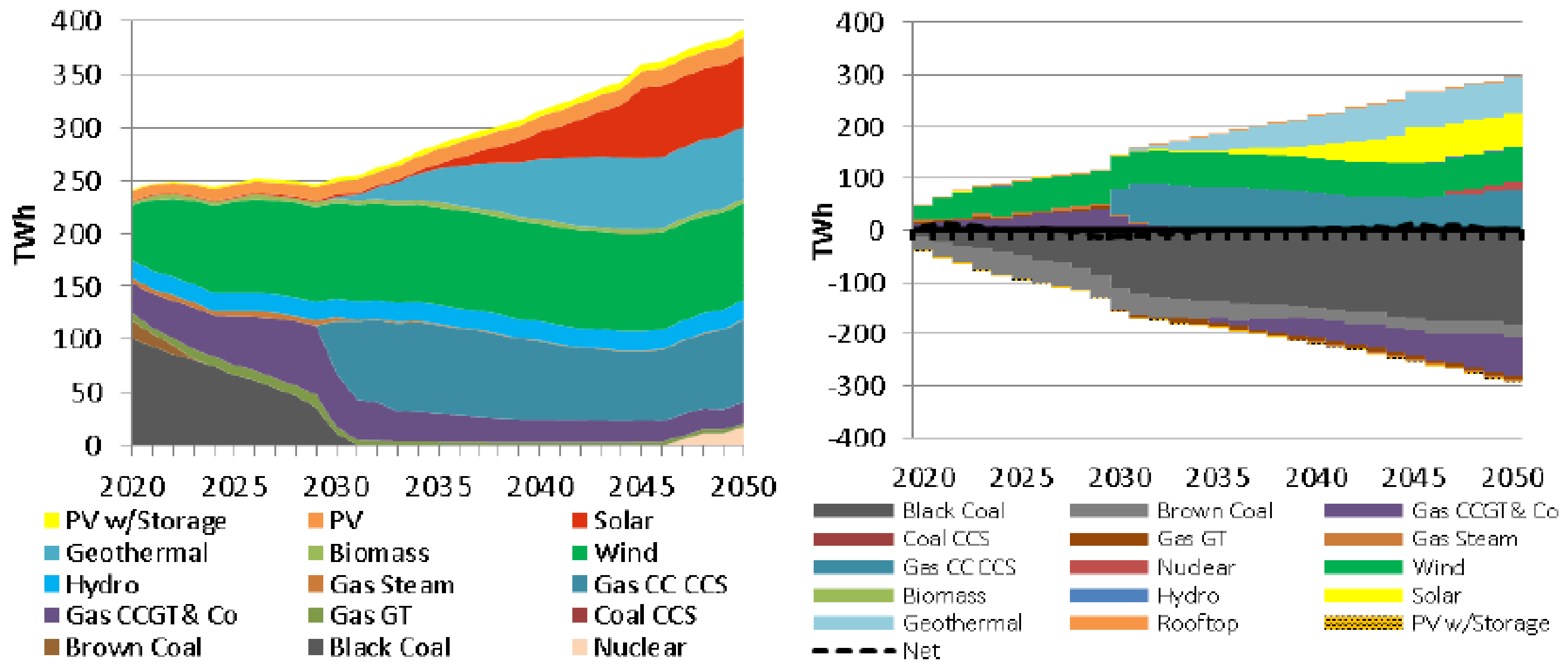
45 Frank Jotzo and Salim Mazouz, *ANU Centre for Climate Economics and Policy*, CCEP Working Paper 1510, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015. [*Submission 4*, Attachment 1].

46 This is because Australia's brown coal plants have lower short run marginal costs than their black coal counterparts, enabling them to potentially remain viable for longer periods.

47 Frank Jotzo and Salim Mazouz, *ANU Centre for Climate Economics and Policy*, CCEP Working Paper 1510, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, p. 8. [*Submission 4*, Attachment 1].

Figure 3.1: Generation mix of electricity supply under an emissions intensity target scenario

The left graph shows absolute figures. The right graph shows figures relative to the reference case.



Source: Jacobs, *Modelling illustrative electricity sector emissions reduction policies: Final Report*, 25 August 2016, p. 59.

