Credible pathways to a 50% renewable energy target for Queensland

Final Report, 30 November 2016

Report of the Queensland Renewable Energy Expert Panel

Queensland Renewable Energy Expert Panel

Queensland
Renewable Energy
Expert Panel
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1. Executive Summary

The Queensland Government has committed to investigating a renewable energy target for Queensland of 50% by 2030. To help deliver on this commitment, the Government has established the Renewable Energy Expert Panel to provide advice on credible pathways to achieving a 50% renewable energy target for Queensland by 2030. The policy seeks to reduce greenhouse gas emissions that drive climate change, as well as to create economic development opportunities in the state.

Throughout its inquiry, the Panel has undertaken a comprehensive consultation process, including the release of an Issues Paper and Draft Report, and two rounds of public and industry forums. Stakeholder feedback collected through the consultation process has been incorporated throughout this report.

The Panel also commissioned modelling and analysis from Jacobs, the Centre of Policy Studies (CoPS) and KPMG.

1.1. Summary of key themes

The Report finds Queensland has strong potential to grow its renewable energy industry, given falling technology costs, market dynamics and a current project pipeline of around 2,400 megawatts (MW) of committed and proposed large-scale renewable plant capacity, primarily in regional Queensland. To the fullest extent possible, the Government should encourage the market to contract and deliver large and small-scale renewable energy. However, significant Government policy action will likely be required to reach a 50% target, with 4,000–5,500 MW of new large-scale renewable generation capacity needed between 2020 and 2030.

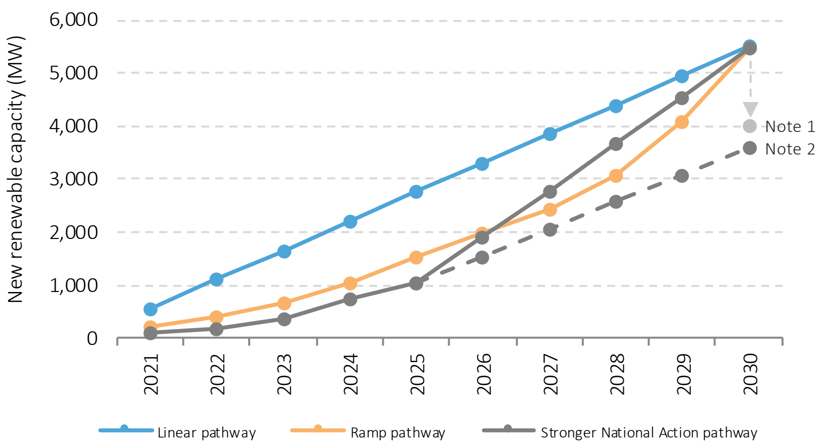
In the short-term, there is an opportunity for the Government to leverage existing Federal schemes to attract projects to Queensland, given the potential challenges in meeting the national Large Scale Renewable Energy Target (LRET) in the period up to 2020. This could occur via a competitive reverse auction process, with the Panel recommending an indicative target of up to 400 MW prior to 2020, with the target to be reviewed based on the level of renewables developed by the market.

In the longer-term, the Panel has assessed three alternative post-2020 pathways to meeting a 50% target for Queensland by 2030:

- *Linear pathway:* Assumes a uniform rate of renewables build from 2020-2030
- *Ramp pathway:* Features a ramp up in effort later in the period to capitalise on falling technology costs later in the period
- *Stronger National Action pathway:* Assesses what additional Queensland Government action would be required to reach a 50% target if a stronger national emissions reduction scheme is put in place from 2020 to achieve a 45% reduction in electricity sector emissions on 2005 levels by 2030.

Figure 1 on the following page shows the capacity (in MW) of new renewables delivered under the 3 pathways.

Figure 1: Large-scale renewable energy capacity delivered under the 3 modelled pathways (MW)



Note 1: Large-scale renewable generating capacity to meet the 50% target could be lower than 5,500 MW depending on future Queensland load requirements. For example, an uptake in rooftop PV or energy efficiency measures by consumers at rates higher than AEMO's forecast, or significant changes in Queensland industrial load could impact the requirements for new large-scale renewable capacity.

Note 2: Under the Stronger National Action pathway, the national emissions intensity scheme results in Queensland reaching around 3,600 MW of large-scale renewables. Approximately 1,900 MW of additional large-scale renewable would be required to reach achieve the 50% target.

The different pathways highlight the benefits, costs and policy relativities. For example, the *Ramp* pathway delivers the 50% renewable target at lower cost than the *Linear* pathway, but with less cumulative emissions reduction to 2030. The *Stronger National Action* pathway results in significant emission reductions nationally and closure of around 1,500 MW of coal-fired generation in Queensland. Annual Queensland electricity sector emissions are 25% lower in 2030 relative to 2016 under the *Linear* and *Ramp* pathways, and 31% lower under the *Stronger National Action* pathway.

The *Stronger National Action* pathway is not within the direct control of the Queensland Government, but represents a credible scenario in the context of national climate change policy. Under this pathway, Queensland is projected to reach 41% renewable energy generation through the operation of the national emissions intensity scheme, with further Queensland Government policy action required to deliver 1,900 MW to reach the 50% target.

The Panel notes that in the event of further reductions in Queensland demand, such as through greater energy efficiency or the closure of large industrial load before 2030, the requirements under the target could be lower. In the Panel's analysis, these factors could reduce the large-scale renewable capacity requirement in Queensland post-2020 to around 4,000 MW.

The Panel has not recommended a preferred pathway but has emphasised the importance of flexibility in designing Queensland's longer-term policy, given the rapidly changing electricity market and uncertain national policy context. The modelled *Linear* and *Ramp* scenarios can be considered two points along a spectrum of options balancing benefits and costs. The Panel notes a strong sentiment from stakeholders that, as part of implementing a 50% target for Queensland, the Queensland Government should support the development of integrated climate and energy policies at the national level, to maximise efficiencies in emissions reduction and uptake of renewable energy.

The Panel has recommended that the policy action should be funded through electricity market mechanisms. Based on the modelling, it is projected that it is unlikely that there will be a price effect on electricity consumers prior to 2020 under Queensland policy measures, given the timing of project development and leveraging of LRET revenues. Post-2020, the modelling projects the *Linear* and *Ramp* pathways would be broadly cost neutral to electricity consumers. Queensland Government policy action to achieve the 50% target under the *Stronger National Action* pathway is not itself projected to effect retail bills, due to new renewable capacity being primarily driven through the national emissions intensity scheme.

The projected cost-neutral outcome under Queensland policy action is due to the modelled suppression of wholesale prices, which is expected to offset the cost of the subsidy payments to renewables, which are estimated at $900 million (NPV) under the *Linear* pathway, $500 million under the *Ramp* pathway, and $50 million under the *Stronger National Action* pathway. The cost neutral outcome is consistent with other recent market modelling, however, the pricing outcome is not guaranteed and could differ, for example, if existing generation capacity is withdrawn from the market, especially coal-fired generation.

While there is no modelled closure of existing coal-fired power stations prior to 2030 under the *Linear* and *Ramp* pathway, the Panel has undertaken separate analysis to understand the sensitivity of prices to coal-fired power station retirement, forcing the closure of 1,400 MW of coal-fired generation from Queensland. Under the sensitivity analysis modelling, the forced closure of coal-fired generation is projected to increase wholesale prices. However, this effect is projected to be marginal by the Jacobs' modelling, with the overall outcome for retail bills projected to be broadly cost neutral.

The Panel has found there is no requirement for additional financial incentives to support investment in small-scale renewables in Queensland. However, the Panel notes there is merit in addressing regulatory and other non-price barriers to greater uptake of small to medium-scale solar PV, particularly at the commercial scale, and supports the Queensland Government's existing initiatives in this area.

Moving to a 50% renewable energy mix will present both opportunities and challenges for market participants, local communities and the broader economy. Economic modelling projects that meeting a 50% target would have a small positive effect on the overall Queensland economy, with Gross State Product (GSP) projected to be 0.2% ($5.4 billion NPV) higher in 2030 under the *Linear* pathway, compared with the *Base case*. The increases in economic output in Queensland are projected to be offset by reductions in the rest of Australia.

The benefits to the Queensland economy would be largely driven by the additional $6.7 billion (NPV) investment in renewable energy for the development of up to 5,500 MW of new large-scale generation plant in Queensland, with a significant, ongoing pipeline of renewable energy projects, particularly in regional Queensland. The Panel has identified opportunities for Queensland to develop a competitive advantage in the supply chain components of development and design, fabrication and construction, operations and maintenance and power system ancillary services. By improving competitiveness in these areas, Queensland could capture a larger portion of the overall investment in the renewable energy supply chain.

While harnessing current mature technologies will be critical, the Panel also recognises the role of research and development (R&D) and innovation in developing new and emerging renewable energy technologies. For example, the Government could consider targeting the development of dispatchable renewable technology and also fringe-of-grid solutions as part of its reverse auction program. Further, there may be a role for the Queensland Government to fund early stage R&D. Over time, commercialisation of new renewable technologies could create opportunities for Queensland businesses.

The modelling projects a net increase in employment in Queensland under the 50% target, with an increase of around 6,400-6,700 full-time equivalent (FTE) employees on average between 2020 and 2030 under the *Linear* and *Ramp* pathways. Increases in employment in Queensland are projected to be largely offset by reductions in employment in the rest of Australia.

There is a projected change in the composition of employment, with an increase in construction employment and a reduction in operational employment within the generation sector. Government may consider working with the impacted communities, individuals and relevant bodies to consider future training and workforce requirements.

While there is no closure of existing fossil fuel generators expected prior to 2030 under the *Linear* and *Ramp* pathways, a 50% renewable energy target is projected to have a significant longer-term effect on this plant, with an estimated reduction in operating cash flow of $600-$1,100 million (NPV) to 2030 under the *Linear* and *Ramp* pathways. Given the Queensland Government owns two-thirds of the state's generation capacity, the Panel has recommended that the Shareholding Ministers consider the effect on Government Owned Corporations.

The Panel notes there will be a significant additional requirement for planning approvals and network connections over the period to 2030, and has suggested ways to streamline processes and improve information provision to project proponents. The Report also notes that while the Australian Energy Market Operator (AEMO) has found there are currently no fundamental barriers to achieving a high penetration of renewables into the electricity grid, ongoing close monitoring and planning will be required as penetration increases. The Panel has recommended that the Queensland Government continue to work with the Council of Australian Governments (COAG) Energy Council, AEMO and the Australian Energy Regulator (AER) in monitoring developments that may affect power system reliability and security and in assessing the need for changes or enhancements in the operation of the National Electricity Market (NEM).

1.2. Overview of findings

The section below outlines the Panel's findings, which have been developed as a result of the Panel's analysis of the key issues, input from the public and industry forums, submissions on the Issues Paper and Draft Report, and modelling of scenarios and outcomes.

Chapter 3: Queensland's electricity sector, greenhouse gas emissions and the role of renewables

- Queensland produces the most greenhouse gas emissions of any state in Australia, with the single largest source of emissions being from the electricity generation sector.
- While Queensland has the highest percentage of small-scale rooftop PV penetration in Australia, it has the lowest installed capacity of large-scale renewables in the National Electricity Market.
- Queensland has significant solar resources and there are potential wind sites that could be utilised to meet the 50% target. Industry advice suggests there is also potential for other renewable energy technologies, such as biomass and pumped storage hydro to contribute to Queensland's energy mix.

Chapter 4: Defining Queensland's renewable energy target

- Queensland should adopt the same set of eligible renewable energy sources as identified under the Federal LRET, on the basis that this is considered an extensive and well understood set of technologies, and would ensure a Queensland target remains consistent with the Federal LRET.
- Setting a floating target (i.e., a percentage of electricity generation) is appropriate for expressing the Queensland Government's long-term goals for renewable energy in Queensland. However, setting fixed targets for short-term objectives can increase investor certainty and reduce the overall costs of the scheme. Fixed targets can be set based on near-term forecasts (which are typically more accurate than long-term forecasts) and any subsequent shorter-term targets can be adjusted up or down to correct for "unders or overs" so as to meet the longer-term floating target of 50% renewable generation by 2030.
- Defining the target with reference to generation output (GWh) rather than capacity (MW) is preferred on the basis that:
  - An output target incentivises renewable energy production at the lowest cost
  - Electricity output is what drives greenhouse gas reductions, rather than installed capacity
  - An output target is consistent with the way other energy targets are implemented nationally and internationally.

  However, it is recognised that adopting a target based of 50% renewable output may deliver approximately 54% renewable energy generating capacity by 2030.

- It is appropriate to count Queensland's pro-rata share of the LRET towards meeting a 50% renewable energy target for Queensland on the basis that Queensland consumers have paid, and will continue to pay, for this electricity generation, even if the actual generation occurs interstate. To not count this pro-rata share would be to underestimate the contribution by Queensland consumers to investments in renewable energy nationally. However, the Queensland Government may seek to increase renewable energy project opportunities in Queensland under the LRET.

Chapter 5: Leveraging existing Federal support schemes to 2020

- There is no requirement for additional financial incentives to support investment in small-scale renewables in Queensland. However, the Panel notes there is merit in addressing regulatory and other non-price barriers to greater uptake of small to medium-scale solar PV, particularly for commercial businesses. Measures to streamline network connection processes for these plants are considered to be particularly important.
- In order to fulfil the requirements of the Federal LRET, it is estimated an additional 6,000 MW of large-scale generation capacity is required to be constructed nationally by 2020. Based on current technology costs, market dynamics and project pipeline, Queensland is likely to see considerable investment in renewable energy over the next few years supported by the LRET.
- Despite there being strong market interest in investing in new large-scale renewable energy, it remains uncertain whether there is sufficient capacity to deliver all of the additional requirements of the LRET by 2020 under medium to long term offtake contracts. Industry analysis suggests there is approximately 4,300 MW of renewable projects that could be committed nationally to 2020 under offtake contracts. When compared to the estimated requirement for 6,000 MW of capacity to meet the LRET, the Panel notes there may be a shortfall of renewable energy by 2020.
- A number of states and territories have announced strong ambitions for renewable energy, and there is potential for competition between jurisdictions for renewable energy investment under the LRET. Those jurisdictions with the most attractive investment and regulatory environment for renewable energy projects are likely to attract the most projects.
- In light of the potential shortfall of renewable energy capacity to meet the LRET, there is an opportunity for the Queensland Government to undertake a reverse auction process in 2017-18 for the delivery of further renewable energy capacity prior to 2020 (potentially up to 400 MW, subject to market activity and the competitiveness of renewable energy projects in the market, and the timeliness of completing the auctions).
- There could be a role for the Queensland Government to fund early stage R&D.

Chapter 6: National energy and climate change policy post 2020

- Australia will likely move to strengthen its current emissions reductions initiatives and mechanisms to ensure that it can achieve 26-28% below 2005 levels by 2030 committed to under the Paris Agreement. The Panel considers it probable that some form of electricity sector emissions reduction mechanism will be introduced nationally prior to 2030.
- In selecting and implementing a pathway for the renewable energy target in Queensland, the Government should have regard to any developments in separate state, territory and federal emissions reduction targets and be clear how the renewable energy policies will deliver greenhouse gas reductions.
- The Panel and stakeholders are generally supportive of Queensland working at a national level to develop and implement nationally integrated climate change and energy policies.
- The credibility and durability of any Queensland renewable energy policy will be enhanced if it is explicitly designed to complement and be flexible to accommodate future changes in national energy and climate policy.

Chapter 7: Queensland renewable energy policy options post 2020

- The Queensland Government should encourage the market to contract and deliver the requisite renewable energy capacity to meet the 50% renewable energy target, and only provide support when the level of renewable generation is not being developed.
- Where additional incentives are required, reverse auctions for CFDs appear to be the most effective policy mechanism to incentivise the development of renewable energy projects in Queensland post 2020. Reverse auctions for CFDs allow the market to determine the required level of financial support, which is more likely to deliver investment in renewable energy efficiently.
- Reverse auctions for CFDs also enable the overall level of support for renewable energy to be scaled up or down based on market developments and changes in national policy, in line with the principles of being complementary and flexible, while still providing investment certainty for contracted parties.
- Alongside harnessing current mature renewable technologies, the Government could consider targeting the development of dispatchable renewable technology and also fringe-of-grid solutions as part of its reverse auction program.
- Modelling for the Panel indicates that early retirement of coal-fired generation in Queensland is not required in order to achieve a 50% renewable energy target. However, should the Queensland Government undertake further consideration of the need for early coal retirements, this should be progressed at the national level and/or with other jurisdictions as part of a broader consideration of emission reduction policies.
- Broader economic policy measures targeted at reducing greenhouse gas emissions, such as carbon pricing, are likely to be an effective enabler of new renewable energy capacity, but given their broad effect and the nature of the interconnected market, these measures would be more efficiently implemented nationally.

Chapter 8: Analysis of credible pathways to a 50% renewable energy target

- The Panel has assessed three alternative post-2020 pathways to meeting a 50% renewable energy target for Queensland by 2030:
  - *Linear pathway:* Assumes a uniform annual rate of renewables build from 2020-2030
  - *Ramp pathway:* Features a ramp up in effort later in the period to capitalise on falling technology costs over the period
  - *Stronger National Action pathway:* Assesses what additional Queensland Government action would be required to reach a 50% target if a stronger national emissions reduction scheme is put in place from 2020 to achieve a 45% reduction in electricity sector emissions on 2005 levels by 2030.
- Analysis of these pathways shows:
  - Under the *Linear* and *Ramp* pathways, between 4,000 to 5,500 MW of new large-scale renewable energy generation capacity is projected to be required in Queensland between 2020 and 2030 to achieve a 50% output target, in addition to Queensland's pro-rata share of the LRET. This equates to up to 13,400 GWh of new renewable generation.
  - Under all three pathways, policy action required by the Queensland Government to achieve the Queensland 50% target is of itself projected to be cost neutral overall to electricity consumers where the cost of funding the policy action is recovered through electricity market mechanisms. This occurs as a result of the policy action having a projected downward pressure on wholesale electricity prices. There is no expected effect on electricity prices prior to 2020 under Queensland policy measures, due to the timing of project development and availability of LRET funding.

- Under the *Linear* and *Ramp* pathways, Queensland's electricity sector emissions in 2030 are projected to be 25% lower (or 12 million tonnes carbon dioxide equivalent (Mt CO_2-e)) relative to 2016 levels. The *Linear* pathway results in greater emission reductions for the 14 years of the policy than the *Ramp* pathway. Under the *Stronger National Action* pathway, Queensland's electricity sector emissions in 2030 are projected to be 15 Mt CO_2-e lower relative to 2016 levels (or 31% lower).
- The cost of constructing renewable generation is projected to fall over time. The overall projected subsidy required to achieve the Queensland target would be lower under the *Ramp* pathway ($500 million NPV) than the *Linear* pathway ($900 million NPV), as projects are commissioned closer to 2030. This however, results in less cumulative emissions reduction during the period between 2016 and 2030 as compared to the *Linear* pathway (59 Mt CO_2-e across the NEM in the *Ramp* pathway compared to 81 Mt CO_2-e in the *Linear* pathway).
- Under the *Stronger National Action* pathway, the national emissions intensity scheme results in Queensland reaching 41% renewables. Approximately 1,900 MW of additional large-scale renewable generation would be required to reach the 50% target, but the projected level of subsidy required ($50 million NPV) would be significantly lower than in the *Linear* or *Ramp* pathways due to the level of contribution of the stronger emissions intensity scheme.
- Operating cash flows for existing Queensland coal generators is projected to decline by $600-$1,100 million NPV under the *Linear* and *Ramp* pathways, due to renewable generation displacing coal generation output and reducing wholesale prices in the NEM, with no effect expected prior to 2020 under the modelling.

► The Panel recognises that the Queensland Government retains ownership of around two-thirds of the Queensland's large-scale generating capacity and while any impact on these generators is outside the scope of the Panel, this impact should be considered by the relevant Shareholding Ministers.

Chapter 9: Facilitating large-scale renewable energy projects

► Given the number of projects required to achieve the 50% target, there will be an increased requirement on local government authorities, state agencies and network service providers to undertake project approvals and electricity network connections. Due to the progressive investment requirements and the nature of renewable energy resources, project approvals and connection processes are likely to occur concurrently and potentially for projects in similar locations.

► While the project planning and approvals processes in Queensland are considered generally appropriate, there are likely to be benefits from a more coordinated approach to assist project developers as well as the entities assessing projects. Similarly, there may be benefits in the Government providing additional support and resources to local government authorities in approving projects.

► The network businesses will be critical in enabling the implementation of the Queensland Government's 50% renewable target. Most new large-scale renewable plant will need to connect to either a transmission or distribution network or will otherwise impact the operation of a network.

► Stakeholders raised concerns with the network connection process for renewable energy projects in terms of timeframes and costs, and suggested that additional resourcing for the network businesses and more streamlined processes for network connection would assist projects.

► There is a range of technical information that can be provided to assist developers in the early stages of the connection process and there are positive indications Queensland's network service providers are working to improve information provision.

- As there are likely to be a number of individual generators seeking to connect to the electricity network, there are likely to be benefits from co-ordinating connections. There will be some natural constraints to co-ordination but there is merit in considering the development of renewable energy hubs or zones.

Chapter 10: Integration of renewables into the National Electricity Market

- Queensland electricity consumers must continue to receive reliable power supply during the transition to 50% renewable generation. Analysis by Jacobs does not identify reliability issues in Queensland, due to significant controllable thermal electricity generation retained in service to 2030.
- AEMO has undertaken analysis of the integration of renewable energy in the NEM and has not identified any fundamental barriers to achieving higher penetrations of renewable generation in Queensland provided complementary measures are in place. AEMO will continue to monitor the integration of renewable energy across the NEM.
- AEMO is also analysing the likely impact on overall system security and the potential need to expand some parts of the Frequency Control Ancillary Services (FCAS) market in particular. This is also the subject of a current Rule Change proposal before the Australian Energy Market Commission (AEMC).
- While the high penetration of renewable energy in South Australia was a contributor to the closure of the local coal-fired power station and higher electricity prices, other factors such as the level of market concentration, heavy reliance on gas-fired generation, rising gas prices, the availability of pipeline capacity and retailer strategies in the South Australian retail market have also had a significant influence on higher prices.
- Modelling indicates the 50% renewable energy target for Queensland can be met while maintaining the required reliability standard in Queensland. In contrast to the South Australian experience, coal-fired generation is expected to continue to play a significant, but reduced role in Queensland to 2030 under a 50% target.
- The Panel understands the Queensland Government is currently investigating options to address the regulatory and commercial constraints to greater uptake of small and medium-scale solar PV, particularly at the commercial-industrial scale.
- The Queensland Government, through participation in the COAG Energy Council, is supporting a range of measures under the National Energy Productivity Plan, which are expected to facilitate uptake of small and medium-scale solar PV.

Chapter 11: Supporting economic development

- While achieving a 50% renewable energy target in Queensland represents a significant shift within the electricity sector, economic modelling indicates it does not result in a major effect across the whole economy. Based on the *Linear* pathway, GSP is projected to be 0.2% higher in 2030 compared with the *Base case* (i.e., $5.4 billion NPV higher). However, Gross Domestic Product (GDP) is projected to remain unchanged in the period to 2030 due to reductions in GSP in other jurisdictions.
- The benefits to the Queensland economy are largely driven by the additional investment in renewable energy, estimated at $6.7 billion (NPV) to 2030, which will be captured primarily in direct construction and construction services. There is a shift from fossil fuels to renewable energy generation, with a reduction in real value added (RVA) from the electricity generation sector.
- The modelling projects a 50% target will deliver a net increase in employment in Queensland, with around 6,400-6,700 additional FTEs employed on average between 2020 and 2030 (primarily relating to construction) under the *Linear* and *Ramp* pathways (compared with the *Base case*). This increase in employment in Queensland is offset by reductions in other jurisdictions with no net projected increase in employment nationally.

- The majority of the economic benefits in Queensland are driven by the increased investment in renewable energy capacity. The modelled reduction in electricity prices contributes around 15-20% of the benefits to the Queensland economy. Almost all of the economic benefits across the rest of Australia flow from modelled lower electricity prices. However, these benefits are more than offset by the projected loss of investment across the rest of Australia.
- While the majority of manufactured components are likely to be imported, there are opportunities for Queensland to capture an increased share of overall investment in renewable energy projects by improving the competitiveness of its relevant supply chain industries. Key opportunities exist in development and design, fabrication, construction and financing.
- Policy initiatives have been utilised in Australia and internationally to increase the competitiveness of local renewable energy supply chains, focusing on improving the skills and capability within local businesses, ensuring local businesses have opportunities to participate in the development of projects and incentivising international businesses to establish operations in local markets.
- The unique characteristics of Queensland's electricity supply system means that Queensland businesses may be well placed to export (nationally and globally) expertise and services relating to fringe-of-grid and isolated network applications, including medium-scale renewable plant and more advanced network solutions for high penetration of distributed renewables.
- The transition to renewable energy would, over the long term, have implications for communities that currently rely on fossil fuel generators for direct and indirect employment and income. However, it is likely that future investment in renewable energy will occur in regional Queensland to offset some of these effects.
- The Government has a role to play in supporting the communities and industries through the transition. Primarily, the Government can influence the pace of the transition, but also has a role in working with relevant bodies to develop the future workforce requirements and shaping the regulatory environment.

1.3. Recommendations

Table 1: Recommendations

Section	Recommendation
Chapter 4: Defining Queensland's renewable energy target	1. The Panel recommends that a Queensland renewable energy target: – Is based on Queensland's electricity generation sector only – Applies the same renewable energy sources as defined under the LRET – Includes contributions made from small-scale solar PV, wind and hydro systems – Follows the principle of technology neutrality, but allows for the development of programs that target specific technologies and/or applications of renewable energy – Is expressed in percentage terms in the long term, but allows for the establishment of short and medium term fixed targets based on predetermined levels of renewable energy generation – Is based on renewable energy output (e.g., GWh), not renewable energy capacity (e.g., MW) – Is not legislated as a broad target, noting that legislation may be required to support specific policy initiatives (for example, legislation may be required where the costs of the scheme are to be recovered from parties outside of the government) – Includes Queensland's pro-rata share of renewable energy generation under the LRET.

Chapter 5: Leveraging existing Federal support schemes to 2020	2.	In order to leverage the opportunities for renewable energy investment under the LRET, the Panel recommends the Queensland Government should undertake a reverse auction process for CFDs in 2017-18 for the delivery of further renewable energy capacity prior to 2020. The Panel recommends an indicative capacity target of up to 400 MW, with the target to be reviewed based on the level of renewables developed by the market, and the competitiveness of projects in the market. Preparatory work should commence as soon as possible on auction design and sourcing the necessary capabilities and advisors to undertake the auction.
	3.	In order to enhance the potential benefits from investment in renewable energy, the Queensland Government could consider incentivising some R&D in renewable energy as part of the policy, with a specific focus on regional Queensland.
Chapter 6: National energy and climate change policy post 2020	4.	As part of implementing its renewable energy policy, the Panel recommends the Queensland Government should proactively support the development of integrated climate and energy policies at the national level, as the most efficient way of achieving carbon emission reductions and uptake of renewable energy.
	5.	The Panel recommends the Queensland Government should consider the principles of complementarity, flexibility and adaptability when designing its renewable energy target, to provide greater credibility and durability to its policy.
Chapter 7: Queensland renewable energy policy options post 2020	6.	The Panel recommends the Queensland Government should not introduce any additional policy mechanisms beyond the Small-scale Renewable Energy Scheme (SRES) that provide financial support for small-scale renewable energy.
	7.	The Panel recommends that the primary mechanism for delivering new large-scale renewable energy capacity post 2020 should be through reverse auctions for CFDs.
	8.	While the overall approach to running reverse auctions should be technology neutral, the Panel recommends the Government investigate opportunities for running specific reverse auctions for dispatchable renewable energy and isolated and/or fringe-of-grid solutions.
	9.	Given that consumers are the ultimate beneficiaries of electricity that is generated in the market, the Panel recommends that the costs of the CFDs are recovered through electricity market mechanisms. Under the modelling the net effects of the policy on consumers are expected to be broadly cost neutral (including the estimated subsidy and modelled effect on wholesale prices).
	10.	The Panel recommends the Queensland Government should not pursue the implementation of broader state-based economic policy mechanisms, such as carbon pricing, for the purpose of meeting the 50% renewable energy target. However, these policies could be considered by the Queensland Government in the context of coordinated policy action with other jurisdictions in the NEM or nationally, aimed at facilitating emission reductions.
Chapter 9: Facilitating large-scale renewable energy projects	11.	The Panel recommends the Queensland Government assess options to provide focused and centralised information about project planning and approvals processes to assist both project developers and those entities assessing proposals. These options could include the development of dedicated web-based resources and the creation of centralised facilitation roles, similar to the NSW Renewable Energy advocate.

	12. The Panel recommends that the Queensland Government work with the network businesses to ensure that the business have adequate internal resourcing and implement appropriate workflow planning measures to be able to manage the expected increase in connections for renewable generators under the 50% renewable energy target. 13. The Panel recommends the Queensland network businesses consider options to improve the process for network connection. This should be considered in the context of a likely increase in the volume of renewable related network connection inquiries. It should also consider the open provision of information to assist early stage assessment and the co-ordination of network connections. 14. The Panel recommends the Queensland Government and the Queensland network businesses continue to consult with ARENA in the development of its Australian Renewable Energy Mapping Infrastructure (AREMI) mapping tool, to ensure accurate and up to date information is included in the map. 15. The Panel recommends that the concept of developing renewable energy hubs or zones should be investigated further in Queensland, with the potential for this to form part of a future reverse auction process.
Chapter 10: Integration of renewables into the National Electricity Market	16. The Panel recommends that the Queensland Government works proactively with AEMO to assist with efficient policy development, particularly in regard to system security and the development of ancillary services markets. Elements of this co-operation could include: – Joint analytical activities monitoring the effect of renewable energy uptake in Queensland, incorporating state and national data to identify potential challenges early on – Leveraging AEMO studies such as the National Transmission Network Development Plan to inform the technical requirements of delivering the target, and stress testing potential policy options as state and federal policies evolve – Exchanges of AEMO and Queensland Government staff to maximise information transfer between the two agencies. 17. The Panel recommends the Queensland Government facilitate the collection and disclosure of relevant data on embedded systems to assist AEMO in managing power system security and reliability, to the extent this data is not collected by other organisations such as the Clean Energy Regulator. 18. The Panel recommends that the Queensland Government continue to explore ways to work co-operatively with other State and Federal Governments on measures to enhance customer uptake of renewable energy systems, so as to avoid duplication of effort and inconsistent approaches across jurisdictions. 19. The Panel recommends that the Queensland Government investigate the use of solar PV on state-owned buildings, where it is cost effective to do so.
Chapter 11: Supporting economic development	20. The Panel recommends Queensland Government engage with Queensland secondary and tertiary education institutions to identify opportunities for research in relevant renewable energy supply chain industries.

	21. The Panel recommends the Government includes consideration of local content as part of any reverse auction process to ensure that local businesses are provided the opportunity to compete for the development of renewable energy projects in Queensland. 22. The Panel recommends the Queensland Government seek to promote investment opportunities in the Queensland renewable industry through its international partnerships and agreements, including developing incentives for attracting international firms to the state.

1.4. Summary of key projected outcomes

A summary is included in Table 2, showing the key projected electricity market and economic outcomes of policy action under the *Linear* and *Ramp* Pathways.

Table 2: Summary of key projected outcomes (relative to the *Base case*)

Indicator	*Linear* pathway	*Ramp* pathway
New large-scale renewables	up to 5,500 MW	up to 5,500 MW
QLD investment	$6.7 billion NPV	$6.1 billion NPV
Residential electricity price effects (average)	Broadly neutral	Broadly neutral
QLD electricity sector emissions reduction in 2030	10 Mt CO_2-e (20% reduction)	10 Mt CO_2-e (20% reduction)
Cumulative emissions reductions (NEM)	81 Mt CO_2-e	59 Mt CO_2-e
Subsidy payments to renewables[1]	$0.9 billion NPV	$0.5 billion NPV
Increase in resource costs[2]	$3.0 billion NPV	$2.5 billion NPV
Increase in QLD Gross State Product	$5.4 billion NPV	$5.2 billion NPV
Net average annual QLD employment, 2020-2030	6,400 FTE	6,700 FTE
Closure of coal-fired plant	Zero MW	Zero MW

1.5. Summary of feedback from stakeholders on Draft Report

In response to the Draft Report (released 12 October 2016), the Panel received a number of public submissions across a range of stakeholder groups, including:

- 237 individualised submissions and 1,700 proforma email submissions from members of the public
- 25 industry organisations (project developers, network businesses and energy retailers)
- 24 peak bodies and community advocacy groups
- 21 environmental organisations
- 2 education institutions.

The 1,700 email submissions identified support for increasing Queensland's renewable energy target to 100%, legislating the target, and developing a plan to ensure a smooth transition.

A summary of the key stakeholder themes is presented in Table 3.

[1] Refers to the NPV of payments under CFDs to contract parties to deliver renewable energy generation
[2] Refers to the NPV of the change in capital, operating, fuel and emissions costs

Table 3: Summary of stakeholder feedback on the Draft Report

Theme	Stakeholder feedback
Defining the target	▶ A number of stakeholders, including environmental organisations and some industry peak bodies, did not support the inclusion of Queensland's pro-rata share of the LRET in the target, suggesting that this approach could result in reduced investment and employment in Queensland. ▶ Several environmental stakeholders and individuals suggested that the target should be legislated on the basis that this would provide a greater degree of certainty for investors. ▶ Environmental groups were generally of the view that wood waste should be removed from being an eligible source of renewable energy under the target.
Policy mechanism	▶ There was general view among stakeholders that renewable proponents should be exposed to an appropriate level of market and commercial risk through the policy mechanism. ▶ Stakeholders generally supported the use of CFDs. However, some industry stakeholders suggested that other approaches, such as the use of upfront capital payments, could be an alternative way of supporting large-scale renewable energy projects. ▶ Industry participants provided a range of suggestions around how CFDs could be structured to reduce the cost to government and electricity consumers. ▶ Some submissions indicated a preference for the Queensland Government to support more than 400 MW through the pre-2020 reverse auction.
National energy and climate change policy	▶ There was broad consensus from stakeholders that the Queensland Government support the development of integrated climate and energy policies at the national level.
Analysis of credible pathways to a 50% renewable energy target	▶ Of the stakeholders that commented on the pathways, there was a general preference toward the *Linear* pathway on the basis of the environmental outcomes that could be achieved under this pathway. However, some stakeholders also supported the *Ramp* pathway, recognising that this approach could deliver renewable energy at lower cost. ▶ A number of industry peak bodies queried the Jacobs' modelled outcome of no coal-fired plant closing under the *Linear* and *Ramp* pathways, and requested further analysis be undertaken to determine the price impacts of early coal-fired retirement.
Integration of renewables into the National Energy Market	▶ The majority of stakeholders acknowledged the importance of system security and were generally supportive of the Queensland Government engaging with AEMO on matters relating to security, reliability and market design. ▶ A number of industry stakeholders highlighted the importance of undertaking more detailed modelling to understand how the system might respond under increasing levels of renewable generation. ▶ Several submissions commented on the importance of introducing dispatchable renewable generation technologies in the market, including renewable energy with storage and demand side management, and the need for ancillary services or other system support markets.
Planning and network connections	▶ Stakeholders supported improvements to planning and approvals process, including efforts to streamline the regulatory framework. ▶ Stakeholders also supported measures to streamline the network connection process, with some industry stakeholders advocating for the introduction of a contestable connections framework.

2. Basis of the public inquiry

2.1. Role of the Expert Panel

The public inquiry into a 50% renewable energy target for Queensland was announced by the Honourable Mark Bailey MP, Minister for Main Roads, Road Safety and Ports and Minister for Energy, Biofuels and Water Supply on 27 January 2016.

An Expert Panel (the Panel) was appointed to undertake the public inquiry review, comprising: Mr Colin Mugglestone, Ms Allison Warburton, Mr Paul Hyslop, Ms Amanda McKenzie and Prof Paul Meredith. The Panel is supported by a Secretariat in the Department of Energy and Water Supply. Biographies of each Panel member are in Appendix A.

The Terms of Reference require the Panel to investigate and report on the costs and benefits of adopting a target of 50% renewable energy in Queensland by 2030, and to determine how the adoption of a renewable energy target and other complementary polices can drive the development of a renewable energy economy for Queensland. The full Terms of Reference are in Appendix B.

2.2. The Panel's approach

In considering the requirements of the Terms of Reference, the Panel has approached the inquiry by considering the opportunities for developing Queensland's renewable industry in two separate timeframes: prior to 2020; and post 2020. The year 2020 marks a critical juncture for several reasons:

- Pre 2020, national policy settings are known and there is an opportunity for Queensland to leverage the Federal LRET to bring more renewable energy projects to Queensland. There is also limited lead time for the implementation of policies, which constrains the policy options available to Government.
- Post 2020, the LRET is expected to be fully subscribed so the development of new renewable projects will more heavily rely on policies implemented by the Queensland Government. In addition, there is greater potential for other emissions reduction policies to be introduced at the national level.

As part of its assessment of credible pathways, the Panel has examined the technical, commercial issues and environmental issues, costs and benefits, and impacts and opportunities involved in meeting a 50% renewable energy target.

The Panel's analysis draws on extensive public consultation undertaken with stakeholders, research undertaken by the Panel, and modelling and analysis commissioned from external advisors.

2.2.1. Public consultation

The Panel consulted widely with interested parties to gather information for the public inquiry, utilising a range of engagement methods, as outlined in Table 4.

Table 4: Summary of consultation methods

	Issues Paper	Draft Report
Stakeholder Submissions	► The Panel released its Issues Paper on 10 May 2016, which set out the main elements of the inquiry ► The Panel received over 50 formal submissions	► The Panel released its Draft Report on 12 October 2016, setting out the Panel's initial findings and recommendations ► The Panel received over 300 individualised submissions and around 1,700 proforma email submissions

	Issues Paper	Draft Report
Forums	▶ During May and June 2016 the Panel hosted public forums in Townsville, Chinchilla, Gladstone, Mount Isa, Brisbane, Sunshine Coast and Emerald ▶ An industry forum was also held in Brisbane ▶ The forums allowed the Panel to gain a detailed understanding of the key issues and concerns of the community and industry, as well as the opportunities, in transitioning toward greater use of renewable energy	▶ During October 2016 the Panel hosted public forums in Mackay, Rockhampton, Cairns, Bundaberg, Toowoomba and Gold Coast ▶ An industry forum was also held in Brisbane ▶ The forums allowed the Panel to receive feedback from the community and industry on the findings and recommendations contained in the Draft Report
Meetings	▶ The Panel conducted 25 face to face meetings with stakeholders representing the renewables industry, electricity retailers and generators, environmental groups, network service providers and unions	
Website	▶ The Panel also used an online platform which allowed members of the public to comment on key questions posed by the Panel, and to make online submissions	

2.2.2. Contractors

In addition to the submissions and stakeholder consultations, the Panel's findings and recommendations have been informed by a range of external advisors, including:

- ▶ Jacobs, who undertook electricity market modelling that assessed the impacts of alternative pathways to 50% renewable energy generation in Queensland by 2030
- ▶ CoPS, who performed general equilibrium modelling to assess the economic costs and benefits of 50% renewable energy generation in Queensland
- ▶ KPMG, who provided analysis on the supply chain opportunities for Queensland as part of establishing a renewable energy economy.

2.3. Report outline

Table 5 provides an overview of the structure of the report.

Table 5: Report structure

Title	Content
Chapter 3: Queensland's electricity sector, greenhouse gas emissions and the role of renewables	▶ Provides an overview of Queensland generation mix and the key contributors to the state's greenhouse gas emissions ▶ Describes Queensland's renewable energy industry and resource potential, and outlines the major support mechanisms for renewable energy currently available in the market
Chapter 4: Defining Queensland's renewable energy target	▶ Considers the elements that will define Queensland's 50% renewable energy target including, what should be included in the target and how it should be measured
Chapter 5: Leveraging existing Federal support schemes to 2020	▶ Identifies the opportunities for incentivising investment in renewables in Queensland prior to 2020
Chapter 6: National energy and climate change policy post 2020	▶ Outlines the current and potential future national energy and climate policies, and discusses how these policies may influence the setting of a state based renewable energy target
Chapter 7: Queensland renewable energy policy options post 2020	▶ Outlines the policies that could be implemented to incentivise investment in renewable energy post 2020

Title	Content
Chapter 8: Analysis of credible pathways to a 50% renewable energy target	▶ Outlines the findings of the quantitative analysis regarding credible pathways to achieving a 50% renewable energy target in Queensland by 2030
Chapter 9: Facilitating investment in renewable energy projects	▶ Outlines approaches to streamlining the process for renewable projects in Queensland
Chapter 10: Integration of renewables into the National Electricity Market	▶ Outlines the technical challenges associated with a higher penetration of renewables, and discusses approaches to managing the integration of high levels of renewable energy generation
Chapter 11: Supporting economic development	▶ Outlines the quantitative analysis of the economic impacts for Queensland associated with achieving 50% renewable energy generation by 2030 ▶ Outlines the supply chain opportunities for Queensland as part of establishing a renewable energy economy

3. Queensland's electricity sector, greenhouse gas emissions and the role of renewables

Draft Findings

- Queensland produces the most greenhouse gas emissions of any state in Australia, with the single largest source of emissions being from the electricity generation sector.
- While Queensland has the highest percentage of small-scale rooftop PV penetration in Australia, it has the lowest installed capacity of large-scale renewables in the NEM.
- Queensland has significant solar resources and there are potential wind sites that could be utilised to meet the 50% target. Industry advice suggests there is also potential for other renewable energy technologies, such as biomass and pumped storage hydro to contribute to Queensland's energy mix.

3.1. Electricity capacity and generation

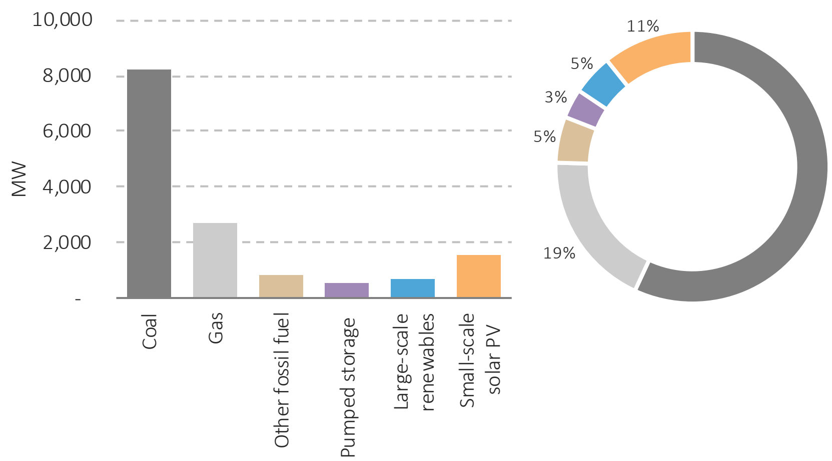
3.1.1. Installed capacity

Queensland currently has approximately 14,100 MW of installed electricity generation capacity, including approximately:

- 12,400 MW of installed capacity connected to the NEM and Mount Isa
- 150 MW of non-market generation capacity, which is either behind-the-meter large-scale generation that is consumed on site, such as at sugar mills (and therefore not connected to the NEM), or below the threshold that requires registration of generation capacity with AEMO (typically below 5 MW)
- 1,550 MW of small-scale solar PV.

As highlighted in Figure 2, coal is the predominant fuel source for electricity generation in Queensland (57% of capacity), reflecting the state's traditionally strong resource sector and high quality coal deposits. Gas is the second biggest source of electricity generation (19% of capacity), with the remainder supplied by renewable energy, pumped storage hydro-electric and other fossil fuels.

Figure 2: Queensland electricity generation capacity, 2015 (MW)



Source: AEMO 2016a, Clean Energy Regulator 2016a

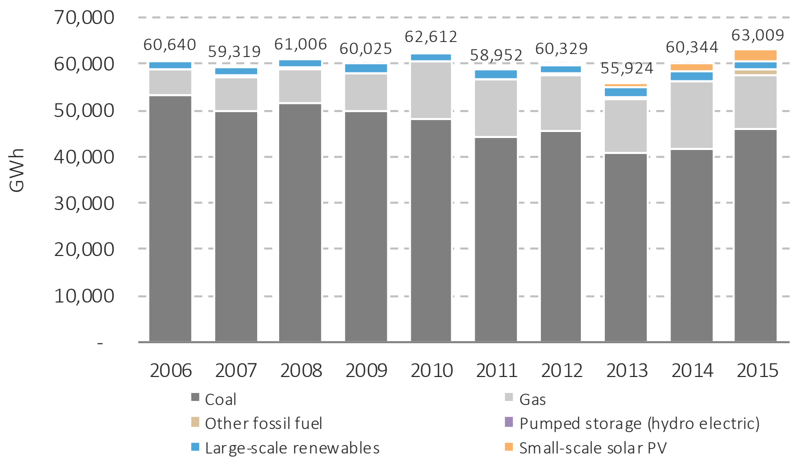
3.1.2. Electricity generation

Figure 3 shows annual electricity generation output in Queensland between 2006 and 2015. While coal has historically provided the majority of Queensland's electricity generation, its share has gradually reduced over the past decade with the growth of Queensland's gas industry. Between 2006 and 2015 the share of coal-fired generation reduced from 88% to 73%, while gas increased from 10% to 18% over the same time period.

Renewable energy has typically contributed a small, but growing, amount of electricity generation in Queensland. Large-scale renewables (mainly comprised of biomass and hydro) have contributed around 3% to Queensland's generation output over the last decade. However, the recent emergence of small-scale solar has had a substantial impact in the Queensland electricity sector, to the extent that rooftop PV (the majority of which is residential) now accounts for around 4% of Queensland's electricity output.

Queensland's remaining electricity generation is mainly from diesel generators used to supply rural areas or remote mine sites.

Figure 3: Queensland electricity generation output, 2006-2015 (GWh)

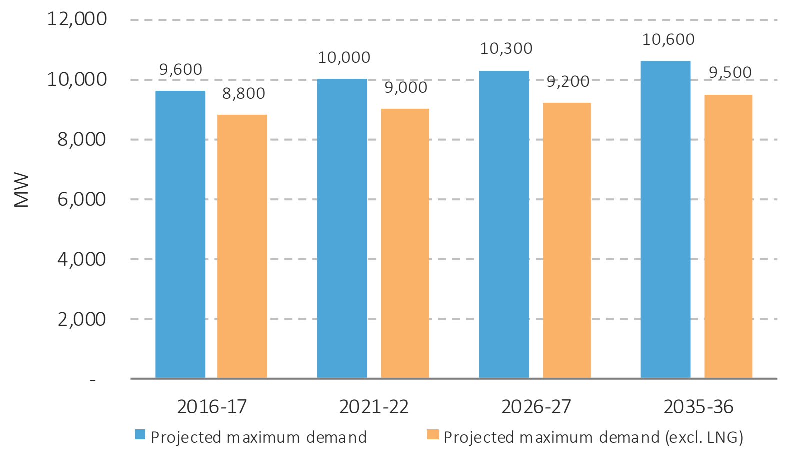


Source: DEWS analysis based on data from AEMO

3.2. Forecasts of future demand

According to AEMO, electricity demand in Queensland is expected to increase by 10.4% (or 0.5% compound annual growth) between 2016-17 and 2035-36, which is the highest rate of demand growth in the NEM (all other states have nil or negative demand growth over the period)[3]. LNG production is expected to be a significant contributor to Queensland's maximum demand over the 20-year period, with AEMO forecasting it could add 1,000 MW to the maximum demand (10% POE) by 2035-36.