3.47 Jotzo and Mazouz argue that such a mechanism would: provide emissions savings from plant closure at least cost; rely on a market mechanism to identify which plant should close and what magnitude payment is required; avoid budgetary costs by sourcing the payments for closure from the power stations remaining in production; and provide some incentives to adjust the power mix to reduce emissions.[48]

Competitive bidding process to identify which stations to close

3.48 Under the Jotzo model, relevant plants (most likely Victoria's brown coal fired power stations) would be invited to submit a bid for the amount of money they would be willing to accept in return for ceasing operations by a predetermined date, remediating their plant site and funding an assistance package to their workers and local communities. A government regulator would then assess the bids, alongside the likely emissions savings resulting from each possible closure, and choose the most cost-effective bid.[49]

3.49 The generator chosen for closure would then receive the full amount specified in their bid, in pre-determined instalments, paid for by the other generators remaining in the market. Under Jotzo's preferred model, the share of payments each remaining generator would need to contribute would be determined on the basis of their carbon dioxide emissions during the year following the closure of the chosen plant, creating further incentives for high-emitting plants to submit low bids in the bidding process.[50]

3.50 Jotzo and Mazouz consider that the cost of such plant closure (and its capacity exiting the market) would be reflected in some rises to electricity prices. They estimate an increase of five to 14 per cent in wholesale prices over the course of one year (and dropping again afterwards), with a corresponding increase in retail prices in the order of one to two per cent, over one year.[51]

3.51 Associate Professor Frank Jozto discussed this model with the committee at a public hearing:

> Our proposal, in a nutshell, is for a market mechanism whereby existing power stations submit bids as to financial compensation required to shut down according to a pre-agreed time line. A government or regulator would choose the most attractive bid, which may well be the bid that delivers the greatest expected emission savings per dollar of compensation required.

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48 Frank Jotzo and Salim Mazouz, ANU Centre for Climate Economics and Policy, *CCEP Working Paper 1510*, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, p. 8. [*Submission 4*, Attachment 1].

49 Jotzo and Mazouz note (at p. 10) that strategic bidding strategies may be employed to distort the optimal outcome of the auction, requiring the regulator to carefully customise design of the auction.

50 Frank Jotzo and Salim Mazouz, *ANU Centre for Climate Economics and Policy*, CCEP Working Paper 1510, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, pp 10–11. [*Submission 4*, Attachment 1].

51 Frank Jotzo and Salim Mazouz, *ANU Centre for Climate Economics and Policy*, CCEP Working Paper 1510, 'Brown coal exit: a market mechanism for regulated closure of highly emissions intensive power stations', November 2015, p. 16. [*Submission 4*, Attachment 1].

> This is a competitive process—best bid wins—and the money is then levied on the remaining power generators. The logic behind that is that these are the power generators that will benefit through increased capacity utilisation of their plants and, to some extent, through increased prices in the wholesale market. This would enable for exit according to a timetable. It would create a source of funding for structural adjustment, and possibly also for improved site rehabilitation above and beyond the level that is required by law of the exiting companies.[52]

Criticism of Jotzo model

3.52 The Jotzo model has been criticised, most notably by Frontier Economics in a May 2016 paper.[53] This paper argues that the predicted electricity impacts of a closure of one of Victoria's brown coal power stations, as advocated for in the Jotzo model, would be much more significant than Jotzo and Mazouz allow for. Frontier's estimates are that retail prices would rise by up to 25 per cent in Victoria in the year immediately following closure, with sustained price rises of 9 per cent in following years, as well as less severe price rises in New South Wales and South Australia.[54]

Options for implementation of policy combinations and need for further research

3.53 Stakeholders highlighted the fact that a combination of policies may be required to effect an orderly exit from the market of coal generators and concurrent increase in generation capacity from renewable sources.[55] In particular, some argued that the continuation of a large scale renewable energy target beyond 2020, when coupled with other policy mechanisms to constrain emissions from coal generators or regulate their closure, would be the most effective means of managing this transition.[56]

3.54 Associate Professor Jotzo made the point that currently, research on options to facilitate closure of coal fired power stations in Australia has been relatively limited. He argued that additional work is required to fully understand the options and provide input to policy, including by further investigating:

- how policy mechanisms for power station closure would interact with other policies, such as baseline-and-credit or the renewable energy target;
- how predictability of exit can be achieved without unduly compromising cost effectiveness, including the potential role for industry compacts; and

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52 *Committee Hansard*, 9 November 2016, p. 18.

53 Frontier Economics, *Sudden Impact: Scrutinising the wholesale price impact of assisted closure of brown coal power stations*, May 2016.