Figure 4: Queensland summer maximum demand forecast, 10% POE (MW)



Source: AEMO 2016b

[3] AEMO 2016b

In AEMO's current assessment of generation requirements, AEMO has estimated new generation capacity will not be needed for Queensland until at least 2025. This means the policy requirement for new renewable generating capacity is likely to occur in an electricity market where there is a limited demand for new capacity in Queensland. This suggests that to achieve a 50% renewable energy target in Queensland by 2030, growth in renewables will be required to outpace growth in electricity demand and displace some generation from existing generators, all other things being equal.

3.3. Climate change and Queensland greenhouse gas emissions

3.3.1. Climate change

Increasing temperatures

Globally, February 2016 was the warmest February in 136 years of modern temperature records – around 0.5°C warmer than the previous record set in February 1998 and 1.35°C above the 1951–80 average[4]. This was not an anomaly, with fourteen of the hottest years on record having occurred in the last fifteen years.

Consistent with global trends, Australia's climate has also warmed since national records began in 1910. According to the Bureau of Meteorology, the average surface air temperature in Australia has warmed by 0.9°C since 1910, and each decade has been warmer than the previous decade since the 1950s[5]. The CSIRO expects Australian temperatures to continue to increase, noting[6]:

> *There is very high confidence in continued increases of mean, daily minimum and daily maximum temperatures throughout this century for all regions in Australia.*

The greenhouse effect

Driving these temperature changes is the build-up of greenhouse gas emissions in the atmosphere. Greenhouse gas emissions trap heat and warm the planet. Over the last 150 years, human activities are responsible for almost all of the increase in greenhouse gas emissions in the atmosphere, with the main contributors being burning of fossil fuels, deforestation, and land use change[7].

Implications for Queensland

Queensland has much to lose should the impacts of climate change be realised. The Australian Government has identified a series of potential impacts of climate change to Queensland in the long run, being[8]:

- Putting at risk significant transport and building infrastructure as a result of rising sea levels
- Substantial economic and employment loss as a result of coral bleaching within the Great Barrier Reef Marine Park
- Loss of flora and fauna in the Wet Tropics rainforests due to increasing average temperature and reduced rainfall
- More intense storm activity, with the potential for cyclones to move further south as sea surface temperatures rise.

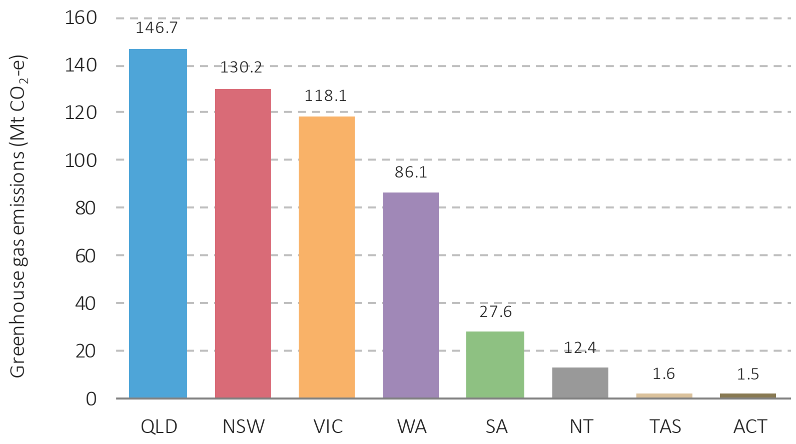
Increasing the contribution of renewable energy in the power generation mix is a key strategy for mitigating the impacts of climate change. By displacing the use of coal and gas-fired generation, renewable energy will reduce the carbon intensity from the electricity generation sector. For example, the Federal RET, is projected to reduce emissions by about 200 million tonnes of carbon dioxide equivalent (Mt CO_2-e) between 2015 and 2030[9].

[4] NASA 2016
[5] Bureau of Meteorology 2016a
[6] CSIRO 2015, p6
[7] United States Environmental Protection Agency 2016
[8] Department of the Environment and Energy 2016a
[9] Climate Change Authority 2015, p7

3.3.2. Queensland's greenhouse gas emissions

Queensland is currently the largest producer of greenhouse gas emissions in Australia, and Australia is the 7th largest emitter of greenhouse gases in the OECD[10]. In 2014, Queensland's greenhouse gas emissions were 146.7 Mt CO_2-e, representing around 28% of Australia's total emissions (524.2 Mt CO_2-e)[11].

Figure 5: State and territory greenhouse gas emissions, 2014 (Mt CO_2-e)

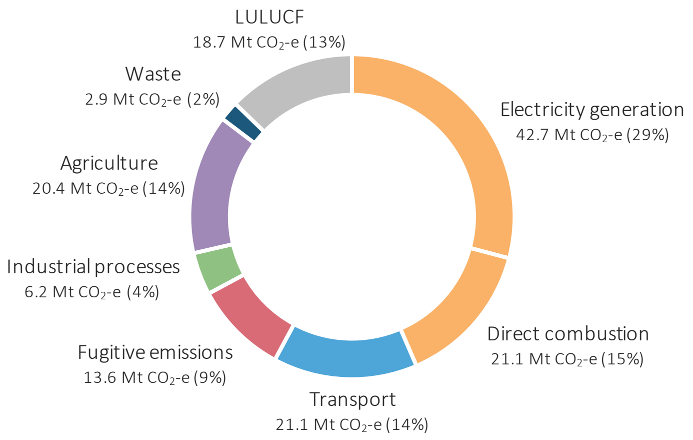


Source: Department of the Environment and Energy 2016b

As illustrated in Figure 6, the stationary energy sector remains the largest source of Queensland's emissions, contributing 63.8 Mt CO_2-e in 2014, or 44% of Queensland's total emissions. Emissions from the stationary energy sector result from the generation of electricity and the direct combustion of fuels for purposes other than transport.

Queensland power stations are the largest single source of emissions in the state, contributing 42.7 Mt CO_2-e in 2014, or 29% of Queensland's total emissions. Emissions from electricity generation have increased by 2.7% per year (compound annual growth) since 1990 levels.

Figure 6: Queensland greenhouse gas emissions by sector, 2014 (Mt CO_2-e)

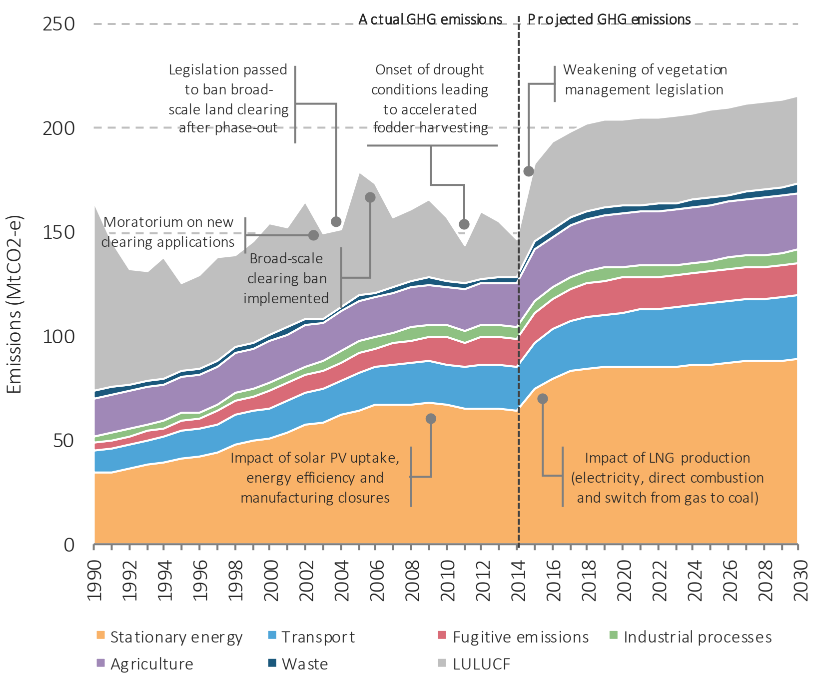


Source: Department of the Environment and Energy 2016b

While Queensland's emissions have trended downward over the last decade, analysis by the Department of Environment and Heritage Protection (EHP) suggests Queensland's emissions could increase to around 215.3 Mt CO_2-e by 2030 without further policy action (Figure 7).

[10] Organisation for Economic Co-operation and Development 2016
[11] Department of the Environment and Energy 2016b

Figure 7: Queensland historic and projected greenhouse gas emissions (Mt CO_2-e)

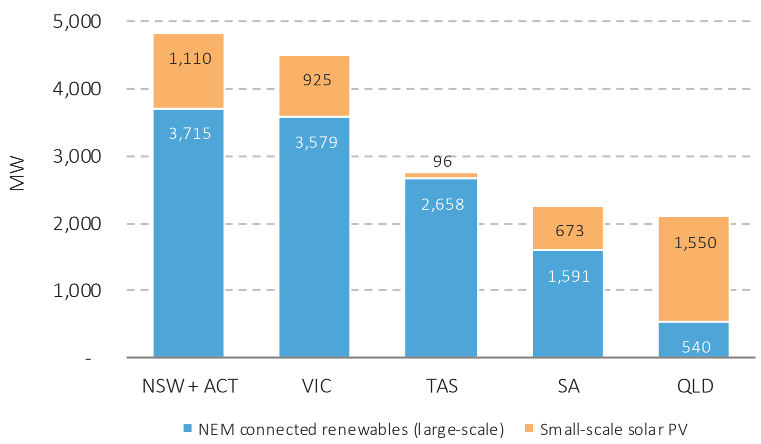


Source: Department of Environment and Heritage Projection 2016, slightly edited

3.4. Renewable energy industry

By NEM standards, Queensland has a relatively minor share of the total installed renewable energy generating capacity. As highlighted in Figure 8, while Queensland has the largest installed capacity of rooftop PV, it has the lowest level of large-scale renewables in NEM.

Figure 8: Renewable energy capacity by NEM region (MW)



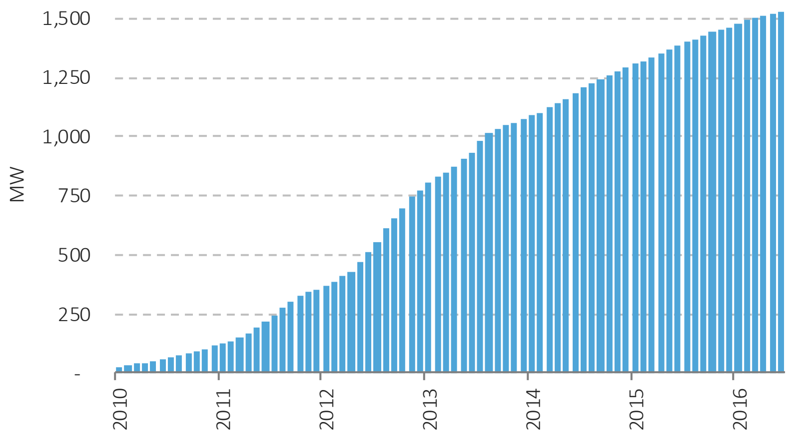
Source: AEMO 2016a, Clean Energy Regulator 2016a

3.4.1. Small-scale renewables

Queensland currently has around 1,500 MW of small-scale solar PV (as at June 2016), which is the highest level of installed capacity of any Australian state. Queensland also has one of the highest penetration of rooftop PV in the world, with almost 30% of all houses having a system installed (478,600 installations) as at June 2016.

Solar uptake peaked in Queensland in 2012, with around 35 MW installed each month on average during the year. While Queensland continues to have the strongest uptake relative to other states, the rate of uptake has slowed since 2012, with around 14 MW installed each month over the last 12 months.

Figure 9: Installed capacity of solar PV in Queensland, as at July 2016 (MW)



Source: DEWS analysis based on data from Energex and Ergon Energy

3.4.2. Large-scale renewables

Table 6 outlines Queensland's existing large-scale renewable generation capacity disaggregated by technology. Most of Queensland's large-scale renewable energy generation is from biomass, burned in plants, which were built between 1950 and 1970, with the majority of these facilities using bagasse as fuel, reflecting the state's strong sugarcane industry. The other major source of large-scale renewable generation in Queensland is hydro. The state has two large-scale hydro facilities, Kareeya (88 MW) and Barron Gorge (66 MW), which operate using river flow.

Historically, Queensland has not seen the level of development in wind generation capacity that southern states have seen, due to a combination of cost, network configuration and existing generation capacity. However, there are indications that this dynamic is changing with Ergon Energy Queensland[12] recently signing a PPA with Ratch Australia Corporation for the output of the 180 MW Mount Emerald Wind Farm to be constructed near Mareeba. Similarly, while Queensland has not yet attracted significant investment in large-scale solar PV, in May 2016 Origin Energy (Origin) announced the signing of a PPA with Fotowatio Renewable Ventures (FRV) for the output of the new 100 MW Clare Solar Farm, near Townsville. Additionally, the Queensland Government is currently in the final stages of a process to provide financial support for the development of 148 MW of large-scale solar PV capacity.

Table 6: Queensland existing large-scale renewable energy capacity, NEM connected and non-NEM connected (MW)

Technology	Number of facilities	Installed capacity
Biomass	48	467.5 MW
Hydroelectric	11	203.5 MW
Wind	2	12.5 MW
Solar	10	10.0 MW [13]
Geothermal	1	0.12 MW
Total	**72**	**693.5 MW**
Hydroelectric pumped storage	1	500 MW

Source: Clean Energy Regulator 2016b

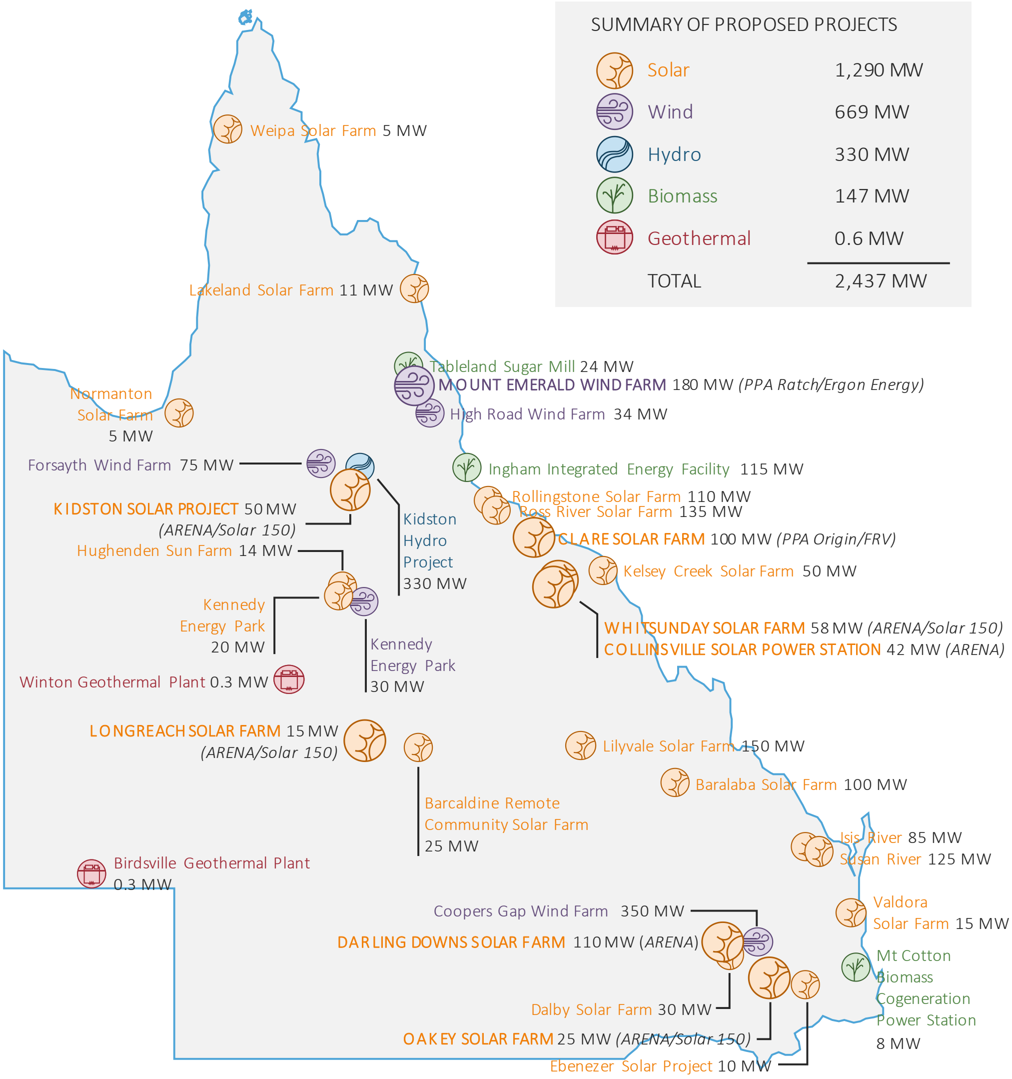
[12] The Panel notes that Ergon Energy and Energex have recently merged under a single parent entity, "Energy Queensland Limited".

[13] Note, the 10MW of "large-scale" solar is comprised of systems in the Commercial Industrial Scale (sector several hundreds of kWs to MWs). This is traditionally classed as medium-scale, but for the purposes of this analysis is the State's largest installed to date.

3.4.3. Queensland's project pipeline

Despite having only a minor share of large-scale renewable generation to date, Queensland has a strong pipeline of new renewable energy projects. There is currently around 2,400 MW of committed and proposed large-scale renewable plant capacity in Queensland, with the majority of this being solar and wind. These projects are at various stages of project development and maturity, with seven projects having secured revenue support (i.e., PPA or equivalent).

Figure 10: Proposed renewable energy projects in Queensland (current at November 2016)

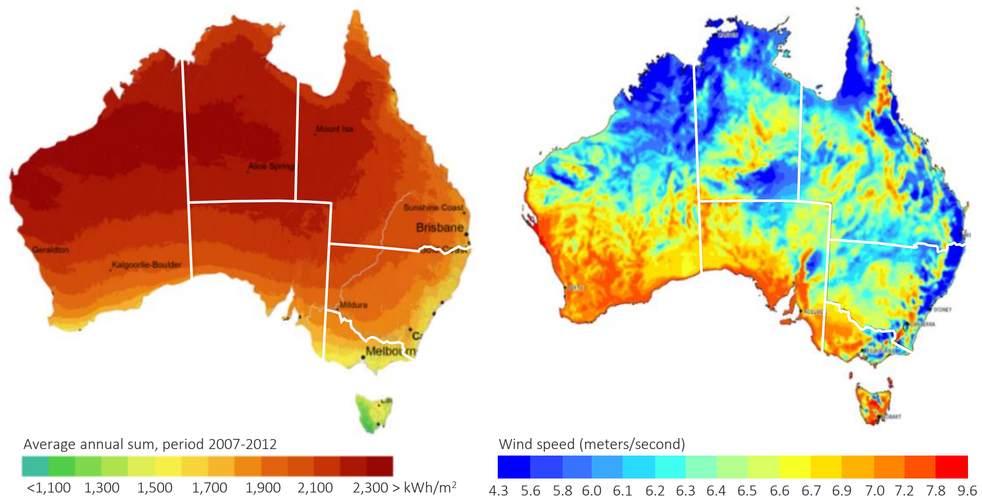


Source: DEWS analysis

3.4.4. Renewable energy resource potential

The maps below illustrate Australia’s solar and wind resource potential.

Figure 11: Solar and wind resources in Australia



Source: SolarGIS 2016 and South Australia Government 2005

Queensland has significant solar energy resources in areas within proximity to the existing electricity network. Analysis by the Department of Energy and Water Supply indicates that there could be up to 60,000 MW of potential solar energy resource in areas within 25 km of existing transmission network (excluding national parks).

When compared with the other states, Queensland has not traditionally been viewed as having a significant wind resource. Despite this, there are locations in Queensland with high quality and nationally competitive wind resources. The Expert Panel was provided analysis by wind resource modelling firm Windlab to estimate the available wind capacity in Queensland, taking into account the underlying wind resource, land-use and proximity to transmission.

Based on their assessment of available land and typical turbine spacing requirements, Windlab indicates there is currently the potential for significant levels of wind capacity that could be developed in Queensland, within close proximity of transmission lines. Allowing for the fact that site specific issues may exclude some of these potential sites, the Panel considers that there could indicatively be significant wind resource in Queensland that could be utilised to meet the target and further detailed analysis of potential wind sites should be undertaken.

Biomass also represents an opportunity for future renewable growth. While not verified by the Panel, the Australian Sugar Milling Council, considers an additional 1,000 MW of bagasse generation capacity could be developed under the LRET[14].

Queensland's diversity of renewable energy resources, combined with the geographic extend of the State's transmission and distribution networks could offer considerable opportunity to address potential issues associated with increased reliance on generation from renewables, such as resource correlation and intermittency of generation.

3.5. Major existing renewable energy support mechanisms

There are various government support mechanisms currently in place that assist the development of renewable energy projects. The primary mechanisms include:

- The Federal Renewable Energy Target, which provides an additional source of revenue for renewable energy projects
- ARENA, the Clean Energy Finance Corporation (CEFC) and the Clean Energy Innovation Fund (CEIF), which provide equity and debt financing support to renewable energy projects.

[14] Australian Sugar Milling Council 2014

Limited support is also provided through the Emissions Reduction Fund (ERF), which provide incentives for projects that reduce greenhouse gas emissions.

3.5.1. The Federal Renewable Energy Target

Australia's renewable energy target incentivises the development of renewable energy generation projects by imposing an obligation on electricity sector participants to acquire renewable energy certificates. This legislative obligation underpins a commercial market for the creation and trade of renewable energy certificates. The nationwide scheme was established in 2001 (known as the Mandatory Renewable Energy Target), initially with a target of achieving 9,500 GWh of additional renewable energy generation in Australia by 2010. In 2007, a series of reviews led to the scheme being separated into the SRES and LRET, and the large-scale target increased to 41,000 GWh by 2020. Following the 2014 RET review, the LRET was reduced to 33,000 GWh by 2020.

Small-scale Renewable Energy Scheme

The SRES supports the installation of small-scale renewable energy systems through the creation of Small-scale Technology Certificates (STCs). STCs are sold to liable entities (typically energy retailers), to offset part of the upfront cost of small renewable energy installations. The Queensland Productivity Commission estimated the revenues from STCs created under the SRES have reduced the up-front cost of purchasing and installing a small solar PV system by around 30–40% on average, as at July 2015[15].

The requirement to purchase certificates is set by the Clean Energy Regulator based on an estimate of the total number of systems that will be installed in each year. This target is adjusted over time to ensure all STCs are purchased, meaning there is no limit on the amount of systems installed under the SRES.

The STCs for a small-scale renewable energy system are all created at the time of installation of the system. The number of STCs that can be created per small-scale renewable energy system is based on its geographic location, year of installation, and the amount of electricity that is expected to be generated, up to a maximum of 15 years. Between 2017 and 2030 the SRES will follow a declining deeming rate by one year in each year. That means that systems installed in 2017 will create certificates for 14 years of output while systems created in 2030 are deemed to create certificates for only one year of output.