54 Frontier Economics, *Sudden Impact: Scrutinising the wholesale price impact of assisted closure of brown coal power stations*, May 2016, pp 11–12.

55 See, for example: Environment Victoria, *Submission 16*, p. 2; Australian Conservation Foundation, *Submission 69*, p. 12.

56 WWF-Australia, *Submission 77*, pp 5–6.

- options to provide effective support for structural adjustment, and how to raise funds for structural adjustment ideally without relying on public budgets.[57]

Recent policy announcements by the Australian Government

3.55 Throughout January to February 2017, the Australian Government began to signal a new approach to energy policy. During his speech at the National Press Club on 1 February 2017, the Prime Minister, the Hon Malcolm Turnbull MP, indicated that the government was willing to support investment in 'clean coal' technology. The Prime Minister stated:

> Australia is the world's largest exporter of coal, has invested $590 million since 2009 in clean coal technology research and demonstration, and yet we do not have one modern High Efficiency Low Emissions (HELE) coal fired power station let alone one with [carbon capture and storage].[58]

3.56 The Prime Minister spoke about the need to secure baseload power capacity:

> Here's the current picture - old, high emissions coal fired power stations are closing down, reducing baseload capacity. They cannot simply be replaced by gas - because it's too expensive - or by wind or solar because they are intermittent.
>
> Storage has a big role to play, that's true, but we will need more synchronous baseload power and as the world's largest coal exporter we have a vested interest in showing that we can provide both lower emissions and reliable base load power with state of the art clean coal fired technology.[59]

3.57 The Prime Minister further noted that future policy should be 'technology agnostic', and identified security and cost as the guiding principles in the government's response to the challenges in the energy sector. [60]

3.58 The Prime Minister's statements were echoed on 2 February 2017 by the Minister for the Environment and Energy, the Hon Josh Frydenberg MP. Minister Frydenberg stated that the government was committed to ensuring baseload capacity to deliver energy security, and that they were 'looking at all their options' in providing that.[61]

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57 *Submission 4*, p. 7.

58 The Hon Malcolm Turnbull MP, Prime Minister, 'Address to the National Press Club', 1 February 2017, transcript available at https://www.pm.gov.au/media/2017-02-01/address-national-press-club (accessed 17 March 2017).

59 The Hon Malcolm Turnbull MP, Prime Minister, 'Address to the National Press Club', 1 February 2017.

60 The Hon Malcolm Turnbull MP, Prime Minister, 'Address to the National Press Club', 1 February 2017.

61 Sabra Lane, 'High efficiency, low emissions coal power crucial to transition to clean energy: Frydenberg', *ABC News*, 2 February 2017, http://www.abc.net.au/am/content/2016/s4612896.htm (accessed 9 February 2017).

3.59 Minister Frydenberg noted that the Clean Energy Finance Corporation (CEFC) did not refer only to renewable energies, and that the government was open to using the fund to assist in financing production of clean coal power stations. He pointed to the prevalence of high efficiency, low emission power stations in Japan as an example of countries using coal technology to provide energy while meeting their obligations under the Paris Agreement.[62]

3.60 During Senate Additional Estimates on 27 February 2017, Mr Oliver Yates, Chief Executive Officer of the CEFC, confirmed that the agency had received a proposal requesting a loan in order to build a $1.2 billion coal plant with carbon capture and storage facilities.[63]

Response from stakeholders

3.61 A number of energy companies responded to the propositions of the Prime Minister and Minister Frydenberg stating that they had no intention of building any new coal fired power stations, which included 'clean coal' plants.[64]

3.62 The Chief Scientist, Dr Alan Finkel AO, stated that such technologies were not suitable for the Australian energy market. While Dr Finkel expressed support for carbon capture and storage technology, he did not support using taxpayer-funded subsidies to fund these projects. Dr Finkel further noted that the Japan case study was not applicable in Australia due to Japan's efforts to phase out nuclear power.[65]

3.63 The banking industry also reacted to the government's proposal with caution. Mr Geoff Summerhayes, Executive Board Member, Australian Prudential Regulation Authority (APRA), warned that there are significant risks to the investment sector in funding clean coal. Citing a report from the Centre for Policy Development and the Future Business Council on the legal issues arising from climate change, Mr Summerhayes stated:

> The opinion found that company directors who fail to properly consider and disclose foreseeable climate-related risks to their business could be held

62 Sabra Lane, 'High efficiency, low emissions coal power crucial to transition to clean energy: Frydenberg', *ABC News*, 2 February 2017, http://www.abc.net.au/am/content/2016/s4612896.htm (accessed 9 February 2017).