The SRES has resulted in the installation of almost 5,000 MW of small-scale solar PV between 2001 and 2016[16].

Large-scale Renewable Energy Target

The LRET supports the development of large-scale renewable energy projects through the creation of Large-scale Generation Certificates (LGCs) for each megawatt hour of generation by accredited renewable energy power stations. Liable entities (again, typically energy retailers) are required to obtain and surrender to the Clean Energy Regulator LGCs proportional to their electricity purchases based on the Renewable Power Percentage (RPP) published by the Regulator each year. The RPP is determined based on the legislated annual targets and the Clean Energy Regulator's estimate of total liable demand in that year. If liable entities do not purchase and surrender enough certificates each year, they must pay to the Clean Energy Regulator a statutory shortfall charge of $65 per certificate. This charge is not tax deductible, which means the market price for certificates can effectively reach up to $93/MWh.

The LRET is technology neutral meaning that LGCs are equivalent across the various eligible renewable energy technologies. The target is location neutral meaning that liable entities can source LGCs regardless of where they are created or the time of day they are created. Together, these encourage the creation and trade of LGCs at the lowest cost.

The LRET will continue through to 2030 but the annual target remains flat from 2020 to 2030 and hence it is not expected to incentivise additional development of renewable generation capacity beyond 2020, assuming the target has been met by that date.

[15] Queensland Productivity Commission 2016a
[16] Clean Energy Regulator 2016a

3.5.2. Australian Renewable Energy Agency, Clean Energy Finance Corporation and Clean Energy Innovation Fund

Separate to the Federal Renewable Energy Target, assistance for renewable energy projects has been available through the ARENA and the CEFC. Both entities were formed by the Federal Government in 2012 aimed at providing different, but complementary support for renewable energy:

- ARENA was established with the objective of accelerating emerging renewable energy along the innovation chain, primarily through the provision of grant funding. Under the *Australian Renewable Energy Agency Act 2011*, ARENA is allocated $1.94 billion in funding out to 2021-22[17]. Since its establishment, ARENA has committed $903 million to 254 projects across Research and Development (R&D), demonstration and deployment. This includes funding of around $99.5 million to 19 projects in Queensland.
- In contrast to ARENA, the CEFC supports the development of renewable energy through the provision of debt and/or equity financing, with the objective of facilitating increased flows of finance into the clean energy sector. $10 billion has been allocated to the CEFC, which it is able to invest through partnerships, trusts and joint ventures, or through subsidiaries, with a focus on projects that are demonstrably commercial. The CEFC has been set a Portfolio Benchmark Return for the performance of funds invested based on a weighted average of the five-year Australian Government Bond Rate. To date, CEFC has invested $91 million directly into clean energy projects in Queensland.

On 23 March 2016 the Federal Government announced the CEIF. The CEIF will provide debt and/or equity finance for clean energy projects that have passed beyond the R&D stage, but are not yet established or of sufficient maturity, size or commercially ready to attract sufficient private sector capital. It is understood funds will be made available to the CEIF from the CEFC's $10 billion funding pool.

While the Fund is a part of the CEFC, investment proposals will be jointly assessed by the CEFC and ARENA, with ARENA providing expert technical review. It is understood the CEIF will not make grants, but will focus on investments that will provide a return to the Fund.

During the election campaign the Government also commitment to invest part of CEFC funds into projects on the Great Barrier Reef and in cities. If this commitment results in changing the direction of CEFC funds this also may offer opportunities for Queensland.

[17] Originally under the *Australian Renewable Energy Agency Act 2011*, ARENA was allocated $2.4 billion. This allocation was subsequently reduced following amendments to the Act in 2016.

Case study: Supporting large-scale solar

ARENA and the CEFC are currently running separate, but complementary programs aimed at increasing investment in large-scale solar.

- Large-scale solar photovoltaics - competitive round: under this program ARENA has allocated $100 million in grant funding to support large-scale solar PV projects through a competitive auction process. On 8 September 2016, ARENA announced 12 successful projects totalling 482 MW of large-scale solar PV. Six of these projects are located in Queensland, totalling 300 MW.
- Large-Scale Solar Program: under this program the CEFC will provide $250 million in lending (fixed-rate longer-dated senior debt) for solar projects above 10 MW, with loan requirements of $15 million or more.

The ARENA solar funding round program has been successful in identifying significant cost reductions in large-scale solar PV. According to ARENA, the average funding requirements for solar projects under the program is $190,000/MW, which compares to $1,600,000/MW in funding required for the solar farms at Moree, Nyngan and Broken Hill developed in 2014. This difference reflects the substantial reduction in costs for large-scale solar in Australia over the past two years. These reductions are partially driven by global reductions in the solar PV commodity chain, and by increased scaling and maturation of the Australian solar industry.

Queensland Government Solar 150 Program

In collaboration with ARENA, the Queensland Government will provide additional financial support to four of the six Queensland projects that were successful under ARENA's large-scale solar PV competitive round, namely:

- Whitsunday Solar Farm, 58 MW
- Kidston Solar Project, 50 MW
- Oakey Solar Farm, 25 MW
- Longreach Solar Farm, 15 MW

The Queensland Government will provide support by way of a long-term CFD, which will provide the projects with a guaranteed minimum level of revenue over the life of the project.

Prior to the collaboration with ARENA, the Queensland Government had initially targeted support for 40 MW of large-scale renewable energy. However, since joining with ARENA, and following ongoing cost reductions in large-scale solar, the Government has been able to gradually increase its level of support to 148 MW.

The collaboration between ARENA and the Queensland Government has delivered efficiencies at number of different levels:

- The Queensland Government has avoided the requirement to undertake its own assessment and shortlisting process.
- Project proponents have not been required to prepare multiple proposals or meet differing project assessment criteria.

3.5.3. Emissions Reduction Fund

The ERF was established in December 2014 as a mechanism to support Australia achieving its 2020 emissions reduction target of 5% below 2000 levels by 2020. The Federal Government has provided $2.55 billion to establish the fund, of which $2.10 billion (82%) has been committed.

The ERF works through a reverse auction process by which the Clean Energy Regulator invites bids from proponents of projects to offer to supply emission reductions. The Clean Energy Regulator has held four auctions to date, with the results outlined in the Table 7[18].

[18] Clean Energy Regulator 2016c

Table 7: Summary of ERF auction results

	Emissions reductions purchased	Average price per tonne of emissions reduction	Number of projects contracted	Total commitment by the Government
Auction 1, April 2015	47.3 Mt CO_2-e	$13.95	144	$660 million
Auction 2, November 2015	45.5 Mt CO_2-e	$12.25	131	$557 million
Auction 3, April 2016	50.5 Mt CO_2-e	$10.23	73	$516 million
Auction 4, November 2016	34.4 Mt CO_2-e	$10.69	49	$367 million
Total	**177.7 Mt CO_2-e**	**$11.83**[19]	**397**	**$2,100 million**

Source: Clean Energy Regulator 2016c

Of the 177.7 Mt CO_2-e purchased under the ERF, most have been for projects relating to vegetation (113.4 Mt CO_2-e, or 64%) and landfill and waste (22.2 Mt CO_2-e, or 12%).

As outlined in s21 of the Carbon Credits (Carbon Farming Initiative) Rule 2015, renewable energy projects generally cannot be eligible for support under both the ERF and the LRET. As support under the LRET has been superior to support under the ERF, no large-scale renewable energy projects have received funding for emissions reduction under the ERF. The exception is for landfill and waste projects where the process of capturing and burning methane reduces the net greenhouse gas emissions and is eligible for the creation of permits under the ERF (which is a separate process from the generation of electricity and the creation of LGCs).

As currently structured there appears to be limited opportunity to leverage support for renewable energy projects under the ERF.

[19] Volume weighted average price per tonne of abatement

4. Defining Queensland's renewable energy target

Findings

- Queensland should adopt the same set of eligible renewable energy sources as identified under the Federal LRET, on the basis that this is considered an extensive and well understood set of technologies, and would ensure a Queensland target remains consistent with the Federal LRET.
- Setting a floating target (i.e., a percentage of electricity generation) is appropriate for expressing the Queensland Government's long-term goals for renewable energy in Queensland. However, setting fixed targets for short-term objectives can increase investor certainty and reduce the overall costs of the scheme. Fixed targets can be set based on near-term forecasts (which are typically more accurate than long-term forecasts) and any subsequent shorter-term targets can be adjusted up or down to correct for "unders or overs" so as to meet the longer-term floating target of 50% renewable generation by 2030.
- Defining the target with reference to generation output (GWh) rather than capacity (MW) is preferred on the basis that:
  - An output target incentivises renewable energy production at the lowest cost
  - Electricity output is what drives greenhouse gas reductions, rather than installed capacity
  - An output target is consistent with the way other energy targets are implemented nationally and internationally.

  However, it is recognised that adopting a target based of 50% renewable output may deliver approximately 54% renewable energy generating capacity by 2030.
- It is appropriate to count Queensland's pro-rata share of the LRET towards meeting a 50% renewable energy target for Queensland on the basis that Queensland consumers have paid, and will continue to pay, for this electricity generation, even if the actual generation occurs interstate. To not count this pro-rata share would be to underestimate the contribution by Queensland consumers to investments in renewable energy nationally. However, the Queensland Government may seek to increase renewable energy project opportunities in Queensland under the LRET.

Recommendation

- The Panel recommends that a Queensland renewable energy target:
  - Is based on Queensland's electricity generation sector only
  - Applies the same renewable energy sources as defined under the LRET
  - Includes contributions made from small-scale solar PV, wind and hydro systems
  - Follows the principle of technology neutrality, but allows for the development of programs that target specific technologies and/or applications of renewable energy
  - Is expressed in percentage terms in the long term, but allows for the establishment of short and medium term fixed targets based on predetermined levels of renewable energy generation
  - Is based on renewable energy output (e.g., GWh), not renewable energy capacity (e.g.,MW)
  - Is not legislated as a broad target, noting that legislation may be required to support specific policy initiatives (for example, legislation may be required where the costs of the scheme are to be recovered from parties outside of the government)
  - Includes Queensland's pro-rata share of renewable energy generation under the LRET.

4.1. Elements of the target

The Panel's Terms of Reference set out a number of requirements for consideration in defining the Queensland target. The Panel has also considered other factors involved in defining a renewable energy target.

The way a renewable energy target is defined is important, as it will influence the nature of investment, and the impact on employment and electricity prices. The way the target is defined may also impact achievability.

Key issues to consider include:

- What should be included in the target?
- How is the target measured, and should it be legislated?
- Should Queensland's contribution to the LRET be included in the target?

The Panel's consideration of these issues is discussed below.

4.1.1. What should be included in the target?

Energy sector or electricity generation sector

The Terms of Reference specifically require the Panel to provide advice on whether the renewable energy target should be limited to the electricity sector or be applied more broadly.

Energy is consumed across virtually all sectors of the Queensland economy. In Queensland, the primary uses of energy are in electricity generation, transport, manufacturing and mining (these sectors account for around 86% of energy consumed in Queensland).

A broader target might include fuels used in the generation of electricity, transport, on agriculture, manufacturing, construction, mining and other sectors. This approach would capture the use of renewables in electricity generation (e.g., solar, wind, hydro and biomass), transport (e.g., biofuels) and other forms of stationary energy (e.g. industrial heat and LNG production).

If restricted to electricity, the target would cover all forms of renewable electricity generation which would be either grid connected or embedded (e.g. rooftop solar PV).

In providing advice in relation to the sectors to which the target should apply, the Panel has considered the practicality of implementing and meeting the target. More specifically:

- Whether technologies are likely to be available at reasonable cost to support meeting the target within a sector
- Whether transaction and administration costs in including specific sectors would be reasonable
- The likely electrification of transport technologies over time.

The Panel is of view that the renewable technologies currently available to the electricity sector are more mature and capable of large-scale deployment across the sector compared to renewable technologies in other sectors such as transport and manufacturing. In addition, the Panel considers that renewable solutions in other energy sectors will largely be derived from the development of electrical technologies in those sectors which then make use of renewable energy generated in the electricity sector (e.g. battery technology for application in transport, industrial heat from electricity alternative industrial processes based on electrical energy). Therefore, establishing greater penetration of renewable generation in the electricity sector will allow more renewable energy to be used in transport and other stationary energy applications over time.

For the above reasons, the Panel recommends that the target should be applied to the electricity generation sector.

Eligible renewable energy sources

A core objective of the Panel's review is to determine how the adoption of a renewable energy target and other complementary policies can drive the development of the state's renewable energy economy. On this basis, when considering which renewable energy resources should be eligible to contribute to a Queensland renewable energy target, the Panel holds the principle of allowing for a broad range of renewable energy sources. This approach will maximise the opportunities for developing the state's renewable energy industry by promoting R&D across the broad spectrum of existing, new and emerging renewable energy technologies.

As part of establishing the Federal LRET, a range of renewable energy sources were identified as eligible under the scheme. These sources are outlined in s17 of the *Renewable Energy (Electricity) Act 2000*, and compiled in the box below.

- Hydro
- Wave
- Tidal
- Ocean
- Wind
- Solar
- Geothermal-aquifer
- Hot dry rocks
- Energy crops
- Wood waste
- Agricultural waste
- Waste from processing of agricultural products
- Food waste
- Food processing waste
- Bagasse
- Black liquor
- Biomass-based components of municipal solid waste
- Landfill gas
- Sewage gas and biomass-based components of sewage

The Panel is of the view that Queensland should adopt the same set of eligible renewable energy sources as identified under the Federal LRET, on the basis that this is considered an extensive and well understood list of renewable energy sources[20]. Adopting this approach would also ensure that a Queensland target remains consistent with the Federal LRET in terms of renewable energy sources.

The Panel notes that environmental organisations were generally of the view that wood waste should be removed from being an eligible source of renewable energy under the target[21]. However, for the reasons above, the Panel did not accept this view.

The Panel proposes that waste coal mine gas is not included under a Queensland target, despite it being currently eligible (albeit in a limited way) under the LRET. It is understood waste coal mine gas was included in the LRET as a transitional measure, and will only remain eligible under the LRET until 2020.

Inclusion of small-scale renewables

In defining eligible renewable energy sources, it is also necessary to consider the role of small-scale renewable energy. Under the Federal SRES, eligible small-scale renewable energy generation includes:

- Solar PV (no more than 100 kW capacity)
- Wind turbines (no more than 10 kW capacity)
- Hydro systems (no more than 6.4 kW capacity).

The SRES also provides support for technologies that displace electricity consumption:

- Solar water heaters
- Air source heat pumps.

Of these technologies, solar PV has experienced the greatest uptake in terms of capacity installed. As noted previously, Queensland has had a high participation in the SRES, attracting over 1,500 MW of rooftop PV. As noted by AEMO in its submission on the Issues Paper, the capacity of rooftop PV in Queensland is comparable to the installed capacity of Queensland's single largest power station – Gladstone Power Station at 1,680 MW.

[20] In its 2012 review of the RET, the Climate Change Authority concluded that the list of eligible sources for the LRET is extensive and allows for a variety of technologies to be deployed. The Authority maintained this position in its 2014 review, recommending that no changes be made to the list of eligible sources.

[21] Australian Conservation Council, Energetic Communities, Environmental Defenders Office, Queensland Conservation Council, The Wilderness Society, Wide Bay Burnett Environmental Council

It is expected small-scale solar PV will continue to play an increasingly important role in Queensland's future energy mix, particularly as the energy market becomes more decentralised.

Given the current capacity of small-scale renewable energy generation in the Queensland market and its predicted growth, the Panel is of the view that generation from small-scale renewable energy technologies (i.e., solar PV, wind and hydro) should be counted in establishing a Queensland renewable energy target. The Panel notes that to date the majority of small-scale solar PV has been deployed on household rooftops with relatively small numbers of sub-100 kW systems in the commercial and industrial sector. This dynamic is likely to change as household penetration levels saturate and new opportunities emerge for small (< 100 kW) and medium-scale (100 kW – 5 MW) PV systems.

While solar water heaters and air source heat pumps are eligible forms of renewable energy under the SRES, these technologies displace electricity consumption rather than act as a source of generation. Due to the challenges around estimating avoided consumption of solar hot water heaters, the Panel considers that the effect of these technologies is best captured through their contribution to reducing overall consumption which in turn reduces the requirement for renewable energy generation under a percentage target. Importantly, this does not preclude the Government incentivising these or other energy efficiency technologies or energy efficiency schemes as a means of advancing the target (by reducing the baseline against which the target is measured).

Targets for specific technologies or applications

An important design element of a target is defining which renewable energy technologies are eligible to contribute to the target. Targets can generally be designed as neutral between renewable energy technologies or designed to support specific renewable energy technologies.

Under a technology neutral renewable energy target, projects with the lowest total cost are generally developed first without considering the renewable source, technology or R&D benefits. This approach ensures new renewable capacity is deployed at the lowest possible cost for consumers. In its submission on the Issues Paper, Powerlink supported a technology neutral target for this reason. AGL also promoted the principle of technology neutrality.

Alternatively, targets can be set to procure capacity from one or more specific renewable energy technologies. This approach has been adopted recently by the ACT Government, which has run separate renewable energy auctions for large-scale solar PV (40MW) and wind (400MW).

Targeting particular renewable energy technologies can deliver additional benefits to stakeholders that may not be otherwise captured. For example, it may allow for improved prioritisation of investment in new energy technologies where there are specific local issues to solve, areas where there is a natural resources advantage, or where there is industry capability to commercialise research.

Targeting specific renewable energy technologies also allows for the development of a "portfolio" of renewable energy options, which can assist in hedging against future uncertainty. This concept was promoted by the Grattan Institute, which recommended funding support be provided to a range of renewable energy technologies initially, and expanded for emerging winning technologies and withdrawn as other technologies fail to progress[22].

Noting these considerations, it is the Panel's view that all eligible renewable technologies should be counted equally under the 50% target. However, the target should also allow for the implementation of measures that optimise opportunities for specific technologies.

[22] Wood 2012, pp9-10

The Government may also look to develop programs to target specific applications of renewable energy or prioritise technologies which deliver higher levels of emission reductions. For example, the Government may consider whether targeting remote or fringe-of-grid projects would provide additional value to Queensland that might not otherwise be realised under current market operation. The Government could also consider incentivising technologies that balance the intermittency of solar PV and wind, for example solar thermal, biomass or energy storage. In consultation on the Draft Report, a number of stakeholders highlighted the value of dispatchable renewable energy technologies[23].

4.1.2. How should the target be measured?

Fixed or floating target

Renewable energy targets can be expressed in two ways:

- *A floating target:* A floating target is expressed as a percentage, relative to a defined baseline. It means that any renewable energy goals (or targets imposed by a specific scheme on market participants) are compared to actual rather than forecast market conditions. An example of a floating target was the Queensland Gas Scheme, which required participants to source a prescribed percentage of their electricity consumption from gas generation.
- *A fixed target:* A fixed target specifies a particular megawatt or megawatt-hour target that should be achieved which is expected to achieve the underlying percentage target based on a forecast of future market conditions. An example of a fixed target is the Federal LRET, which is legislated as the requirement to source specific amounts of renewable electricity each year up to 2030.

The difference between the two approaches is who bears the uncertainty of future conditions. Under a floating target, the amount of renewable energy required can be adjusted in response to market conditions, and the investors (or liable parties, if appropriate) must decide on the physical capacity required to meet the target. While this provides a degree of flexibility, it can be challenging, particularly if different developers have different forecasts, and so the level of incentives or penalties will determine whether sufficient capacity is built to meet the target.

In contrast, fixed targets provide much higher certainty for project developers, potentially reduce financing costs and also allowing them to develop a long-term pipeline of projects to meet a known MW or GWh target. However, if future conditions are not accurately forecast, the desired percentage target may be under- or over-achieved. This occurred with the LRET, which was legislated in 2010 to achieve 41,000 GWh of renewable energy by 2020. At the time of being legislated, the target of 41,000 GWh was intended to constitute a 20% share of renewables. However, due to a decline in electricity demand from the grid, it was estimated the target would result in an effective 26% LRET by 2020. The Federal Government identified this as a key reason for reducing the fixed LRET to 33,000 GWh, equalling approximately 23.5% of Australian energy from renewable energy sources by 2020.

The Panel's view is that setting a floating target is appropriate for expressing the Government's long-term goals for renewable energy in Queensland. This will allow the required ambition (50% renewable energy generation) to be adjusted in response to future market conditions, rather than locking in a fixed capacity of renewables. A floating target would also avoid debates over the appropriateness of the target in the future, such as those that surrounded the purpose and final ambition of the LRET.

However, the Panel finds that setting fixed targets for short-term objectives has the potential to increase investor certainty and reduce the overall costs of the scheme. These fixed targets could be set based on near-term forecasts (which are typically more accurate than long-term forecasts) and any subsequent shorter term targets could be adjusted up or down to correct for "unders or overs" so as to meet the longer term floating target of 50% renewable generation by 2030.

[23] AGL, Aurecon, Australian Conservation Council, Community Power Agency, Electrical Trades Union, Great Barrier Reef Divers, Mackay Conservation Council, Queensland Conservation Council, Sustainable Queensland Forum, Wide Bay Burnett Environmental Council, World Wildlife Fund

The use of shorter-term targets may also be beneficial in the context of establishing the trajectory to achieving the 50% target. For example, it is anticipated that the cost of renewable energy technologies will decline over time[24]. In order to capture the benefits of lower development costs in the longer term (and therefore reduce the overall subsidy required to achieve the target), it may be beneficial to set interim fixed targets that reflect a gradual ramping of renewable generation over time.

However, the setting of lower interim targets in the short term would need to be balanced against:

- Achieving lower levels of emission reductions in the short term
- The capability of the industry to deliver higher levels of renewable energy in the latter years of the target.

Output or capacity

A percentage target can be defined with reference to either electricity output (e.g., GWh) or installed capacity (e.g., MW). The Panel is of the view that a Queensland target should be based on output rather than capacity on the basis that:

- An output target incentivises renewable energy production at the lowest cost, rather than promoting projects that are inexpensive to construct but are comparatively inefficient at producing electricity. For example, while a wind farm may be more expensive to construct than a solar PV facility, a wind farm (based on current technologies) produces more electricity per unit of installed capacity, making it more cost-efficient at generating electricity. It is unlikely a capacity target would recognise this, favouring the project with the lowest upfront development cost.
- Favouring capacity over output may encourage the use of lower quality inputs that reduce upfront costs, potentially resulting in lower electricity output
- By encouraging efficiency an output target may create an environment for driving further technology improvements
- Electricity output is what drives greenhouse gas reductions, rather than installed capacity. This will help the Queensland Government more clearly understand the benefits of pursuing 50% renewable energy.
- A target based on output would ensure efforts made to improve energy efficiency are captured. For example, if overall electricity consumption is reduced due to improvements in energy efficiency, the corresponding requirements for renewable energy output are also reduced. Until improvements in energy efficiency drive the retirement of installed generating capacity, a capacity target is unlikely to change.
- An output target is consistent with the way other energy targets are implemented nationally and internationally, for example:
  - The LRET, which aims to achieve 33,000 GWh of additional renewable electricity generation in Australia by 2020
  - California's Renewable Portfolio Standard, which requires the amount of electricity generated and sold to retail customers per year from eligible renewable energy resources be increased to 50% by 2030.

An output target does not preclude the setting of short-term capacity targets, or policies to procure certain quantities of renewable energy capacity (e.g., through a reverse auction). However, the selection of projects should be driven by their ability to produce electricity at the lowest cost, subject to other criteria under the particular policy.

[24] The Expert Panel's Issues Paper presented the mid-point technology costs of various renewable energy technologies based on the 2015 Australian Power Generation Technology Report. It found the Levelised Cost of Energy of utility scale solar PV and wind could reduce by 3.6% and 1.1% per annum (compound annual reduction), respectively between 2016 and 2030.

The Panel is of the view that the target should be referenced against Queensland's total electricity consumption. Queensland electricity consumption is preferred to Queensland electricity generation as the basis for the target as this provides a closer alignment with the way liabilities are set under the current LRET and reduces the sensitivity of the target to Queensland electricity imports from or export to New South Wales. In addition, the target should also include electricity consumed from embedded generation (e.g., small-scale renewable energy systems).

To streamline the process of establishing the baseline for the target, the Panel recommends the Queensland Government leverage existing processes for defining and measuring consumption and embedded generation. This could be achieved in consultation with the Clean Energy Regulator and, in the case of embedded generation, AEMO who has outlined a requirement for improving the mechanism for collecting and managing data on distributed energy resources[25].

It should be noted that adopting a target based on 50% renewable output may deliver more than 50% renewable energy generating capacity. Based on the modelling in Chapter 8, a 50% output target may deliver up to 54% renewable energy generating capacity.

Legislation

The terms of reference require the Panel to consider whether a renewable energy target for Queensland should be legislated.

Legislating a renewable energy target can be valuable to the extent that it provides a clear statement of intent from the government about its objectives for renewable energy. However, the Panel finds that by itself, a legislated target is unlikely to provide meaningful additional certainty for project developers, when compared to a well-developed government policy initiative. Developing and implementing legislation can also be time consuming and resource intensive, and can sometimes result in unexpected constraints on future activities if the legislation proves to have been drafted too narrowly.

By contrast, in circumstances where a target is supported by a scheme, legislation may be necessary for establishing the legal framework for how a scheme operates (including how it is regulated), obligations for complying with the scheme, penalties for non-compliance, and how compliance costs are recovered between parties. By way of example, a number of existing schemes for renewable energy have required the development of legislation, such as:

- *The Renewable Energy Target:* legislation setting out the mechanism for achieving the target through the creation and trading of renewable energy certificates
- *The ACT's Solar Auction process:* legislation setting out the mechanism for proponents receiving feed-in tariff support payments.

Considering these issues, the Panel is of the view that legislating a 50% renewable energy target for Queensland is not necessary on the basis that legislating the target is unlikely to provide any additional certainty for developers seeking to make renewable energy investments in the Queensland. If, however, achieving the renewable energy target requires the development of a scheme, where the costs of the scheme are to be recovered from parties outside of the government, the Panel recognises that legislation may be required.

[25] AEMO's submission to the Expert Panel's Issue Paper

In submissions on the Draft Report, there was some support from stakeholder groups and individuals for legislating the target on the basis that this could provide a greater degree certainty for investors[26]. However, as described above, the Panel is of the view that an effective investment environment can be provided through a well-developed government policy, and as such, maintains its position of not recommending the target be legislated.

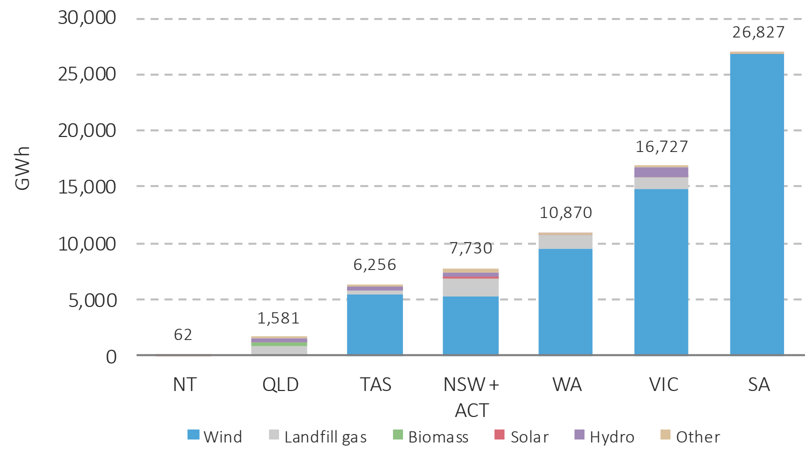
4.1.3. Queensland's contribution to the Federal LRET

The Federal LRET is a national scheme aimed at increasing Australia's consumption of renewable energy. The LRET has resulted in significant investment in large-scale renewable energy projects in Australia, with around 4,400 MW of new large-scale renewable energy capacity installed under the scheme.

The LRET is designed to ensure renewable generation is constructed at the lowest cost, and is technology and location neutral. At present, wind generation is the lowest cost form of large-scale renewable generation that can be widely deployed in Australia.

Figure 12 shows cumulative electricity output from large-scale renewable projects constructed between 2001 and 2015 supported under the LRET[27]. Wind generation has provided the majority of output over the period, with this occurring primarily in the states of South Australia and Victoria.

Figure 12: Large-scale renewable generation output by fuel source (supported by LRET), 2001-2015



Source: Clean Energy Regulator, 2016c

The costs of meeting the LRET target are recovered from consumers of electricity as an additional component of their retail bill, proportionate to their own level of consumption. These costs are broadly similar for residential consumers regardless of where they live, and significantly, regardless of where the investment was made.

This has meant that while a relatively small amount of renewable energy has been developed in Queensland under the LRET to date (2.3% of national renewable electricity generation), Queensland consumers have contributed significantly more toward the value of all renewable projects developed under the LRET[28].

[26] Alliance to Save Hinchinbrook Inc., Andrew Davidson (individual submission), Alternative Technology Association (Toowoomba Branch), Australian Conservation Foundation, Bribie Island Environmental Protection Association Inc., Christine Carlisle (individual submission), Community Power Agency, Endeavour Veterinary Ecology, Energetic Community, Environmental Defenders Office, Fraser Island Defenders Organisation, Gecko, GetUp, Great Barrier Reef Divers, Hugh Paine (individual submission), James Fitzgerald (individual submission), John Fuller (individual submission), Jeanette and John Lippiatt (individual submission), John van Grieken (individual submission), Ken Mewburn (individual submission), Kerry Brady (individual submission), Lara Harland (individual submission), Lee Terrell (individual submission), LDK Consulting, Matthew Simons (individual submission), Murray Vincent (individual submission), North Queensland Conservation Council, Queensland Conservation Council, Peter Nisbet (individual submission), Range Environmental Consultants, Rosey Groves (individual submission), Seed Savers' Foundation, Sue Goodrick (individual submission), Sylvia Cooper (individual submission), Trish Lake (individual submission), Wanda Grabowski (individual submission), Whitsunday Residents Against Dumping, Wide Bay Burnett Environmental Council, Wildlife Preservation Society of Queensland, William Norfolk (individual submission), World Wildlife Fund

[27] Excludes waste coal mine gas

[28] Jacobs estimates Queensland's pro-rata share of national electricity consumption at 26% in 2016

The Panel considers it appropriate to count Queensland's pro-rata share of the LRET towards meeting a 50% renewable energy target for Queensland. The pro-rata share includes renewable energy already built under the LRET, as well as renewable energy that will be built in the future. Queensland consumers have paid, and will continue to pay, for this generation, even if the actual production occurs interstate. In particular, to not count this pro-rata share would be to underestimate the contribution by Queensland consumers to renewable energy nationally.

The Panel also notes that including Queensland's pro-rata share of the LRET will likely result in lower levels of greenhouse gas emission reductions from the electricity sector in Queensland. However, given the relatively short period to 2020, and Queensland's small share of the LRET projects to date, the Panel considers this approach is appropriate.

In response to the Draft Report a number of stakeholders did not support including Queensland's pro rata share of the LRET in the target, on the basis that this could lead to lower investment and employment than might otherwise occur[29]. Noting these considerations, the Panel maintains its view on the including Queensland's pro-rate share of the LRET for the reasons outlined above. Importantly, the Panel describes in the next chapter how Queensland can seek to maximise renewable energy project opportunities under the LRET in the remaining years of the scheme to benefit Queensland.

[29] Alliance to Save Hinchinbrook Inc., Alternative Technology Association (Toowoomba Branch), Australian Solar Council, Community Power Agency, Environmental Defenders Office, GetUp, Great Barrier Reef Divers, Mackay Conservation Group, Queensland Conservation Council, Wide Bay Burnett Environmental Council, World Wildlife Fund

5. Leveraging existing Federal support schemes to 2020

Findings

- There is no requirement for additional financial incentives to support investment in small-scale renewables in Queensland. However, the Panel notes there is merit in addressing regulatory and other non-price barriers to greater uptake of small-to-medium scale solar PV, particularly for commercial businesses. Measures to streamline network connection processes for these plants are considered to be particularly important.
- In order to fulfil the requirements of the Federal LRET, it is estimated an additional 6,000 MW of large-scale generation capacity is required to be constructed nationally by 2020. Based on current technology costs, market dynamics and project pipeline, Queensland is likely to see considerable investment in renewable energy over the next few years supported by the LRET.
- Despite there being strong market interest in investing in new large-scale renewable energy, it remains uncertain whether there is sufficient capacity to deliver all of the additional requirements of the LRET by 2020 under medium to long term offtake contracts. Industry analysis suggests there is approximately 4,300 MW of renewable projects that could be committed nationally to 2020 under offtake contracts. When compared to the estimated requirement for 6,000 MW of capacity to meet the LRET, the Panel notes there may be a shortfall of renewable energy by 2020.
- A number of states and territories have announced strong ambitions for renewable energy, and there is potential for competition between jurisdictions for renewable energy investment under the LRET. Those jurisdictions with the most attractive investment and regulatory environment for renewable energy projects are likely to attract the most projects.
- In light of the potential shortfall of renewable energy capacity to meet the LRET, there is an opportunity for the Queensland Government to undertake a reverse auction process in 2017-18 for the delivery of further renewable energy capacity prior to 2020 (potentially up to 400 MW, subject to market activity and the competitiveness of renewable energy projects in the market, and the timeliness of completing the auctions).
- There could be a role for the Queensland Government to fund early stage R&D.

Recommendations

- In order to leverage the opportunities for renewable energy investment under the LRET, the Panel recommends the Queensland Government should undertake a reverse auction process for CFDs in 2017-18 for the delivery of further renewable energy capacity prior to 2020. The Panel recommends an indicative capacity target of up to 400 MW, with the target to be reviewed based on the level of renewables developed by the market, and the competitiveness of projects in the market. Preparatory work should commence as soon as possible on auction design and sourcing the necessary capabilities and advisors to undertake the auction.
- In order to enhance the potential benefits from investment in renewable energy, the Queensland Government could consider incentivising some R&D in renewable energy as part of the policy, with a specific focus on regional Queensland.

The Terms of Reference for the Inquiry require the Panel to provide advice on how Queensland can leverage existing Federal renewable energy support schemes. In addressing this requirement, the Panel has considered small-scale and large-scale renewables separately.

5.1. Small-scale Renewable Energy Capacity

5.1.1. Is there a case for additional financial support for small-scale solar PV?

As noted previously, Queensland has experienced high participation in the SRES, with over 1,500 MW of installed small-scale solar PV capacity. Aside from support available under the SRES, a number of other factors have contributed to Queensland's high level of solar PV, including:

- *The Queensland Government's Solar Bonus Scheme*: provides up until 2028 a 44 cent/kWh feed-in tariff for customers who applied between 1 July 2008 and 9 July 2012 for net eligible electricity and maintain their eligibility[30]
- *Declining system costs:* the average cost of a 3kW system in Brisbane has reduced from $2.42/kW in August 2012 to $1.41/kW in July 2016 (noting that these costs include subsidy available through the SRES). This represents a reduction of around 42% or an indicative compound reduction of 13% per year[31].
- *A rise in electricity prices for residential customers over the period 2007 to 2016 of approximately 120%*: installing solar PV allows customers to offset their electricity costs
- *Strong solar resource:* Queensland experiences high levels of solar irradiation across a large part of the State.

In considering whether there is a case for providing additional support for small-scale (<100 kW) renewables in Queensland, the Panel notes the following:

- The general outlook for small-scale solar PV in Queensland is positive. Under existing policy settings, there is an expectation of continued uptake in small-scale solar PV between 2016 and 2030, particularly in the commercial sector. In 2016, Jacobs prepared a report for AEMO on the projected uptake of small-scale solar PV in the NEM[32]. For Queensland, the report projected that small-scale PV:
  - In the residential sector could increase from around 1,450 MW in 2016 to around 4,200 MW in 2030 (7% compound annual growth).
  - In the commercial sector could increase from 150 MW in 2016 to 800 MW in 2030 (12% compound annual growth). A large fraction of this is likely to be in systems > 100 kW – 5 MW (medium-scale).
- The SRES will continue in place until 2030, although the number of STCs that can be created from the installation of a new system will decline towards 2030
- The rooftop solar industry has matured in Queensland, and in most cases there is a financial case for investing in solar PV in Queensland without the need for additional financial incentives. The payback to consumers is around 7 years, which experience indicates is the point at which customers are willing to invest.

Given these factors, the Panel considers there is no requirement for additional policy mechanisms that provide financial assistance for small-scale renewables in Queensland. However, the Panel considers that there are some non-financial measures that could be implemented to facilitate uptake of small to medium-scale renewables both in the residential and commercial and industrial sectors. These are discussed in Chapter 10.

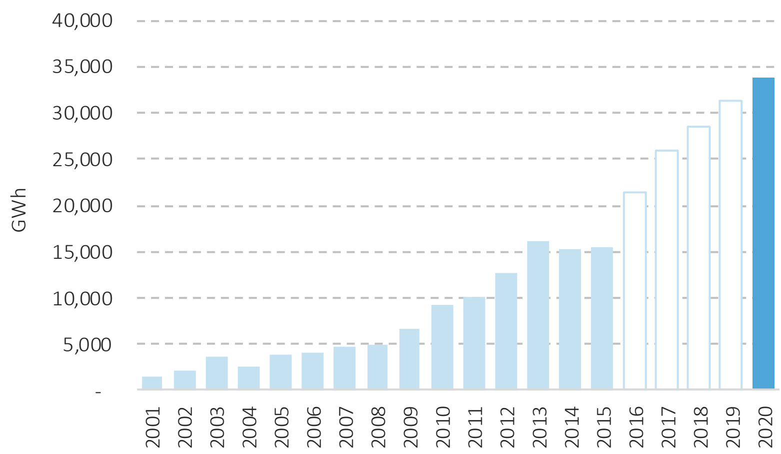
[30] Participants in the Solar Bonus Scheme lose eligibility if they move house, sell (or let) their house, increase their inverter size, close their electricity account or are disconnected.
[31] Solar Choice 2016
[32] Jacobs 2016

5.2. Delivering the remaining requirements of the LRET

5.2.1. LRET requirements

As highlighted in Figure 13, there has been steady increase in the supply of electricity generated by large-scale renewables under the LRET. However, in order to meet the total cumulative demand for LGCs through to 2020, significant new build of large-scale renewable projects will be required. The Clean Energy Regulator estimates an additional 6,000 MW of installed capacity is required to meet the total cumulative demand for large-scale generation certificates through to 2020[33].

Figure 13: Generation from LRET eligible large-scale renewables (GWh)



Source: Clean Energy Regulator 2016c

5.2.2. Project developments and pipeline

Recent project announcements indicate that the market is actively considering opportunities to achieve the LRET. As noted by the Clean Energy Regulator in its 2015 Administrative Report and Annual Statement:

> *There is evidence that new commitments are in the pipeline. For example in recent months, both private and state-owned energy businesses have announced tenders or finance models for renewable energy or large-scale generation certificates. These businesses include AGL Energy, Alinta Energy, Ergon Energy (Queensland Government) and Synergy (Western Australian Government), and state-owned entities in Victoria, New South Wales and South Australia, and the City of Melbourne. The strong level of interest in the Australian Renewable Energy Agency's (ARENA) large-scale solar competitive round in 2015 also indicates strong prospects for projects to become committed.*

The Panel has undertaken a review of publicly announced renewable energy projects across Australia, and has identified around 1,000 MW of projects/processes that have a high probability of being developed under the LRET (Table 8). These relate to renewable energy projects that have already secured offtake agreements with retailers or processes announced by Government entities for the procurement of renewable energy capacity.

[33] Clean Energy Regulator 2015, p8

Table 8: Renewable energy commitments

Project / Program	Technology	State	Capacity
Mount Emerald Wind Farm	Wind	QLD	180 MW
Clare Solar Farm	Solar PV	QLD	100 MW
Whitsunday Solar Farm (ARENA/Solar 150)	Solar PV	QLD	58 MW
Kidston Solar Project (ARENA/Solar 150)	Solar PV	QLD	50 MW
Oakey Solar Farm (ARENA/Solar 150)	Solar PV	QLD	25 MW
Longreach Solar Farm (ARENA/Solar 150)	Solar PV	QLD	15 MW
Darling Downs Solar Farm (ARENA)	Solar PV	QLD	110 MW
Collinsville Solar Power Station (ARENA)	Solar PV	QLD	42 MW
Emu Downs Solar Farm (ARENA)	Solar PV	WA	20 MW
Griffith Solar Farm (ARENA)	Solar PV	NSW	25 MW
White Rock Solar Farm (ARENA)	Solar PV	NSW	20 MW
Dubbo Solar Hub (ARENA)	Solar PV	NSW	24 MW
Manildra Solar Farm (ARENA)	Solar PV	NSW	43 MW
Parkes Solar Farm (ARENA)	Solar PV	NSW	51 MW
Sydney Metro Northwest	Not specified	NSW	52 MW
Melbourne Renewable Energy Project	Not specified	VIC	42 MW
Synergy renewable energy tender	Not specified	Not specified	190 MW
Total			**1,047 MW**

Source: DEWS analysis

Beyond these projects, industry analysis suggests there is over 16,000 MW of potential renewable energy projects nationally, albeit at different stages of maturity. As noted in Chapter 3, there is around 2,400 MW of committed and proposed large-scale renewable plant capacity in Queensland (refer to Figure 10).

Reports also suggest a willingness from the major retailers to support significant levels of new renewable energy capacity under the LRET. For example:

- AGL recently announced its “Powering Australian Renewables Fund”, which will seek to target around 1,000 MW of large-scale renewables, with a total investment of $2-3 billion. In July 2016 it was announced that AGL will provide $200 million in cornerstone equity, while QIC and the Future Fund will contribute $800 million in equity funding. It is understood projects developed under the fund will assist AGL in managing its LRET liability.
- In May 2016, Origin indicated a requirement for 1,500-2,000 MW of renewable energy projects to meet its LRET liabilities to 2020. It is understood Origin will seek to meet the majority of its LRET liabilities through PPAs and project developments.

5.2.3. Potential shortfall in committed projects

While there is currently strong interest in the market for new renewable generating capacity, it remains uncertain whether there is sufficient capacity in the market to deliver all of the additional requirements of the LRET under long-term contracts.

In June 2016, Citigroup prepared a report analysing the capability of the market to meet the LRET. The report found there is approximately 4,300 MW of renewable projects committed to 2020 through long-term contracts (based on existing project commitments and the major retailers – AGL, Origin and Energy Australia – fully meeting their LRET liabilities). When compared against the Clean Energy Regulator's estimated requirement for 6,000 MW of additional renewable generation to meet the LRET, the analysis suggest there may be a shortfall of committed renewable energy by 2020.

While the major retailers have indicated a willingness to meet the LRET liabilities through project development and long-term contracts, the Panel notes there are a limited number of retailers that are able to provide the long-term certainty of offtake agreements required for financing renewable energy projects. While projects can also be financed on a merchant basis, historically there have been few projects delivered in this way in Australia.

If the LRET is not met, those retailers that are unable to purchase renewable energy certificates to meet their liability will be required to bear the effective penalty cost of $93/MWh, which would be expected to be passed through to consumers in electricity bills. Under this situation, consumers would be paying for the LRET, without any additional renewable energy generation being built.

5.3. Opportunity for Queensland to leverage the LRET

Over the next few years, Queensland is likely to see considerable investment in renewable energy. This reflects both the requirement for significant levels of new renewable generation nationally to meet the LRET, and Queensland's strong pipeline of large-scale renewable energy projects.

The Panel considers that the market is the preferred option for the delivery of new renewable energy projects in Queensland and notes the recent increase in project commitments and general market activity.

However, in light of the potential shortfall of renewable energy capacity between what is required nationally to meet the LRET and what is currently committed, the Panel is of the view that there may be an opportunity for the Queensland Government to facilitate the development of additional renewable energy projects prior to 2020 under the LRET. Leveraging the subsidy available from the LRET will assist in the earlier development of new renewable generation capacity in Queensland and at a lower net cost to Queensland, while also delivering an increase in renewable investment and employment in the state. It could also assist in facilitating the development of Queensland's renewable energy industry to support the delivery of the target after 2020.

5.3.1. Stakeholder views on direct support for renewable energy

The Panel notes that stakeholders have contrasting views on the merits of the Queensland Government providing direct financial support for renewable energy projects.

In its submission on the Issues Paper, the Australian Energy Council did not support the use of direct policy incentives for renewables, suggesting the Queensland Government, *"…not seek to intervene in the natural allocation of resources in a natural market, unless there is a clear market failure and the costs and benefits of intervention have been weighed"*. The Council also noted that, *"solar PV technology is no longer an emerging technology that requires assistance to make it to market."*

Similarly, in its submission on the Issues Paper, Origin suggested the Queensland Government should focus less on providing direct funding support for large-scale solar PV, and more on improving regulatory frameworks, such as streamlining development approvals, connection agreements and the availability of land.

By contrast, a number of stakeholders supported the Government's Solar 150 Program, including the Australian Conservation Foundation, Equis Australia and Trustpower. The Clean Energy Council also highlighted its support for this approach in its submission on the Issues Paper. It noted:

> *The Palaszczuk Government's Solar 120 Program is an outstanding example of a policy option that is likely to deliver increased investment in renewable energy generation in Queensland in an effective and efficient manner… By providing long term financial support the Solar 120 Program complements ARENA's program which will provide upfront capital grants to construct major renewable energy generators.*

5.3.2. Proposed action in other jurisdictions

A number of other Australian jurisdictions have established strong local ambitions for increasing the use of renewable energy in the near term (Table 9).

Table 9: Renewable Energy Targets by jurisdiction

Jurisdiction	Target
ACT	100% renewable energy by 2020
SA	50% renewable energy by 2025
VIC	25% renewable energy by 2020 and 40% by 2025
NSW	Supports the national RET of 20% by 2020
QLD	50% renewable energy by 2030

Note: It is understood the new Northern Territory Labor Government will adopt a target of 50% renewable energy by 2030

The ACT Government has been running reverse auctions for the procurement of renewable energy capacity to achieve its target, with around 450 MW of renewable capacity tendered to date. It is understood the Victorian Government will hold a series of competitive auctions for up to 5,400 MW wind capacity and large-scale solar[34].

With the exception of the ACT, it understood that renewable energy projects constructed in each jurisdiction prior to 2020 are intended to be complementary to and access the benefits of the LRET. By default, this creates the situation where each jurisdiction is effectively competing for the same investment in renewable projects under the LRET. Those jurisdictions that provide the most attractive investment environment for renewable energy projects are likely to attract the most investment, potentially at the expense of other jurisdictions. However, the Panel notes that employing financial incentives as part of package of incentives risks an environment where states compete by paying higher subsidies without any real increase in renewable energy and greenhouse gas emission reductions.

5.3.3. Overall assessment

In accepting the Queensland Government's policy objective of achieving a 50% renewable energy target by 2030 and in consideration of the above policy positions of other jurisdictions, the Panel considers that it is feasible for the Government to undertake specific action to support the delivery of LRET-based renewable generation capacity in Queensland prior to 2020. However, the Panel is of the view that any efforts should be complementary to the projects that are likely to be delivered under the LRET, should avoid crowding out market investment that would otherwise occur, and should also avoid competing on the basis of financial incentives to be paid to the projects that the Queensland Government chooses to support.