63 Senate Environment and Communications Legislation Committee, *Estimates Hansard*, 27 February 2017, p. 48.

64 Ben Potter, 'Energy industry gives Malcolm Turnbull's clean coal power call the cold shoulder', *Australian Financial Review*, 1 February 2017, http://www.afr.com/news/energy-industry-gives-malcolm-turnbulls-clean-coal-power-call-the-cold-shoulder-20170201-gu39hz (accessed 3 February 2017).

65 Mark Ludlow, 'Chief Scientist Alan Finkel says 'clean coal' has to stack up', *Australian Financial Review*, 2 February 2017, http://www.afr.com/news/politics/chief-scientist-alan-finkel-says-clean-coal-has-to-stack-up-20170201-gu3nzs (accessed 3 February 2017).

> personally liable for breaching their statutory duty of due care and diligence under the Corporations Act.[66]

3.64 Some witnesses who gave evidence to the committee were critical of the government's preference for clean coal, arguing that the cost and complexity of these technologies make them unviable.[67] This evidence is discussed later in this chapter.

Announcement of plan to expand the Snowy Hydro scheme

3.65 On 16 March 2017, the Prime Minister announced a plan to expand the Snowy Hydro scheme, aiming to increase its 4,000 MW output by 50 per cent through the construction of new tunnels and power stations in the scheme, at a cost of up to $2 billion. It was announced that a feasibility study for the project would be completed by the end of 2017, with the new plant aiming to come online within four years.[68]

The South Australian energy market

3.66 On 14 March 2017, South Australian Premier, the Hon Jay Weatherill, announced a new policy framework to ensure that energy is affordable and reliable, while ensuring that power is sourced, generated and controlled within South Australia. The $550 million plan included the construction of the largest battery in Australia to store wind and solar energy, building a government-owned gas-fired power station with a 250 MW capacity to secure back-up resources, and incentivising gas production.[69]

3.67 In announcing the plan, Premier Weatherill emphasised the need for a state energy plan that included renewable technology:

> South Australia will now lead our nation's transformation to the next generation of renewable storage technologies and create an international reputation for high-tech industries.[70]

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66 Geoff Summerhayes, 'Speeches - Australia's new horizon: Climate change challenges and prudential risk', *Australian Prudential Regulation Authority*, 17 February 2017, http://www.apra.gov.au/Speeches/Pages/Australias-new-horizon.aspx (accessed 27 February 2017).

67 See, for example: Mr John Asquith, Community Environment Network, *Committee Hansard*, 22 February 2017, p. 34; Dr Bradley Smith, Senior Climate and Energy Campaigner, Nature Conservation Council of New South Wales, *Committee Hansard*, 22 February 2017, p. 6.

68 Caitlyn Gribbin, 'Snowy Hydro scheme boost to secure electricity supply on east coast: Government', *ABC News Online*, 16 March 2017, http://www.abc.net.au/news/2017-03-16/snowy-hydro-scheme-funding-boost-to-secure-electricity-supply/8358502 (accessed 16 March 2017).

69 Premier Jay Weatherill, *News releases – South Australia is taking charge of its energy future*, 14 March 2017, http://www.premier.sa.gov.au/index.php/jay-weatherill-news-releases/7198-south-australia-is-taking-charge-of-its-energy-future (accessed 14 March 2017).

70 Premier Jay Weatherill, *News releases – South Australia is taking charge of its energy future*, 14 March 2017, http://www.premier.sa.gov.au/index.php/jay-weatherill-news-releases/7198-south-australia-is-taking-charge-of-its-energy-future (accessed 14 March 2017).

3.68 Critically, the proposal also seeks to give the South Australian Energy Minister powers to override the AEMO and direct power stations and utilities to act in the interests of South Australians. The Energy Minister, the Hon Tom Koutsantonis, stated:

> We can't rely on this broken national market any longer. Our plan will deliver increased local generation and powers to help prevent outages and more competition to put downward pressure on power prices for families and businesses.[71]

International developments in energy policy and markets

3.69 The committee heard evidence at its Sydney public hearing regarding the dramatic shifts occurring in the way energy policy and markets are being restructured globally. Mr Tim Buckley, Director of Energy Finance Studies at the Institute for Energy Economics and Financial Analysis (IEEFA), identified five key drivers for the transformation occurring internationally away from coal fired power generation:

- continued technology innovation;
- economies of scale (particularly with the weight of China taking a global leadership position in this process) driving renewable costs down;
- the rapid build up of global financial sector capacity in response to rising stranded asset risks;
- the global commitment to policy action as agreed at the COP21 in Paris; and
- the critical requirement for countries like China and India to deal with air, water and particulate pollution.[72]

3.70 Mr Buckley highlighted key recent developments in China and India, including:

- China's cancellation of plans to construct a further 100 GW of new coal fired power plants, as its electricity generation mix rapidly diversifies away from coal generation towards hydro, renewables and nuclear;[73]
- the announcement in December 2016 of India's draft national electricity plan, which involves not constructing any new coal fired power plants in the next decade while increasing India's renewable energy stores fivefold in the same period; and

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71 Premier Jay Weatherill, *News releases – South Australia is taking charge of its energy future*, 14 March 2017, http://www.premier.sa.gov.au/index.php/jay-weatherill-news-releases/7198-south-australia-is-taking-charge-of-its-energy-future (accessed 14 March 2017).

72 Opening statement, tabled by the Institute for Energy Economics and Financial Analysis (public hearing, Sydney 22 February 2017), p.1.

73 Opening statement, tabled by the Institute for Energy Economics and Financial Analysis (public hearing, Sydney 22 February 2017), p. 2.

- the outcome in February 2017 of a reverse auction tender in India which will deliver power from a new 750 MW solar facility at a cost of US$45 per megawatt hour, the lowest price ever recorded for such a contract.[74]

Providing reliable power through Australia's energy transition

3.71 An overarching issue discussed throughout the inquiry was how to ensure reliability of power supply in Australia while the transition from an energy system dominated by coal fired generation to a renewables-dominated system is completed.

3.72 Various possibilities for promoting reliability of supply were discussed at the committee's public hearings, including the use of clean coal technologies, the role of gas fired power generation, and emerging energy storage solutions, primarily battery storage.

Possibility of utilising 'clean coal' technologies

3.73 Various stakeholders to the inquiry commented on the possible role of 'clean coal' technologies; either through implementing carbon capture and storage technologies (integrated into new coal plants, or retrofitted onto existing plants), or through building new, more efficient coal fired power plants.

3.74 The Minerals Council of Australia argued in its submission that building new, high-efficiency, low emissions coal fired power plants in Australia and deploying carbon capture and storage technologies could be part of the solution in Australia's transition to a lower-emissions energy mix:

> Australia has the opportunity to upgrade its coal generation fleet as existing plants come to the end of their life. We do not argue that all coal plant should be replaced by another coal plant. No energy source should be guaranteed market share. But the option of [high-efficiency, low emissions] coal must be on the table. It is the most competitive option. It can deliver baseload power and it can deliver 50 per cent lower emissions with the promise of further substantial emissions reductions with the deployment of carbon capture and storage technologies.
>
> …
>
> New super-efficient black coal plants are commercially available and operating throughout the world…Super-efficient brown coal plants are also planned or already delivering low cost, baseload energy around the world, including in Germany, Poland, the United States and Thailand. With a bold vision NSW, Queensland and Victoria and other jurisdictions can invest in Australia's future by building ultra-supercritical black and brown coal base load plants here too.[75]

3.75 This issue was explored extensively at the committee's two public hearings held in February 2017, in the context of comments from government ministers in support of clean coal. Several potential problems with implementing clean coal

74 *Committee Hansard*, 22 February 2017, pp 39-40.

75 *Submission 29*, pp. 1-2 and Attachment 1, p. 11.

technologies were raised with the committee, relating primarily to the cost and complexity of implementing the technology.

3.76 Councillor Martin Rush, Mayor of Muswellbrook Shire Council, expressed the view that while the possibility of utilising 'clean coal' technologies should not be summarily dismissed, its potential will likely be overridden by cost factors which will make coal uncompetitive over time:

> The reality is that coal itself as a former fuel for power generation is becoming relatively more expensive compared with renewables. So we have to see clean coal within the context of the larger cost. There will come a time, and it will happen before too long, and it already occurs in some aspects of the demand for energy—for example, daytime peak—where solar is overwhelmingly cheaper already than coal. It is true for base load that thermal coal is still cheaper, but that will not be the case forever. So when we look at the issue of clean coal it has to be done across the whole of the strata of cost, not just the externalities. The only thing clean coal is dealing with is that fraction of the total cost that is the externality of the carbon footprint. The problem for clean coal, ultimately, is that its relative costs continues to increase. So I think the practical economic reality is that by 2050 clean coal is certainly not a solution—we have already heard that—and as a transition it is probably pie in the sky. But let's not rule it out. But if we are going to make policy decisions based upon whether or not clean coal is a viable transition pathway, then let's get some science around it first.[76]

3.77 Mr Tim Buckley, IEEFA, stated that carbon capture and storage technologies significantly increase the net cost of energy production compared with current coal fired generation, and that this makes it unlikely to be competitive into the future.[77]

3.78 Mr Barry Ladbrook from Sustainable Energy Now also commented on the complexity and cost of carbon capture and storage technologies:

> It is possible to…strip CO2 out of a variety of sources…The issue is just the enormous cost that is associated with it. And when I say 'enormous', I mean: basically, you are sticking a chemical process that is quite expensive onto a power system, so you are adding a whole other degree of complexity. You are then sticking a transport system onto that. You are then sticking a geological injection system onto that. So you are sticking three very different, very complex systems onto one that is already a complex system. So you have got a whole lot of logistical operational issues to deal with there…[Y]ou are effectively spending a lot of money to make a power system less efficient. And, when you add all those costs up together and all that complexity—never mind the reputational issues, and the security issues about the geological structure being sound—it really is a minefield.[78]

76 *Committee Hansard*, 22 February 2017, pp 12-13.

77 *Committee Hansard*, 22 February 2017, p. 43.

78 *Committee Hansard*, 23 February 2017, pp 8-9.

3.79 The Global CCS Institute disputed the claim that carbon capture and technologies are prohibitively expensive:

> [This misconception] stems from simple comparisons to cheap and intermittent forms of renewable energy, rather than on comparisons of 'value' in providing controllable electricity supply and on a cost per tonne of CO2 avoided basis. To illustrate this point, the high penetration of intermittent renewables requires significant additional expenditure on a combination of backup dispatchable generation, battery storage, transmission augmentation, demand side management, and other technologies to ensure the reliability and resilience of the grid. Coal and gas-fired generators with [carbon capture and storage] do not introduce cost or risks associated with grid integration.[79]

3.80 Dr Bradley Smith, Nature Conservation Council, argued that holding out the promise of clean coal was misguided, as it is still not viable to implement despite significant investment in attempts to develop the technology:

> Clean coal is a fairytale. It is a distraction, but it is a very dangerous one because all it does is delay. We know this plant is not going to get built. What we need are real things that can be built now. This debate goes back a decade, I think, to when people gave the clean coal thing a try and found out that it would not work…We cannot afford to waste another 10 years. We need to move forward with our energy transition. We are in the middle of it now, so we need solutions we can deploy now.[80]

3.81 Ms Daisy Barham, Nature Conservation Council, concurred that 'clean coal' is used as a delay tactic by its proponents that would ultimately make the inevitable transition to renewable energy more expensive and more painful for communities currently reliant on coal fired generators.[81]

Role of gas fired power generation

3.82 The question of whether gas fired generation could play a more substantial role as a transitional power source in Australia was discussed at length during the committee's public hearings.

3.83 Mr John Asquith, Community Environment Network, noted that gas fired generation operates at approximately double the efficiency rate of coal fired power generation, and argued that gas should be utilised while better energy storage systems are still in development.[82]

3.84 Mr Asquith highlighted that a significant benefit of gas fired generation over coal fired generation is its ability to respond more quickly to demand signals, with gas generators able to commence electricity production within one to two hours' notice, as

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79 *Submission 134*, p. 3.

80 *Committee Hansard*, 22 February 2017, p. 6.

81 *Committee Hansard*, 22 February 2017, p. 9.

82 *Committee Hansard*, 22 February 2017, p. 35.

opposed to a timeframe of 24-48 hours for a coal fired generator to ramp up to its full production capacity.[83]

3.85 Problems with the gas market in Australia that affect its availability and cost-effectiveness as a fuel source were also noted by stakeholders to the inquiry. For example, Mr Buckley of the IEEFA expressed the view that with gas prices at historically high levels, gas-fired power generation 'is no longer a low-cost source of supply'.[84]

3.86 Ms Blair Palese of 350.org argued that the cost of infrastructure for expanded gas fired generation, coupled with the unpredictability of gas prices, worked against utilising it as a transitional energy source:

> [T]he price question of gas is a really critical one. It is quite transient up and down based on international market standards. We cannot control that even if we try hard. Price-wise it does not compete in anyway with solar and wind… Secondly, when you look at investing in more gas, you are looking at 30 to 40 years of fossil fuel infrastructure, and that is expensive. When you add those two things up, to be honest, if you put a market mechanism in place, gas would not be in the mix. It would be very quickly moved out because it is just too costly to install a whole new system and the gas itself is expensive.[85]

3.87 Ms Barham advocated for bypassing gas as a transition fuel altogether, on the grounds of maximising possible reductions in carbon pollution:

> Gas is still a fossil fuel. It does still have significant carbon emissions whereas we know that renewable energy does not have those carbon emissions. So we are strongly advocating that we skip straight to renewable energy, as we have seen so many other parts of the world do, and even states in Australia are really investing in renewables. We do not need gas.[86]

Emerging energy storage technologies

3.88 Technologies which store electricity in order to provide power when it is not available from renewable energy sources have become an emerging focus in developing solutions to provide reliability of power supply in a renewables-dominated system. Battery storage technologies, solar thermal storage and pumped hydro storage were all discussed during the committee's inquiry.

Grid level storage

3.89 As noted earlier in this chapter, the South Australian Government has recently committed to building Australia's largest battery storage facility, via a $150 million renewable technology fund, to create a grid-connected battery providing 100 MW of

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83 *Committee Hansard*, 22 February 2017, pp 35-6.

84 *Committee Hansard*, 22 February 2017, p. 45.

85 *Committee Hansard*, 22 February 2017, p. 6.

86 *Committee Hansard*, 22 February 2017, p. 6.

storage capacity.[87] The Victorian Government has also recently announced funding of $25 million to be invested in energy storage projects, with the aim of creating 100 MW of energy storage capacity in Victoria by the end of 2018.[88]

3.90 Evidence to the committee from solar thermal company SolarReserve and submissions from Repower Port Augusta made a strong case that solar thermal, with some government assistance, would be a viable contribution to both storage and new energy production.[89]

3.91 In February 2017 the Australian Renewable Energy Agency and Clean Energy Finance Corporation also announced additional funding to be directed towards accelerating the development of flexible capacity and large-scale storage projects including battery storage.[90]

3.92 The Australian Government's recently announced plan to expand the capacity of the Snowy Mountains Hydro scheme over the next four years would also significantly increase the amount of storage-based electricity available to be fed into the grid during times of peak demand.[91]

Household battery storage solutions

3.93 Several witnesses predicted that while household battery storage solutions are not currently widespread, they will become commercially competitive and become a significant factor in the overall energy market within the next few years. Mr Bruce Mountain of Carbon and Energy Markets Australia told the committee:

> [M]y estimate is that a household in Adelaide that installs a battery and solar combination will outlay around $16,000, and the all-in price of electricity that they incur, after paying down that investment plus the net export to the grid and the net purchase from the grid, beats any offer in the residential retail market. So households would be better off. As a consequence I expect rapid uptake of battery and solar combinations. I

87 South Australian Government, 'Our Plan: Battery Storage and Renewable Technology Fund'; available at http://ourenergyplan.sa.gov.au/our-plan.html#OP1 (accessed 14 March 2017)

88 The Hon Daniel Andrews, Premier of Victoria, and the Hon Lily D'Ambrosio, Victorian Minister for Energy, Environment and Climate Change, 'Large Scale Energy Storage: An Investment in Jobs, Reliability and Affordability', *Media Release*, 14 March 2017, available at http://www.premier.vic.gov.au/large-scale-energy-storage-an-investment-in-jobs-reliability-and-affordability/ (accessed 14 March 2017).

89 *Committee Hansard*, 17 November 2016, p. 52

90 Australian Renewable Energy Agency, 'ARENA and CEFC support solutions for certainty of energy supply, including flexible capacity and large scale energy storage', 1 February 2017, available at https://arena.gov.au/media/arena-and-cefc-support-solutions-for-certainty-of-energy-supply-including-flexible-capacity-and-large-scale-energy-storage/ (accessed 14 March 2017).

91 See: Caitlyn Gribbin, 'Snowy Hydro scheme boost to secure electricity supply on east coast: Government', *ABC News Online*, 16 March 2017, available at: http://www.abc.net.au/news/2017-03-16/snowy-hydro-scheme-funding-boost-to-secure-electricity-supply/8358502 (accessed 16 March 2017).