Following the positive outcomes of the Queensland Government's Solar 150 Program, the Panel considers that the Queensland Government should undertake a similar reverse auction process for further renewable energy capacity that is complementary to the LRET.

[34] Department of Environment, Land Water and Planning 2016

The objectives of this would be to:

- Assist in the delivery of Queensland renewable energy projects that contribute to achieving the LRET by providing longer-term revenue certainty which may not be available in the market up to 2020
- Assist in achieving the Queensland Government's 50% renewable energy target
- Potentially contribute to achieving the Queensland Government's target of 3,000 MW of solar PV by 2020 (to the extent that solar PV is competitive under the process)
- Assist the Queensland Government to develop experience and capability in undertaking reverse auctions
- To profile Queensland's renewable energy potential to companies who are currently establishing or expanding their activities in the Australian renewable energy industry.

The Panel notes that Origin did not agree with the use CFDs to support the development of projects under the LRET. In its submission on the Draft Report, Origin suggested the Government could provide upfront funding to a project in order to lower its capital costs and help it secure project finance. According to Origin, this approach would better address the cost structures of large-scale renewable energy projects, being high capital costs and low ongoing costs. The Panel addresses its views on policy mechanisms in more detail in Chapter 7 and retains its preference for CFDs.

5.4. Considerations for running a Queensland-specific process prior to 2020

Should the Queensland Government decide to offer financial support for additional renewable energy capacity under the LRET, there are a number of factors the Government will need to consider, such as the scale of the auction, timing, whether the process is technology neutral, the capabilities required to undertake the process, and the structure of the support mechanism. Each of these factors is discussed below.

5.4.1. Timing

A reverse auction process generally contains three phases, as noted in Table 10.

Table 10: Phases of a reverse auction

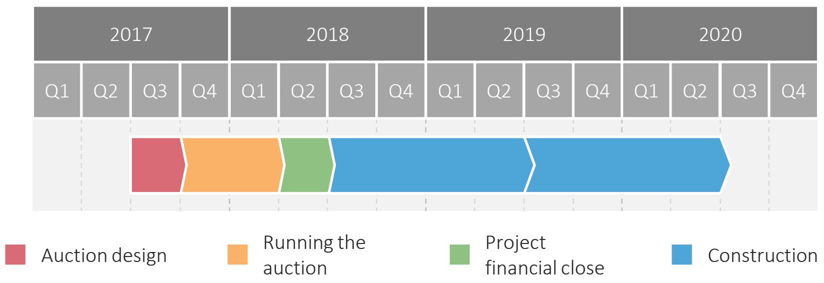
Phase	Key activities	Time to complete
Phase 1: Auction design	► Identify auctions parameters ► Develop auction documentation ► Establish evaluation process	3 months
Phase 2: Running the auction	► Publish auction documentation ► Invite participants to submit bids ► Review submissions ► Select successful projects	6 months
Phase 3: Project financial close	► Finalise and execute financial contracts with project developer ► Project developer finalise contracts (including EPC, network connection access agreement, financing etc) ► Project developer reach financial close	3 months

Taking into account the tasks involved in each phase, the Panel estimates a reverse auction process could take around 12 months to complete. Following financial close, it is probable projects would be operational within 12-24 months, depending on the technology[35].

In order to contribute to meeting the LRET by 2020, projects would most likely need to be constructed and commissioned before 2020. Assuming the auction commences mid-2017, projects with shorter construction timeframes (such as solar PV) could be operational by mid-2019 (refer to Figure 14). Importantly, this timing assumes projects have made significant progress on grid connection and project development approvals (which are typically lengthy processes) prior to participating in the auction. Issues relating to these processes are discussed in Chapter 9 and Chapter 10.

In order for projects to maximise the revenue available from the LRET, it is important that projects are delivered as quickly as possible prior to 2020. However, the Panel is aware there are a range of internal Government approvals that would need to be obtained prior to the auction process commencing. The Panel also notes the Government may also be required to seek further approvals during the auction process. To ensure these do not affect the timeframes for delivering projects prior to 2020, it is important the Government initiates the approval process early in 2017, and considers opportunities to streamline the approvals process throughout the auction.

Figure 14: Timeframe for undertaking a reverse auction prior to 2020



5.4.2. Scale of the reverse auction

The Panel considers that the capacity to be procured under the auction process should be determined with respect to Queensland's pro rata share of any additional renewable energy capacity required to meet the LRET. This should be determined as part of the auction design phase, however the Panel notes this could be up to 400 MW based on current industry expectations[36].

The Panel has undertaken a preliminary assessment of the level of financial support that may be required to support the delivery of 400 MW of large-scale solar PV in Queensland under the LRET. Based on a CFD with a strike price similar to the current market for CFDs and projected wholesale pool and LGC prices provided by Jacobs, analysis indicates a requirement for limited financial support prior to 2030.

The Panel recommends the Government undertake more detailed financial modelling as part of the auction design process in order to provide a clearer understanding of the possible costs of the CFD. This modelling should also include assessment of alternative renewable energy technologies such as wind and biomass.

5.4.3. Technology

Consistent with the recommendations for defining the target, the Panel is of the view that the reverse auction should be technology neutral. However, the Panel acknowledges that the requirement to have projects operational by 2020 or soon after may result in some projects and technologies being less competitive under the process.

[35] Construction of a solar farm generally takes around 12 months, while construction of a wind or biomass project generally takes around 2 years, based on more complex construction requirements.

[36] In response to the Draft Report, a number of submissions suggested the Queensland Government should seek to support more than 400 MW of renewable energy capacity through this process.

As noted earlier, on 8 September 2016 ARENA announced funding support for six Queensland large-scale solar projects under its Large-scale solar photovoltaics – competitive round process. It is understood there were a number of other high-merit Queensland projects not selected to receive ARENA funding. Given their advanced state (in terms of project design, planning), these projects may be well placed to participate in any additional reverse auction.

5.4.4. Capability

While the Queensland Government has not yet independently run a full reverse auction process, the Department of Energy and Water Supply has collaborated with ARENA in its large-scale solar funding process. In doing so, the Department has gained important insights into the design and operation of a reverse auction process.

In undertaking a reverse auction process independently it will be important for the Queensland Government to commit sufficient resources to ensure successful delivery. This will require external advisory services in the following areas:

- Commercial and financial
- Legal
- Technical
- Probity.

Following commissioning of the projects, the Government would also need to establish appropriate contract management processes that deal with settlements of CFD payments and treatment of LGCs.

5.4.5. Treatment of LGCs

As noted above, renewable projects successful under the auction process would be complementary to the LRET, meaning that the LGCs created by the projects would be eligible to be traded in the market. In designing the CFD, the Government will need to determine how LGCs created by the projects are treated.

The Government could structure the CFD to include both the wholesale pool price and LGC component as a bundled price. Under this approach, LGCs created by projects would be transferred to the Government. The Government would then have an opportunity to make the LGCs available to be traded in the market to reduce the cost of the CFD to the Government and to make the LGCs available to meet liabilities under the LRET. Importantly, the Government would need to assess the optimum arrangements for making the LGCs available for trade in the market having regard to:

- The size of the renewable project and associated volume of LGCs
- The need to balance the state's interests in maximising revenue from the sale of LGCs with market transparency as to when and how the LGCs are likely to come into the market.

Alternatively, the Government could structure the CFD based on the wholesale price component only. This would transfer the price and volume risk associated with the LGCs to the project developer and potentially reduce the level of financial support provided by the Government through the CFD. However, this structure may be less attractive to developers.

The treatment of LGCs should be determined as part of the auction design process, and following market sounding with project developers to understand the preferences in the market to manage the risk associated with the LGCs.

5.4.6. Structure of the CFD

The Panel recommends that the CFD be structured in such a way as to minimise the state's financial exposure and maximise the state's flexibility to transfer or deal with the arrangement at a future time. This should include a review of the key components of the Solar 150 support framework, such as:

- *Term length:* Traditionally offtake agreements have covered the length of a renewable project's life (15 to 25 years), which has been considered necessary for renewables projects to obtain finance. However, recent activity in the market suggests the tenor of contract may be reduced. For example:

  - AGL's Powering Australian Renewables Fund will seek to sign PPAs with a duration of between 5-7 years
  - Ergon Energy has signed a 12.5 year PPA with Ratch for the output of the Mount Emerald wind farm
  - Origin has signed a 13 year PPA with FRV for the output of the Clare solar farm.

  Following these precedents, the Panel is of the view there is an opportunity for the Queensland Government to offer CFDs with a tenor of between 7 and 15 years[37]. This is likely to provide project developers with sufficient revenue certainty, while reducing the long liability of the CFD.

- *Contracted volume:* the Government may only need to provide partial support to a project for it to proceed, which would minimise its financial exposure. For example, as part of the ACT Government's first wind auction, the Government has entered into a PPA for 40% of the electricity generated by the Ararat Wind Farm, which was sufficient for the project to be developed[38].

- *Pricing*: the Government may consider using a fixed price CFD combined with "collar arrangements". This would provide a minimum stream of revenue to support debt financing but allow for the sharing pool risk with equity financiers.

  In feedback on the Draft Report, AEMO suggested that a price floor be introduced to account for the fact that there could be extended periods where generation from renewable energy results in negative wholesale price outcomes. AEMO also identified that incorporating time and locational prices signals could also enable efficient investment in renewable energy. These aspects were also recognised by AGL in its submission on the Draft Report. This could be considered by the Queensland Government as part of designing the CFD.

- *Assignability*: The Government may desire flexibility to assign (sell) the CFD and LGC offtake arrangement (if applicable) in the future should the market conditions present that opportunity. To allow for this, the Government should consider the contract counterparty which may not have a Government guarantees, but put in place a credit rating test on the off-taker.

[37] Despite this recent market precedent, some stakeholders suggest there is merit in the Government providing longer-dated contracts. For example, in submissions on the Draft Report the Clean Energy Council, CleanSight Pty Ltd, GetUp and World Wildlife Fund suggested longer tenor contracts (i.e., up to 20 years) could facilitate a lower CFD strike price thereby reducing the cost of the contract to Government and consumers. The Panel notes that longer dated contracts face much greater risk from uncertainty and disruption.

[38] Ararat Wind Farm 2016

There are number of options for structuring the CFD, which balance differing levels of revenue certainty for developers and exposure to market price signals, as well as the total cost of the CFD. Common structures include:

- *A two-way CFD*: This structure guarantees a set level of revenue for a project based on revenue collected through the wholesale market and revenue provided under the CFD up to an agreed strike price (e.g., the lowest auction bid). If wholesale revenue exceeds the strike price, the project developer pays back the difference to the counterparty and vice versa. This approach provides a clear indicator of the true cost of project given that generators are bidding for their total revenue stream (and take on no market risk). The ACT Government used two-way CFDs in its recent solar and wind reverse auctions.
- *A CFD with a collar*: This structure imposes both a minimum and a maximum on the total revenue that a project can receive. Under this approach a project developer receives additional revenue when the wholesale price exceeds the floor price, but this is capped by imposing a price ceiling (above which the developer makes payments back to the government similar to a two-way CFD). This can provide revenue certainty for the developer while still exposing the developer to market signals and balancing the market risk faced by the counterparty.
- *A one-way CFD*: Under this structure, generators are guaranteed a minimum level of revenue, but maintain additional levels of revenue if wholesale market prices exceed the strike price. This approach, which gives upside opportunities for project developers, would be expected to result in a lower strike price relative to a two-way CFD. A lower strike price may reduce short-term obligations for the counterparty compared to a two-way CFD.

Given the improving commerciality of renewable energy technologies, the Panel is of the view the Government should be structuring CFDs in a way that increases the exposure of projects to as much of the market price as possible. This point was supported by a number of industry stakeholders in consultation on the Draft Report[39]. For example, the Australian Energy Council noted:

> *Project proponents, rather than energy users (or QLD taxpayers) should bear the normal commercial risk of new generation projects. Project developers need to bear some risks in order to encourage the development of the most productive, efficiently sized and located projects that will work in tandem with the wholesale electricity market.*

Ideally, the CFDs would only de-risk and support a project to the extent necessary to secure project financing. The Panel also considers that the strength of the market signal should be improved through the course of the contract, resulting in projects adopting higher levels of market risk over time.

In considering the CFD structure that could be applied, this will ultimately depend on the market conditions at the time of the reverse auction. Therefore, ahead of the reverse auction, it will be important for the Government to engage with industry to identify the risk appetite of project developers and financiers. In addition, the reverse auction may allow complying and non-complying responses from participants which could be assessed based on the quantified risk to Government.

The Panel considers the Queensland Government should also undertake market sounding in order to identify whether other opportunities exist to mitigate the State's financial exposure and at the same time avoid competing with retailers in the delivery of projects under the LRET.

5.4.7. Leveraging ARENA, the CEFC and the CEIF

As part of this process, the Queensland Government could look to leverage support provided through ARENA, CEFC and the CEIF. The funding allocation to ARENA has been recently restructured and there could be further opportunities for the Queensland Government to collaborate with ARENA to access grant funding.

[39] AEMO, AGL, Australian Energy Council

Alternatively, there may be opportunities for leveraging support through the CEFC and/or the CEIF in the provision of financing products. For example, if the CEFC/CEIF was able to offer attractive debt financing (e.g., longer tenor debt with some level of merchant risk), when combined with the Queensland Government providing medium to long-term revenue certainty this may provide a strong value proposition for attracting private sector investment.

Investing in research and development

Much of the R&D in low and zero emissions technology can be considered a public good – as the global benefits from the successful development of various low and zero emissions technologies are immense; and yet it would be almost impossible for developers to capture even a small fraction of those benefits. Therefore if left to private investors, R&D in low and zero emission electricity generation technologies will be much less than is warranted by the potential social benefits. This characteristic of public goods is a well understood area of market failure.

A solution to this market failure is for governments to step in and invest in R&D at “efficient” levels (i.e., levels that are likely to give a positive return on an expected basis). Investment in R&D can be understood as investing in real options to meet an uncertain future. The value of the investment depends on how the expected value of the portfolio of real options changes with the additional investment. Therefore the expected value of the portfolio might be enhanced where it is linked to technologies in which Australia has a strong competitive advantage (such as solar energy) but would also value diversity and R&D that creates synergy with other R&D.

To date ARENA has been the primary provider of R&D funding for low and zero emissions technologies in Australia including renewable energy. The Panel acknowledges that ARENA is a primary source of funding for the purposes of R&D. The Panel considers that the Queensland Government may consider incentivising some R&D in renewable energy as part of the policy. This could involve a specific focus on regional Queensland, especially earlier in the development process. This would have the potential to further reduce costs of renewable energy deployment later in the policy, but more importantly contribute to the development of longer term solutions needed to mitigate greenhouse gas emissions globally.

6. National energy and climate change policy post 2020

Findings

- Australia will likely move to strengthen its current emissions reductions initiatives and mechanisms to ensure that it can achieve 26-28% below 2005 levels by 2030 committed to under the Paris Agreement. The Panel considers it probable that some form of electricity sector emissions reduction mechanism will be introduced nationally prior to 2030.
- In selecting and implementing a pathway for the renewable energy target in Queensland, the Government should have regard to any developments in separate state, territory and federal emissions reduction targets and be clear how the renewable energy policies will deliver greenhouse gas reductions.
- The Panel and stakeholders are generally supportive of Queensland working at a national level to develop and implement nationally integrated climate change and energy policies.
- The credibility and durability of any Queensland renewable energy policy will be enhanced if it is explicitly designed to complement and be flexible to accommodate future changes in national energy and climate policy.

Recommendations

- As part of implementing its renewable energy policy, the Panel recommends the Queensland Government should proactively support the development of integrated climate and energy policies at the national level, as the most efficient way of achieving carbon emission reductions and uptake of renewable energy.
- The Panel recommends the Queensland Government should consider the principles of complementarity, flexibility and adaptability when designing its renewable energy target, to provide greater credibility and durability to its policy.

In developing credible pathways to achieving a 50% renewable energy target in Queensland by 2030, the Panel is required to consider the interaction between Queensland and national policy settings. This is important, as climate change and energy policy at the national level will influence the costs, benefits and achievability of a Queensland renewable energy target.

In addition, the Queensland Government has identified protecting the environment, including reducing carbon emissions, as one of its key policy objectives for energy. National climate and energy policy will have a major effect on this objective. This is similarly reflected in the Terms of Reference which require the Panel to consider the effect of different scenarios on Queensland’s greenhouse gas emissions.

The Queensland Government is part of the federal system and can influence both national and state policies as part of its role on the COAG Energy Council. Accordingly, the Panel has considered how the Queensland Government could act through the national process to optimise outcomes under its own renewable energy policy. The Panel has also considered how a Queensland policy could be designed to complement national policies.

6.1. 2030 emissions reduction targets

6.1.1. Current Australian Government commitment

Australia has committed to domestic and international action on climate change through the Paris Agreement which commits to a global goal of limiting global temperature increases to below 2˚C above pre-industrial levels, and pursuing efforts to limit increase to less than 1.5˚C.

The Australian Government has committed to a 26-28% reduction in emissions by 2030 relative to 2005 levels. At present, emission reductions are being achieved through a combination of:

- Existing programs, including energy efficiency schemes, the LRET, and support for small-scale renewable generation
- Emission reduction opportunities purchased through the ERF

- Limits on emissions growth through the Safeguard Mechanism, which places sectoral and individual limits on emissions from existing entities.

Under the Paris Agreement, it was agreed that countries will review and update their emissions reduction targets every five years, with updated targets to be more ambitious than the previous target. This means that while Australia has a current commitment to reducing emissions by 26-28% of 2000 levels by 2030, this target will need to be increased over time.

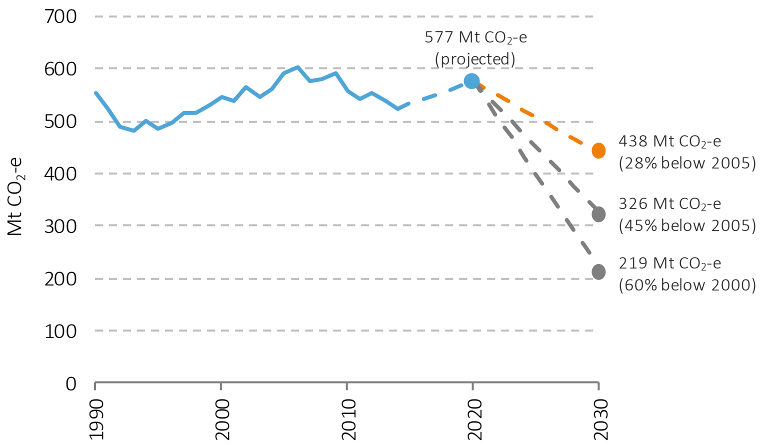
6.1.2. Alternative views

Both the Australian Labor Party and the Australian Greens have policies which propose higher levels of emission reductions than the current Federal Government. The ALP proposes a 45% reduction in emissions by 2030 (relative to 2005 levels), while the Australian Greens support net zero or net negative greenhouse gas emissions within a generation.

In February 2014, the Climate Change Authority prepared a report for the Federal Government making a series of recommendations on emissions reduction goals for Australia based on an assessment of requirements to limit global warming to below 2˚C. The Authority recommended Australia target a trajectory range for emissions reductions of between 40-60% below 2000 levels by 2030 (this equates to 45-63% below 2005 levels).

Figure 15 depicts Australia's national greenhouse gas levels between 1990 and 2014, and highlights the various emissions reduction targets, relative to projected levels in 2020.

Figure 15: National greenhouse inventories and emissions reductions targets, existing and proposed (Mt CO_2-e)



Source: Department of the Environment and Energy 2016b

6.2. Post 2030 emission reductions

6.2.1. Consensus on long-term emissions reduction requirements

It is widely accepted that the global economy will need to be carbon neutral by the second half of the century. As set out in the Paris Agreement, in order to limit global temperature increases to below 2˚C above pre-industrial levels, it is necessary *to "achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century"*[40].

There is also broad political and industry acceptance of the need for targeting net zero emissions in Australia in the longer-term. For example:

- On 29 November 2015 in preparation for the Paris Conference of Parties meeting, Prime Minister Malcolm Turnbull noted, "*It's very important that we reach agreement on the five-year reviews - Paris is not the end of the journey, it is a step along the way to achieving a net zero emissions world.*"[41]

[40] United Nations Framework Convention on Climate Change 2015, p3
[41] Sky NEWS 2015

- On 27 November 2015, in a speech to the Lowy Institute, Opposition Leader Bill Shorten commented, *"The first, long-term objective Labor pledges itself to today, is for Australia to achieve net zero pollution by 2050."*[42]
- In June 2015, the Australian Climate Roundtable, which consists of climate and business groups, agreed that, *"[<2°C] will require … most countries including Australia eventually reducing net greenhouse gas emissions to zero or below."*[43]

These statements are consistent with the Intergovernmental Panel on Climate Change's assessment that global emissions will need to reach zero between 2050 and 2100, with developing and developed countries having potentially different trajectories to that goal.

6.2.2. Australia's carbon budget

Climate change outcomes are driven by total emissions over time and in meeting any particular target, delaying action in the short-term results in the need for deeper and more rapid action later. This aggregate emissions allowance is commonly referred to as a "carbon budget".

In order to have a high level of confidence of limiting global mean temperature increases to below 2˚C above pre-industrial levels, the CCA has determined that Australia's emissions will need to decline to net-zero by approximately mid-century. Importantly, the CCA's proposed trajectory to zero emissions is based on stronger emission reduction targets by 2030 than are currently in place. This suggests that stronger action than currently anticipated is likely to be required either before or after 2030 in order to reach a zero net emissions target.

6.3. Emissions reduction from the electricity sector

There are differing views as to whether the Federal Government's existing policies will deliver the levels of emission reductions necessary to achieve target of 26-28% below 2000 levels by 2030. There is also uncertainty in relation to the required contribution of the electricity generation sector to achieving the 2030 target. In May 2016, Energetics prepared a study for the Australian Government Department of the Environment, modelling national emission reduction opportunities between 2021 and 2030. Energetics' analysis found that the Government's 2030 emissions reduction target could be met under existing policies and programs, with the majority of reductions achieved through energy productivity and land-use change (together delivering almost 800 Mt CO_2-e in cumulative emission reductions). Importantly, the analysis suggested Australia's emissions reduction target could be achieved without significant emission reductions from electricity generation. However, these results were dependent on substantial energy productivity savings and introducing fuel emissions standards.

In contrast to the Energetics analysis, others hold the view that the electricity sector will need to play a greater role in meeting Australia's emissions reduction targets than is currently envisaged under the ERF. For example, in developing the AEMO's 2016 National Electricity Forecasting Report, the COAG Energy Council advised AEMO to assume a 28% reduction by 2030 in emissions by the electricity sector from 2005 levels in its ongoing forecasting and planning processes[44]. The Panel is also aware that most electricity market studies by industry experts include the assumption of some form of additional carbon constraint on the electricity sector (carbon tax/price, cap on emissions or mandatory closure of high emissions intensive plant).

Given the above discussion, it is reasonable to expect the electricity sector would be required to play a part of Australia's emission reductions. Accordingly, it is likely that some form of national electricity sector emission reduction policy will be introduced before 2030.

[42] Parliament of Australia 2015
[43] Australian Climate Roundtable 2015, p2
[44] AEMO 2016b, p15

6.3.1. The role of renewables in reducing electricity sector emissions

Renewable energy generation is an important source of emissions reduction. Historically, the LRET has made a key contribution to Australia's emissions reduction efforts from the electricity sector, almost exclusively in the absence of a carbon pricing mechanism. As noted earlier, the Federal RET is projected to reduce emissions by about 200 Mt CO_2-e (cumulatively) between 2015 and 2030[45].