> expect that they will continue to be connected to the grid for backup…It will take time for the market to adopt, for the installer capacity to develop and so on. I think the fleetness of foot that we have seen in the installation community with solar is likely to be replicated in battery. I cannot see a reason why we will not have a rapid uptake amongst the household consumers. But I think, realistically, it will be sizeable commercial factor in five years time.[92]

3.94 Ms Jemma Green, a Research Fellow at Curtin University, was even more optimistic about the timeframe for household battery storage units to become commonplace:

> The announcement by Tesla of their Powerwall on 30 April 2015 moved the price of battery storage to around $350 per kilowatt hour. Since then the price has come down further and it sits at around $275 per kilowatt hour. What that means in practice is that battery storage is likely to compete with grid sourced electricity pricing within the next 24 months. It is not really at that point where you will see mainstream uptake of battery storage, but, when the delta between grid priced electricity and battery sourced is probably 20 per cent cheaper, then I think you will start to see mainstream uptake.[93]

3.95 Ms Green noted research from Morgan Stanley expressing view that the point at which there would be mainstream uptake of this technology would be when the price for a combined solar and battery storage household system decreased to around $10,000, which is forecast to happen within the next 18 months.[94]

3.96 In relation to the cost of household storage systems, Mr Ian Porter from Sustainable Energy Now stated:

> [T]he cost of battery storage is on the same cost-decline curve as solar PV, which we saw between 2009…and 2014: the cost of solar PV fell by 80 per cent, and is on the same continuing cost decline…Battery storage is on the same cost-decline curve. As we know, Tesla in Nevada, in the US, are opening a plant which will double the capacity of lithium storage. Lithium is one form of battery. There are many other types of storage systems under development at this time which we will see come into the public domain within the next few years, and this will contribute of course to the disruption technologically, driven by the economics.[95]

3.97 In discussing the impact of the increased uptake of household solar and battery packages on the broader energy market, Mr Mountain predicted it would create significant challenges for electricity retailers:

> I think the impacts will be very significant for retailers. They would lose almost all of their volume to a customer that installs a battery and a

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92 *Committee Hansard*, 22 February 2017, pp 47-8.

93 *Committee Hansard*, 23 February 2017, p. 21.

94 *Committee Hansard*, 23 February 2017, p. 22.

95 *Committee Hansard*, 23 February 2017, p. 7.

> reasonably-sized solar system. I think there will also be a significant impact to the network service providers, which, absent regulatory change, will translate into higher revenues to be got back from the remaining customers.[96]

3.98 When asked whether electricity retailers could change their business model in response to this change by buying power from groups of households with storage to then on-sell to other consumers, Mr Mountain commented:

> Yes. I should think there is no particular trading advantage. They can either buy wholesale or aggregate up a number of smaller households with solar and battery that they can buy at a retail level, and that may well happen. I doubt, though, that it will be anywhere near as profitable as the existing retail business. In fact, it is not that I doubt; I am absolutely certain it will not be.
>
> I think the commercial model of electricity retail as we have today—buying it wholesale, or, in the case of the larger generator retailers, producing much of what they sell and then on selling to the customer—will change for many small customers.[97]

3.99 Other possible solutions to better integrate household solar and battery storage systems into the broader grid were also highlighted to the committee. For example, Ms Green informed the committee of the work of her company Power Ledger, which has developed technology allowing peer-to-peer trading of electricity generated by households with rooftop solar systems:

> The technology that we have developed uses a blockchain to enable peer-to-peer trading of electricity. So, if you have solar panels and you have electricity surplus to your requirements, you can sell that to your neighbour via the regulated network...It means, if you do not have solar panels, you are able to procure renewable electricity. Maybe you are in a rental property or in a building that does not have suitable access to the roof space, it means you are able to get renewable electricity. If you are a household you might size your solar and battery system to self supply but you might have additional roof space and you would like to monetise that. So this technology enables those transactions to take place.[98]

3.100 Ms Green stated that electricity retailers may start utilising these kinds of technologies in the future to offer peer-to-peer trading as a premium service to consumers, or may even offer a solar and battery system to consumers at no up-front cost, with revenue derived from the system then to be shared by the consumer and the retailer.[99]

96 *Committee Hansard*, 22 February 2017, p. 48.

97 *Committee Hansard*, 22 February 2017, p. 48.

98 *Committee Hansard*, 23 February 2017, p. 22.

99 *Committee Hansard*, 23 February 2017, p. 22.