While the current design of the RET is legislated until 2030, the RET may nevertheless be changed over the next 13 years. For example, the ALP currently has a policy position of 50% renewable energy by 2030. Stronger ambition for renewable energy is also evidenced at the jurisdictional level with the ACT, South Australia and Victoria setting higher renewable targets compared to the RET.

It is commonly recognised that renewable energy is not the lowest cost form of emission reduction from an economy-wide perspective in the short-term. As noted by The Grattan Institute[46]:

> *In an ideal policy world, a market mechanism such as emissions trading would be used to meet the [emissions] target, and renewable energy would play whatever role was economically efficient to meet the cap at lowest cost.*

However, since the repeal of the *Clean Energy Act 2011*, there is no existing national policy framework for delivering a market based emissions reduction mechanism and it may be some time before one is re-established. Given the likely requirement for significant emission reductions from the electricity sector to meet longer term climate outcomes, combined with the potential benefits of taking early action, the Panel is of the view that increasing the use of renewable energy, while unlikely to deliver the lowest cost emissions reduction[47], is an option for achieving this requirement.

6.4. Queensland's role in influencing national policy

As part of the federal system, the Queensland Government has a direct role in shaping energy and climate change policies through its participation in the COAG Energy Council. In response to the Issues Paper and Draft Report, a number of stakeholders strongly supported that Queensland should be active in promoting integrated national climate and energy policies, to achieve the dual objectives of reducing emissions and increasing the uptake of renewables:

> *The [Australian] Energy Council supports Queensland in participating in the formation of policies to lower emissions and integrate renewable energy to Australia's energy markets through the Council of Australian Governments (COAG). A consistent, national approach is required to tackle the challenge of emissions reduction and renewable integration.*[48]

> *Policy options developed by the Queensland Government should remain cognisant of the national physical, financial and regulatory architecture that governs the National Electricity Market as well as the role of the Commonwealth Government to implement policy consistent with Australia reaching its emission reduction commitments under the Paris Agreement.*[49]

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[45] Climate Change Authority 2015, p7

[46] Wood 2015

[47] Renewable energy targets are less efficient because they do not target displacement of lowest cost emissions and tend to displace the highest cost generation which is often less emissions intensive (in particular gas-fired generation). As energy targets they also do not produce incentives to provide capacity at times when it is most valued.

[48] Australian Energy Council submission to the Expert Panel

[49] AGL submission to the Expert Panel

> *…the ENA suggests that the Queensland Government should work co-operatively with the other jurisdictional governments and the Australian Government on emissions reduction policy. ENA supports the COAG Energy Council's recent agreement to develop a national approach to better integrate carbon reduction and energy policies in the interests of consumers.*[50]

In addition, in its draft report on electricity pricing, the Queensland Productivity Commission recommended that the Expert Panel should consider *"the benefits of an inter-jurisdictional approach to emissions reduction policy"*[51].

In this context, the Panel considers that as part of pursuing a 50% renewable energy target in Queensland, the Queensland Government should seek to drive and influence the development of stable, efficient climate change and energy policies at the national level. For example, a national electricity sector emissions reduction policy (such as an emissions intensity baseline scheme), in tandem with state-specific complementary measures, would likely deliver the Queensland Government's policy intent at lower overall economic cost than a state-specific renewables scheme alone. This approach is modelled as a credible pathway in Chapter 8.

Against this background, it will also be important for any Queensland policy post 2020 to be cognisant of national policy. In terms of design principles, the Panel recommends the Queensland policies should be:

- *Complementary to national policy:* The objectives and design of Queensland's target should work in tandem and seek to leverage and avoid duplication with federal policies. This will ensure that new renewable capacity is developed in an efficient manner.
- *Adaptable and flexible:* Queensland's target should be adaptable to future changes in national policy. For example, if the national RET is increased beyond the existing target of 33,000 GWh by 2020, there may be a reduced requirement for state-based policy intervention. Therefore, Queensland's policies should be flexible enough to adjust as required.
- *Forward looking:* While the Panel recognises the Terms of Reference relate to the period up to 2030, the Panel also recognises that substantial emissions reductions will be required beyond 2030. Importantly, action undertaken between 2020 and 2030 will influence future emission reduction opportunities.

As well as being more cost-effective, the Panel is of the view that a Queensland policy that is complementary to national policies will be more credible and durable, as it will adapt to changes in the policy landscape. The next chapter discusses the implications of these principles and this approach for the development of the 50% target.

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[50] Energy Networks Association submission to the Expert Panel

[51] Queensland Productivity Commission 2016, pxiv

7. Queensland renewable energy policy options post 2020

Findings

- The Queensland Government should encourage the market to contract and deliver the requisite renewable energy capacity to meet the 50% renewable energy target, and only provide support when the level of renewable generation is not being developed.
- Where additional incentives are required, reverse auctions for CFDs appear to be the most effective policy mechanism to incentivise the development of renewable energy projects in Queensland post 2020. Reverse auctions for CFDs allow the market to determine the required level of financial support, which is more likely to deliver investment in renewable energy efficiently.
- Reverse auctions for CFDs also enable the overall level of support for renewable energy to be scaled up or down based on market developments and changes in national policy, in line with the principles of being complementary and flexible, while still providing investment certainty for contracted parties.
- Alongside harnessing current mature renewable technologies, the Government could consider targeting the development of dispatchable renewable technology and also fringe-of-grid solutions as part of its reverse auction program.
- Modelling for the Panel indicates that early retirement of coal-fired generation in Queensland is not required in order to achieve a 50% renewable energy target. However, should the Queensland Government undertake further consideration of the need for early coal retirements, this should be progressed at the national level and/or with other jurisdictions as part of a broader consideration of emission reduction policies.
- Broader economic policy measures targeted at reducing greenhouse gas emissions, such as carbon pricing, are likely to be an effective enabler of new renewable energy capacity, but given their broad effect and the nature of the interconnected market, these measures would be more efficiently implemented nationally.

Recommendations

- The Panel recommends the Queensland Government should not introduce any additional policy mechanisms beyond the SRES that provide financial support for small-scale renewable energy.
- The Panel recommends that the primary mechanism for delivering new large-scale renewable energy capacity post 2020 should be through reverse auctions for CFDs.
- While the overall approach to running reverse auctions should be technology neutral, the Panel recommends the Government investigate opportunities for running specific reverse auctions for dispatchable renewable energy and isolated and/or fringe-of-grid solutions.
- Given that consumers are the ultimate beneficiaries of electricity that is generated in the market, the Panel recommends that the costs of the CFDs are recovered through electricity market mechanisms. Under the modelling the net effects of the policy on consumers are expected to be broadly cost neutral (including the estimated subsidy and modelled effect on wholesale prices).
- The Panel recommends the Queensland Government should not pursue the implementation of broader state-based economic policy mechanisms, such as carbon pricing, for the purpose of meeting the 50% renewable energy target. However, these policies could be considered by the Queensland Government in the context of coordinated policy action with other jurisdictions in the NEM or nationally, aimed at facilitating emission reductions.

The previous chapter considered some of the design principles that should guide the development of a Queensland renewable energy target. This was specifically within the context of current and possible future national climate change and energy policies.

This chapter outlines some of the policy options that could be pursued at a state level in the period post 2020. Given the potential for complementary national emissions reduction policies to be introduced at the national level post 2020, the principles of flexibility and adaptability will be particularly important.

The Issues Paper outlined a series of policy options that can be used to incentivise investment in renewable energy. These were grouped into two broad categories, namely:

- *Direct policy incentives:* These policies directly mandate, fund or provide favourable finance for renewable energy generation, and can include:
  - Auctions for contracts for difference
  - Concessional loans
  - Tenders for capital grants
  - Certificate schemes
  - Feed-in tariff.
- *Broader economic policy measures*[52]*:* These measures apply penalties to various types of greenhouse gas emissions including to competing generators such that renewable energy projects are installed independently, and might include:
  - Carbon pricing
  - Fossil fuel levy
  - Emissions reduction auctions
  - Mandated coal-fired generation retirements.

The Issues Paper also considered policies that provide non-financial incentives for renewables, such as streamlining the project approvals, and the improving the network connections process. These policies are addressed in Chapter 10.

7.1. Direct policy options

A description of the direct policy mechanisms is outlined in Table 11.

Table 11: Direct policy options for increasing investment in renewable energy

Policy	Description
Auctions for contracts for difference	Contracts for Difference (CFD) provide a long-term revenue stream for renewable energy generators, funding the difference between the strike price (set through a competitive process driven by project costs) and market revenues. If awarded through reverse auctions, the CFD price can be based on either the marginal bid for that round or based on each project's bid price. Marginal bidding is more likely to encourage projects to bid their true costs, but may increase the overall cost of the scheme and may provide limited competition benefits. There are a range of different structures of CFDs and they can feature more complex structures such as higher upfront payments and lower long-term payments, or contracts escalating with CPI or higher. Payments could also be partially or wholly linked to the wholesale electricity price, providing less certainty but passing through some of the market price signals to developers. Reverse auctions for CFDs can be technology neutral, or applied for specific renewable technologies if the Government considers there is value in creating technology diversity. CFDs can be flexibly integrated with the LRET.

[52] The Issues Paper used the terminology "Indirect Policy Incentives". "Broader Economic Policy Measures" has been used here as the Panel considers that it better reflects the range of measures that could be used.

Policy	Description
	While CFDs provide a high degree of revenue certainty for project developers, the counterparty can be exposed to fluctuations in the wholesale pool price which can increase its financial obligations under a CFD. CFDs by nature are intended to be highly fungible. However, in practice, the more tailored the terms of the CFD, the less fungible it will be in the market.
Concessional loans	Concessional financing can be used to assist renewable energy developers in securing adequate finance to support a project. Concessional financing provides more favourable financing terms than could be expected between a private sector lender and private sector borrower. For example, concessional finance can offer: ▶ Lower than market interest rates ▶ Longer loan maturity ▶ Some linkage to market pricing ▶ Greater flexibility before the payment of principal/interest is due.
Tenders for capital grants	Capital grants provide partial funding for projects (generally 20-50% of total costs) with project developers required to source debt and equity finance for the remainder. Grants can be effective in reducing the risk of developing projects with high upfront costs. Competitive tendering can be used to determine grant levels, with each project developer submitting bids for the minimum level of grant their project would require. While grant funding may be an appropriate mechanism for assisting projects at the pre-commercial and R&D phase, there are challenges in running grant tendering schemes for projects that are larger in scale and further along the technology deployment curve.
Certificate scheme	Certificate-based schemes grant renewable generators “certificates” for each MWh of generation above an agreed baseline. Liable loads (typically electricity retailers and some end users) must procure a certain number of certificates equating to a fixed amount of renewable generation, which acts as an additional source of revenue for renewable generators. To the extent that the market is confident the scheme will not be adjusted, long-term targets set under a certificate scheme can provide a high level of certainty for developers making investments and establishing a pipeline of projects. However, should the scheme be exposed (or perceived to be exposed) to changes in its design, this can create uncertainty for project development.
Feed-in tariff	FiTs are fixed payments made to renewable energy generators based on the volume of electricity produced. For small-scale systems a FiT can be provided based on either the volume generated or the amount exported into the grid. For large-scale applications, FiTs may be a payment on top of wholesale market revenue, or provide a guaranteed minimum revenue stream based on renewable energy production. FiTs may be paid for either by consumers or government. A FiT is a particularly useful policy instrument where the objective is to rapidly increase the deployment of a particular renewable energy technology, or develop certain aspects of the renewable energy industry. However, setting the price of a FiT is a particularly challenging exercise. If the FiT is set too low, the subsidy is insufficient to incentivise project development. If the FiT is set too high, as is more commonly the case, or if technology costs fall more rapidly than anticipated, then project developers may receive windfall payments.

7.1.1. Panel views on direct policy options

Ultimately, each of the policies outlined above are designed to incentivise the development of renewable energy projects. However, the degree to which each policy delivers renewable energy investment in a timely and cost effective manner depends on the policy instrument, the level of the incentive available through the policy and how the policy interacts in Queensland in the context of the national electricity market and other policy initiatives at the state and Federal level.

In considering each of the direct policy options, the Panel is of the view that reverse auctions for CFDs is likely to be the most effective policy mechanism to incentivise the development of renewable energy projects in Queensland post 2020. Reverse auctions for CFDs was widely recognised among stakeholders as the most prospective policy mechanism for delivering additional renewable energy capacity[53].

Reverse auctions for CFDs allow the market to determine the required level of support, which is more likely to deliver investment in renewable energy in a cost-effective manner. Implementing a series of reverse auctions up to 2030 would provide the Government with flexibility to:

- Integrate with existing complementary policies and respond to new climate and energy policies that may be introduced nationally
- Adjust the terms of the CFD offered to projects at each auction in response to changing market conditions and feedback from industry
- Modify the auction parameters over time, which could take into account improvements in particular renewable energy technologies or the needs of the Queensland grid (including for example, fringe-of-grid requirement, as they emerge).

In considering the suitability of the other direct policy options, the Panel is of the view that:

- Concessional loans play an important role in filling funding gaps and encouraging other financiers in renewable projects. However, given this function is already provided by the CEFC (and potentially the CEIF in the future), the Panel is of the view that there is limited requirement for the Queensland Government to provide concession loan financing by itself. It will be important for projects to utilise funding arrangements offered through the CEFC, and there may be a role for the Queensland Government in assisting projects with accessing these funds and possibly combining with the CEFC in reverse auctions to offer "stapled-financing" products[54].
- Grant funding is an appropriate form of support for projects and technologies that are at the R&D, demonstration or pre-commercial stage of development. For example, capital grants could be an appropriate policy mechanism if the Government was interested in developing solar thermal technology in Queensland. However, given the likelihood that mature technologies such as wind and solar PV will provide the majority of Queensland's 50% renewable energy target, grant funding should not be considered as the primary policy mechanism for achieving the Government's objectives[55].

[53] Specifically, the following stakeholders supported the use reverse auctions for CFDs in submissions to the Panel: Aurecon; the Australian Conservation Council; AGL; Beyond Zero Emissions; Cleansight; the Clean Energy Council; the Department of State Development; Elevare; Energetic Communities; Equis Australia; the North Queensland Conservation Council; Solar Reserve; and the Sustainable Queensland Forum.

[54] Stapled financing refers to a financing package offered to potential auction participants distributed with (or "stapled to") the auction information memorandum.

[55] In its submission to the Panel, Aurecon also made that point that competitive processes for capital grants can be burdensome for large-scale projects, from the point of view of applying for funds (i.e., these processes typically have high degrees of administration on the developer side).

- While a renewable energy certificate scheme can also be an effective mechanism for increasing investment in renewable energy, there are clear challenges for implementing a renewable energy certificate scheme in Queensland[56]. These include the complexities associated with operating a certificate scheme within a single jurisdiction, as well as the regulatory burden on liable parties. There are also restrictions on Queensland being able to establish a certificate scheme for renewable energy, as section 7C of the *Renewable Energy (Electricity) Act 2000* limits the scope for individual states to implement similar schemes.
- Although a FiT provides a clear and transparent price signal for project developers, the difficulty in setting the FiT at an appropriate level creates an unacceptable risk of the Government or consumers paying more than is necessary. The Panel considers that other policy options can provide a similar price signal with lower risk.

Stakeholder views (Draft Report)

Origin and the Electrical Trades Union (ETU) did not support the use of CFDs as the policy mechanism to incentivise investment in renewable under the target. According to Origin, this approach "imposes a disproportionate risk on Queensland electricity consumers/taxpayers and electricity market participants" (noting that Origin's views appeared to be more relevant to projects developed under the LRET).

AGL put forward an alternative approach for the policy mechanism. AGL's approach is for the Government to provide upfront payments (that represent the present value of future payments) to a renewable developer to reduce its upfront costs. According to AGL, this approach could provide Government with greater visibility about the overall cost of the scheme. While this approach could provide enhanced certainty about the level of funding support provided to a project, the Panel notes there is a risk that it could increase price volatility for consumers. The Panel notes these views but retains its preference for CFDs for reasons outlined throughout the report.

7.1.2. Considerations for reverse auctions for CFDs

Achieving the target of 50% renewable energy generation by 2030 will require significant new renewable generation capacity in Queensland between 2020 and 2030. Delivering this amount of renewable capacity between 2020 and 2030 will therefore require a series of auctions calling for substantial levels of renewable capacity.

There is a range of factors that the Queensland Government will need to consider in establishing and undertaking the auction processes. The key considerations are outlined below.

Funding the costs of the subsidy

As noted in the Issues Paper, where additional subsidies are required to support new renewable energy projects, these can either be funded through market mechanisms (as is the case under the RET), or funded by the Government.

During the Panel's public and industry forums, the cost of electricity emerged as a common theme, with many stakeholders suggesting that electricity prices are already high. Similarly, many submissions received on the Issues Paper were of the view that if subsidies were required for renewable projects, the costs should be borne by the Government rather than consumers[57]. Particular concern was raised in relation to the effects on low income or vulnerable customers.

Alternatively, some submissions considered it was appropriate for renewable subsidies to be funded by consumers, provided the cost is transparent and explicitly identified on consumer retail bills[58]. As part of the public forums undertaken by the Panel, some participants suggested that consumers may be willing to accept increased prices if the benefits could be clearly demonstrated.

[56] A number of submissions on the Issues Paper supported the use of a certificate schemes to meet the target, including Equis Australia and Mackay Sugar.
[57] Australian Energy Council, ERM Power, Electricity Networks Association
[58] Alistair Buchan (individual), Aurecon, Energex, Ergon Energy, AGL, Mackay Sugar

Most recently, the ACT Government has funded the cost of its renewable energy reverse auctions by placing the obligation on the network business, ActewAGL. A similar approach could be relatively easy to administer in Queensland as it would place the obligation primarily on Energex and Ergon Energy, who would then be able to include the cost of the subsidy as part of their network charges. However, while there is a transparent process for applying the costs to the network charges, this may not be fully transparent to electricity customers as network charges and their components are not usually separated out by retailers for the purposes of billing customers.

Alternatively, the obligation to fund the subsidy could be placed onto retailers, similar to the approach for the RET. This approach is likely to be more complex as it involves arrangements with a larger number of retailers and would require the Government to determine the liability for each retailer based on their individual market share.

Regardless of where the obligation sits, in order for the subsidy cost to be funded through market mechanisms, the Government would be required to develop an appropriate mechanism to facilitate this. In the short term, opportunities may exist for the Government to utilise non-legislative arrangements to recover the cost of the subsidy, for example through the *Government Owned Corporations Act 1993.* However, to ensure the longer-term stability of the mechanism, it would be preferable for it to ultimately be established under legislation.

While attributing the costs of the Queensland target could be implemented in a relatively straightforward and transparent manner, identifying the benefits of the target is likely to be more challenging.

Beneficiaries pay

The Panel notes that consumers are the ultimate beneficiaries of electricity that is generated in the market. Without this demand for electricity, the existing levels of electricity-based greenhouse gas emissions would not be emitted. Consumers currently benefit from the relatively low cost of coal-fired electricity generation but this cost does not include the costs associated with greenhouse gas emissions as they are not currently priced in the market.

The market modelling undertaken by Jacobs projects that wholesale electricity prices in Queensland would be lower as a result of the increased level of renewable energy in the market (with the renewable energy causing an oversupply of generation capacity). Once the estimated subsidy cost is offset against this reduction in wholesale energy prices, it is projected that the effect on consumer bills is largely cost neutral over the study period (discussed in more detail in Chapter 8). This is largely due to the so called “merit-order effect”, with subsidised renewable capacity that enters the market displacing dispatch of higher cost coal and gas generation.

While consumers may not explicitly notice the effects that lower wholesale pool prices might have on their electricity bills, should these effects eventuate, these benefits will nevertheless be expected to be accrued by customers. Given that the market modelling by Jacobs projects there to be neutral cost outcomes for consumer retail electricity bills (including the estimated subsidy), the Panel is of the view that electricity consumers are the beneficiaries and have the capacity to pay for the subsidy required to incentivise projects constructed under the Queensland target.

Treatment of Large-scale Generation Certificates

Renewable projects developed prior to 2030 will be eligible to create LGCs. The Panel considers that the LGCs from projects that are developed after 2020 and supported by CFDs should be transferred to the Queensland Government. However, the Panel notes that under the existing structure of the LRET, there is not expected to be a requirement for new sources of LGCs post 2020. The Panel therefore recommends the Queensland Government should adopt measures to avoid distorting the market price for LGCs and affecting the viability of projects build prior to 2020 that are relying on the LGC market for support. These could include voluntary surrender of LGCs on an annual basis.

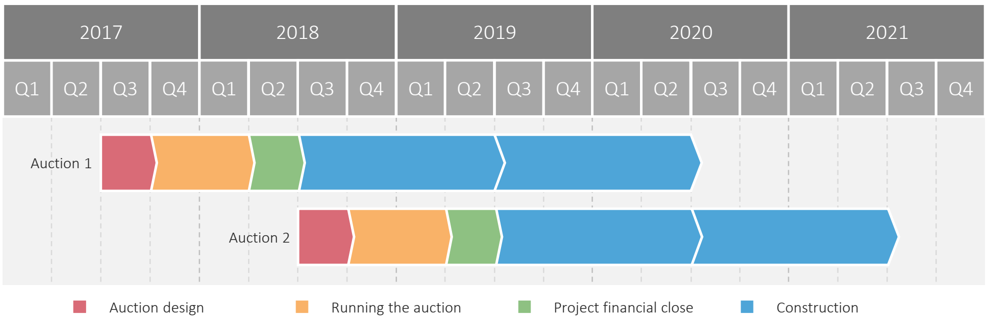
Should the LRET be strengthened beyond its existing target, the Panel notes there may be opportunity for the Governments to make these LGCs available to be traded in the market to reduce the cost of the CFDs.

Timing of auctions

In Chapter 5, the Panel identified the Government's initial reverse auction process could take 12 months to complete. As noted in Chapter 5, the projects developed under this process would most likely need to be constructed and commissioned before 2020 in order to receive revenue from the LRET.

Assuming the first tranche of non-LRET projects were required to be built by 2021, the Government's second reverse auction process would need to commence in mid-2018, almost immediately following the financial close of projects in the first auction (although some overlap of the auction process could be considered including any refining of the auction design). Figure 16 illustrates indicative timeframes for the first two auctions.

Figure 16: Timing of auctions



Auction schedule

In order to ensure a strong pipeline of projects, it would be appropriate for the Government to develop an indicative schedule of auctions over the 2020-2030 period. In order to broaden the pool of participants in each auction, the Government may consider advertising the auction prior to its commencement. This would encourage project developers to accelerate project planning and development requirements, thus ensuring projects are at an advanced stage when the auction commences.

A schedule of auctions also has the potential to limit boom-bust development cycles (that may otherwise occur for one-off or ad-hoc auctions) and enable more effective long-term energy planning. However, the schedule of auctions would need to maintain a degree of flexibility to take into account any changes in energy and climate policy at the federal level.

Prequalification criteria

To help ensure realistic and credible bids during each auction process, the Government may consider establishing the requirement for bid-bonds or performance penalties (noting that this may have the effect of reducing participation, particularly from smaller developers). Alternatively, the Government could introduce prequalification criteria, or requirements on participants to have substantially progressed the negotiation of network connection agreements prior to presenting bids.

Technology and applications

The Government will need to develop a strategy for technology choice if auctions are not technology neutral. This will be particularly important if a single technology emerges in large quantities, which could result in sub-optimal generation mix. For example, if solar PV is deployed exclusively this could have implications for wholesale pool prices in the middle of the day.

Alternatively, there may be a case for targeting specific technologies to address technology specific risks or promote technologies which may have higher costs but deliver other benefits, such as delivery of peak generation, improved network integration and grid stability, or provide higher levels of emissions reduction[59].

[59] In its submission to the Panel, Wilmar Sugar suggested there be recognition of the "un-priced" benefits of renewables. Similarly, Aurecon highlighted the benefits of renewable energy technologies that can dispatch on demand and bid in the ancillary services market.

This is particularly relevant in considering the period after 2030 and ensuring there is a smooth transition to a larger volume of renewable energy in the grid. These considerations are discussed further in Chapters 9, 10 and 11 in the context of developing enhanced ancillary services (to maintain system security) and maximising economic benefit by targeting specific Queensland competitive advantages and requirements in technology development.

The use of renewable energy in isolated and fringe-of-grid locations, as well as dispatchable renewable energy, was recognised by stakeholders as an area where Government could provide direct support. The development of renewable energy projects in the Ergon Energy network could reduce the cost of supplying power to regional Queensland through replacement of diesel generation or minimisation of line losses, and hence reduce the cost of the community service obligation (estimated at $561 million in 2016-17[60]). While this benefit cannot currently be accrued by project developers, it would represent a direct saving to the Queensland Government. On this basis, the Panel recommends the Government should consider running a specific auction process for these applications, in collaboration with Ergon Energy, and local council or community organisations as appropriate.

7.2. Broader economic policy measures

A description of each of the broader economic policy measures is outlined in Table 12.

Table 12: Broader economic policy measures for increasing investment in renewable energy

Policy	Description
Carbon pricing	Carbon pricing creates an incentive to reduce greenhouse gas emissions, which can encourage investment in renewable energy generation. A number of difference types of carbon pricing exist, including cap-and-trade schemes, sectoral baselines (or limits) on emissions, baseline and credit schemes (including emissions intensity targets), and a fixed price on carbon.
Emissions reduction auctions	The government could procure bids for reductions in energy sector emissions, which could directly or indirectly increase renewable investment.
Fossil fuel levy	Increasing the royalty rates applied to coal and/or gas mining could increase competition for renewable energy generation. Any additional revenue raised through increased royalties could be used to support the transition to renewable energy, including structural assistance programs in the event of fossil fuel power station retirements.
Mandated coal-fired retirements	Retiring the oldest or emissions intensive coal generation plant could reduce greenhouse gas emissions and create opportunities in the market for new renewable energy generation. Approaches being considered by Governments around the world include limits on total emissions, declining thresholds for emissions intensity, and mandated retirement for capacity beyond a certain age.

7.2.1. Panel views on broader economic policy measures

Carbon pricing

While the primary objective of the inquiry is to investigate pathways to achieving 50% renewable energy in Queensland by 2030, the Panel notes that achieving emissions reductions from the electricity sector is also a key objective.

The Panel considers that a carbon price is widely considered as one of the most economically efficient mechanisms for reducing emissions from the electricity sector. However, as noted previously in chapter 6, the Panel is of the view that carbon pricing is more effectively implemented at the national level, rather than at a state level.

[60] Queensland Government 2016, p8

A carbon price applied to Queensland alone would likely result in increased electricity imports from New South Wales, therefore dampening the effectiveness of the emissions price signal in Queensland. This point was also recognised by the Australian Energy Council in its submission on the Issues Paper. This may limit the ability of such policies to effectively drive greater investment in renewables in Queensland.

A carbon price implemented at the national level would act as an important enabler for renewable energy in Queensland as well as a significant driver of emission reductions. Therefore, the Panel is of the view that policies to reduce emissions continue to be progressed through the COAG Energy Council.

Carbon emissions reduction auctions

At present, the Emissions Reduction Fund is the primary policy for reducing emissions in Australia. To date, the fund has resulted in limited investment in renewable energy. The Panel’s view is that targeted reverse auctions for CFDs in Queensland is likely to deliver new renewable generation capacity much more effectively than broader Queensland carbon emissions reduction action.

Fossil fuel generation levy

A fossil fuel levy can act both to increase the competitiveness of renewable energy and provide a source of funding for Government to support new renewable generation, or to assist communities in the event of closure of fossil fuel plant. The Victorian Government recently announced an increase in the state’s coal royalty rate from 1 January 2017, in order to *“support the transition to cleaner energy sources and ensure that the State receives a fair value for its endowment of natural resources*”[61]. It is understood the royalty rate will increase from $0.076/GJ to $0.228/GJ of energy produced, with the new rate projected to deliver $252 million in revenue to the Victorian Government between 2016-17 and 2019-20.

This type of policy may result in more targeted emission reductions. However, the Panel notes that the Queensland Government has ruled out a fossil fuel levy as a means of funding new renewable energy generation.

Coal retirements

The Panel considers that investment in electricity generation capacity is best supported by overall supply-demand fundamentals. According to AEMO[62], there will be a surplus of generation capacity in Queensland until at least 2025, reflecting limited future demand growth (AEMO’s forecast does not extend beyond this timeframe). On this basis, an option to establish market demand for renewable energy investment can be through the retirement of coal-fired generation capacity.

The retirement of coal-fired generation must also be considered in the context of national emission reduction policy. Where there is an appropriate carbon pricing mechanism in place, the timing of any retirement would be likely delivered through the market. In the absence of an appropriate carbon pricing in the energy sector, the case for planned coal retirement is strengthened.

There is a first-mover disadvantage associated with the early exit of coal-fired plant from the NEM. As plant exit the market, remaining generators tend to benefit from an uplift in wholesale electricity prices. The Panel notes that consideration has previously been given to a planned or orderly exit of coal-fired generation to complement carbon pricing (the previous Federal Government’s Contracts for Closure program). However, under this process no outcome was able to be achieved between the Federal Government and generators. Since that time there have been increasing calls from within the energy community for a more nationally coordinated approach to coal closure. A number of large energy companies have announced dates by which they will close their coal-fired power station assets.

Unlike the other emission reduction policies discussed above, the retirement of coal-fired generation could feasibly be undertaken by individual jurisdictions. This is particularly true in Queensland, given the Government’s unique position as owner of over 60% of the State’s coal-fired generation capacity.

[61] Victorian Government 2016, p116
[62] AEMO 2016c

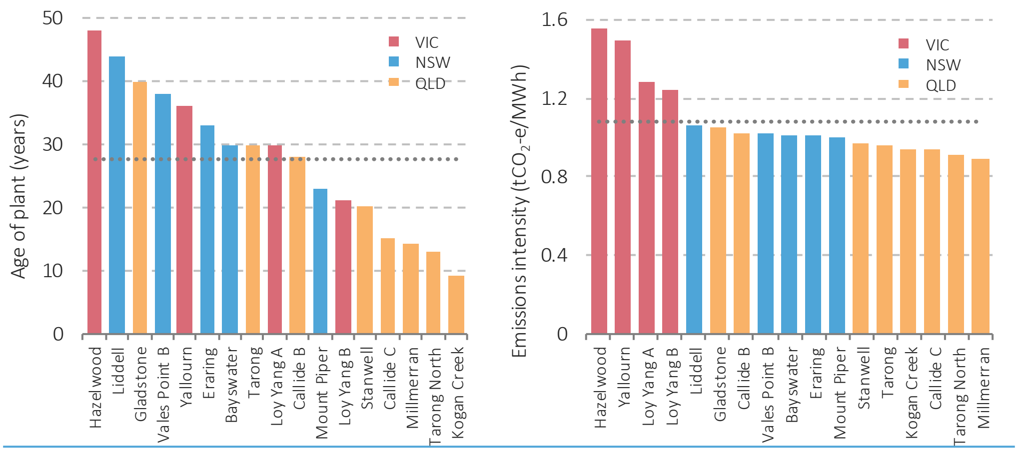
However, analysis by the Panel shows that Queensland has the newest and least emissions-intensive fleet of coal-fired generators in the NEM (refer to Table 13 and Figure 17), with Queensland having the only supercritical coal plant in the NEM (Callide C, Kogan Creek, Millmerran and Tarong North), totalling almost 3,000 MW. As a result, any independent action from the Queensland Government may result in a sub-optimal outcome for reducing national emissions. That is because it would offer an advantage to coal generators in other states that have higher emissions intensities. For this reason, the Panel is of the view that any planned closure would best be coordinated through national processes.

Table 13: Average age and emissions intensity of NEM coal-fired generation, by region

Region	Average age of coal plant (years)	% of average	Average emissions intensity of coal plant Installed capacity (t CO_2-e/MWh)	% of average
VIC	33.8	122%	1.39	129%
NSW	33.6	121%	1.02	94%
QLD	21.1	76%	0.96	89%
NEM	27.8	100%	1.08	100%

Source: DEWS analysis

Figure 17: Age and emissions intensity of NEM coal-fired generation plant



Source: DEWS analysis

Modelling undertaken for the Panel indicates that no coal-fired generation in Queensland would be required to retire out to 2030 under scenarios where the 26-28% national emissions reduction target is applied and where a 50% renewable energy target is achieved in Queensland (noting that coal generation output is, however, projected to decline). The modelling shows there may be a requirement for retirement of coal-fired generation in Queensland under a scenario where a stronger national emissions reduction target is in place (i.e., 45% emissions reduction by 2030 relative to 2005 levels).

The Panel is also aware of recent analysis by The Climate Institute that finds that there may be a limited requirement to retire coal plant in the period 2020 to 2030 in order to meet Australia's current emission reduction targets[63]. However, this analysis also indicated that as longer term emission reduction targets become clearer, significant and simultaneous coal retirements may be required in the NEM beyond 2030, potentially resulting in distortionary effects on the market.

On balance, the Panel does not see a 50% renewable energy target driving the early retirement of coal-fired generation plant in Queensland. However, the Panel is of the view that should the Queensland Government undertake further consideration of the need for early coal retirements, this should be progressed at the national level as part of a broader consideration of coordinated national emission reduction policies.

[63] The Climate Institute 2016

8. Analysis of credible pathways to a 50% renewable energy target for Queensland

Findings

- The Panel has assessed three alternative post-2020 pathways to meeting a 50% renewable energy target for Queensland by 2030:
  - *Linear pathway:* Assumes a uniform annual rate of renewables build from 2020-2030
  - *Ramp pathway:* Features a ramp up in effort later in the period to capitalise on falling technology costs over the period
  - *Stronger National Action pathway:* Assesses what additional Queensland Government action would be required to reach a 50% target if a stronger national emissions reduction scheme is put in place from 2020 to achieve a 45% reduction in electricity sector emissions on 2005 levels by 2030.
- Analysis of these pathways shows:
  - Under the *Linear* and *Ramp* pathways, between 4,000 to 5,500 MW of new large-scale renewable energy generation capacity is projected to be required in Queensland between 2020 and 2030 to achieve a 50% output target, in addition to Queensland's pro-rata share of the LRET. This equates to up to 13,400 GWh of new renewable generation.
  - Under all three pathways, policy action required by the Queensland Government to achieve the Queensland 50% target is of itself projected to be cost neutral overall to electricity consumers where the cost of funding the policy action is recovered through electricity market mechanisms. This occurs as a result of the policy action having a projected downward pressure on wholesale electricity prices. There is no expected effect on electricity prices prior to 2020 under Queensland policy measures, due to the timing of project development and availability of LRET funding.
  - Under the *Linear* and *Ramp* pathways, Queensland's electricity sector emissions in 2030 are projected to be 25% lower (or 12 million tonnes carbon dioxide equivalent (Mt CO_2-e)) relative to 2016 levels. The *Linear* pathway results in greater emission reductions for the 14 years of the policy than the *Ramp* pathway. Under the *Stronger National Action* pathway, Queensland's electricity sector emissions in 2030 are projected to be 15 Mt CO_2-e lower relative to 2016 levels (or 31% lower).
  - The cost of constructing renewable generation is projected to fall over time. The overall projected subsidy required to achieve the Queensland target would be lower under the *Ramp* pathway ($500 million NPV) than the *Linear* pathway ($900 million NPV), as projects are commissioned closer to 2030. This however, results in less cumulative emissions reduction during the period between 2016 and 2030 as compared to the *Linear* pathway (59 Mt CO_2-e across the NEM in the *Ramp* pathway compared to 81 Mt CO_2-e in the *Linear* pathway).
  - Under the *Stronger National Action* pathway, the national emissions intensity scheme results in Queensland reaching 41% renewables. Approximately 1,900 MW of additional large-scale renewable generation would be required to reach the 50% target, but the projected level of subsidy required ($50 million NPV) would be significantly lower than in the *Linear* or *Ramp* pathways due to the level contribution of the stronger emissions intensity scheme.
  - Operating cash flows for existing Queensland coal generators is projected to decline by $600-$1,100 million NPV under the *Linear* and *Ramp* pathways, due to renewable generation displacing coal generation output and reducing wholesale prices in the NEM, with no effect expected prior to 2020 under the modelling.
- The Panel recognises that the Queensland Government retains ownership of around two-thirds of the Queensland's large-scale generating capacity and while any impact on these generators is outside the scope of the Panel, this impact should be considered by the relevant Shareholding Ministers.

8.1. Context of the analysis

The Terms of Reference require the Panel to provide advice on credible pathways to meeting a 50% target by 2030.

This chapter assesses three pathways to 50% renewable energy generation in Queensland that the Panel considers to be credible, and presents the potential outcomes for consumers, the environment, existing generators and the broader economy under each pathway, in line with the Panel's requirement to assess pathways against the Queensland Government's energy policy objectives.

Two of the pathways represent options the Queensland Government could select in seeking to achieve 50% renewable energy generation by 2030. These pathways are assessed against a base case, reflecting current national and Queensland policy settings.

The third pathway assesses what additional Queensland Government action would be required to reach a 50% target if a stronger national emissions reduction scheme is put in place from 2020 to achieve a 45% reduction in electricity sector emissions by 2030. This pathway is not within the direct control of the Queensland Government, but represents a credible scenario in the context of national climate change policy.

The three pathways are not intended to exclusively define the options or trajectories that the Queensland Government could pursue, but rather to outline the potential costs, benefits and requirements under a range of credible trajectories to 50% renewable energy for Queensland, while still allowing for the Government to choose a trajectory in between or outside this range.

The three pathways are:

- *Linear pathway*: The Government undertakes a series of reverse auctions for renewable energy from 2021 to 2030, and there is moderate national action on electricity sector emissions reduction. A linear trajectory to 50% renewable energy is implemented, building an average of 400-500 MW of new capacity each year from 2021 to 2030. This creates a steady pipeline of projects to provide certainty for developers, but requires greater action earlier when renewable energy costs are higher.
- *Ramp pathway*: In this scenario, the Government gradually increases the size of the capacity sought through the reverse auctions over time starting at around 200 MW in 2021 escalating to up to 1,500 MW by 2030. This takes advantage of improving resource costs (technology "learning rates" over time) in various renewable energy industries including batteries. This allows the 50% target to be achieved at lower overall cost, and allows time for local industries to develop and deliver a greater share of the target. However, the growth of renewable energy in Queensland is delayed, and results in less carbon emission reductions relative to the *Linear* pathway.
- *Stronger National Action pathway*: To quantify the potential effects of national action, this pathway considers a scenario where the Federal Government implements stronger emissions reduction policies, consistent with the lower band of the target from the Climate Change Authority's analysis. Under this pathway, Queensland is projected to reach 41% renewable energy generation through the operation of the national emissions intensity scheme, with further Queensland Government action required to reach the 50% target. This pathway is not directly comparable with the other two pathways in some aspects (e.g., the pathway achieves significantly higher emission reductions across the NEM), but it provides insight into how jurisdictional and national approaches could interact.

8.1.1. Modelling approach and limitations

The Panel engaged Jacobs to undertake electricity market modelling[64]. Jacobs employed a long-term forecasting model, “Strategist”, to determine the least cost generation mix in the electricity sector under a range of scenarios and Queensland policy options. Modelling was undertaken from 2016 to 2030, with an additional 10 years of indicative analysis included in the model to ensure that long-term effects of near-term investment decisions were captured.

The Panel notes that future market and economic development is inherently uncertain, and all models require approximations that limit their ability to capture all real world market conditions. This includes assumptions about strategic response of other market participants, conditions for entry and exit of capacity in the electricity market and the renewable resource of specific projects. In particular, pricing effects can be highly dependent on a range of factors not captured in the modelling. Prices in any single year can be higher or lower due to weather conditions or forced outages of generation or transmission, and single decisions by large users or generators of electricity can have significant effects on future prices.

In particular, the *Linear* and *Ramp* pathway modelling projects no closure/exit of existing coal and gas-fired generation. The additional renewable capacity modelled under each of the pathways creates a significant oversupply of capacity and in turn puts downward pressure on prices. While the existing generators are projected to suffer very large reductions in future profits, under both pathways they are expected to be able to continue to meet their avoidable costs and provide modest returns to capital.

However, Queensland is one of the most concentrated regions in the NEM (on the supply side) and most generation units form part of larger generation portfolios. The closure of one or more gas or coal-fired generation units in response to the policy-led oversupply, would likely have significant portfolio benefits for the remaining generation units within that portfolio because of the likely upward movement in wholesale electricity prices. These portfolio responses are difficult to predict and have not been captured in the modelling undertaken for the Panel.

Within these limitations, modelling can provide important insights into the trends and effects of future market developments. In particular, the Panel has used the modelling to investigate the relative effect of the Queensland policy under each of the identified credible pathways.

Unless otherwise stated, all financial figures are in real July 2016 dollars, and total figures over the study period (from 2016 to 2030) are presented as discounted present values as a real discount rate of 7%. Some individual figures may not add to cumulative totals due to rounding.

8.2. *Base case* - market development without new Queensland policies

To conduct the assessment of the credible pathways to 50% renewable energy, the Panel has developed a *Base case* that represents the potential development of the electricity market in the absence of any additional policy intervention by the Queensland Government. This scenario is built on “middle of the road” forecasts developed by AEMO and by Jacobs. The key assumptions are shown in Table 14.

The Panel notes that there are a broad range of potential futures which could eventuate, and there remains considerable uncertainty around the various input assumptions. Some of these uncertainties, such as the gas price, would affect the net cost of meeting the target, while others, such as future demand, would also influence the total renewable generation build required. Furthermore, no modelling can account for unpredicted evolutions in technology, or the creation of unforeseen products and services. The Panel has adopted the approach of producing a central estimate, and focussing on the relativities between pathways, which are expected to be less sensitive to future uncertainties. Section 8.3 considers the effect of various demand sensitivities on the requirements for meeting the target.

[64] Jacobs has extensive experience in providing advisory services to inform and support the development of both Federal and State policy, and has been involved in energy and resources policy for over two decades and in the development of renewable energy schemes for significantly longer.

Table 14: *Base case* modelling assumptions

Key input	Source	Assumptions
Demand growth	AEMO	▶ AEMO Moderate scenario – 2016 National Electricity Forecasting Report
Rooftop PV uptake	AEMO	▶ AEMO Moderate scenario – 2016 National Electricity Forecasting Report
Gas prices	Jacobs	▶ $7/GJ in SEQ in 2020 ▶ Long-term trend of $6.30/GJ in SEQ
Emissions reduction	AEMO / COAG	▶ Proxy emissions reduction cost applied to the electricity sector, set at $25/t CO_2-e in 2020 rising to $40/t CO_2-e by 2030 ▶ Implemented through an emissions intensity scheme with trading.
Other renewable energy policy	Various	▶ Existing state based renewable energy schemes (e.g., ACT wind and solar auctions) are continued. ▶ Schemes that are not yet in place are not included (e.g., Victorian renewable energy target)

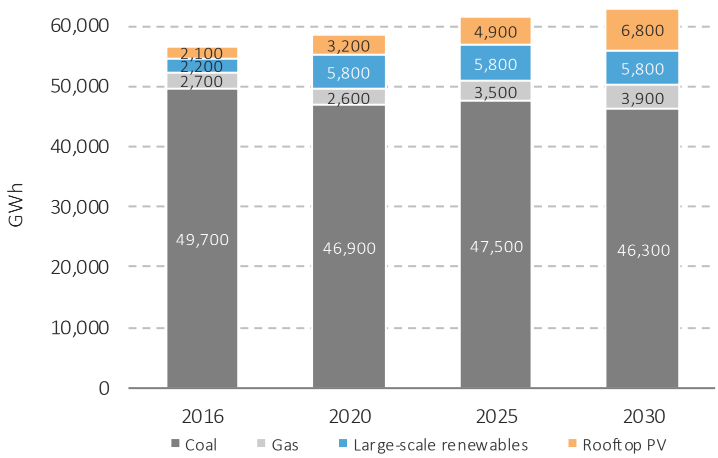
As discussed in Chapter 6, Australia has an emissions reduction target of 26-28% below 2005 levels by 2030. Under this policy there is currently no explicit requirement on the electricity sector to reduce emissions. However, the Panel considers it probable that the electricity sector will be required to make an additional contribution to reducing Australia's emissions, consistent with advice provided to AEMO by COAG. The *Base case* (and *Linear* and *Ramp* pathways) therefore assumes a proxy carbon emissions reduction cost is applied to the electricity sector, starting at $25/t$CO_2$-e in 2020 consistent with AEMO modelling in the 2016 NEFR, and rising to $40/t$CO_2$-e by 2030 (real 2016 dollars).

Jacobs has modelled this through a national emissions intensity baseline and credit scheme (emissions intensity scheme) which is considered to be a natural extension of the existing ERF Safeguard Mechanism. Under this approach, generators who exceed an emissions intensity threshold are required to purchase emissions reduction offsets from generators below the emissions intensity threshold or from other domestic or international sources.

8.2.1. Renewable energy generation mix (*Base case*)

Figure 18 depicts Queensland's projected generation mix (in GWh) over the period between 2016 and 2030 under the *Base case*. Coal generation is expected to remain the dominant source of Queensland energy.

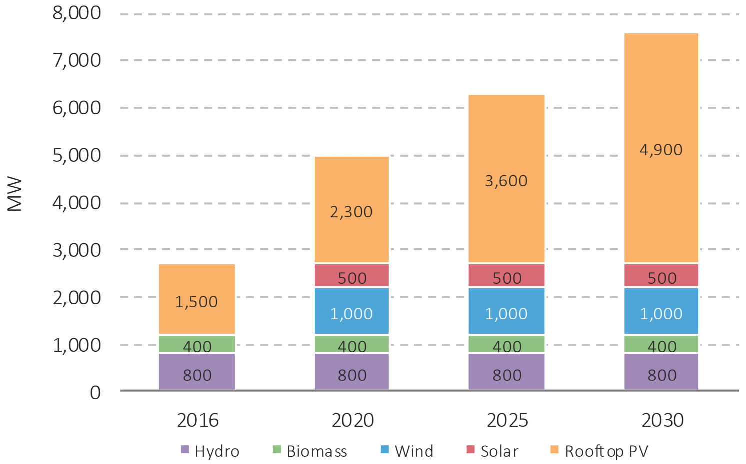
Figure 18: Queensland generation 2016-2030, *Base case* (GWh)



Source: Jacobs analysis

Figure 19 illustrates the breakdown of renewable energy technologies (in MW) built in Queensland under the *Base case*.

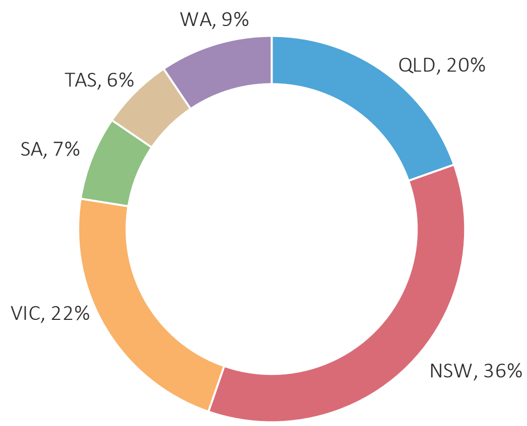
Figure 19: Queensland renewables by technology 2016-2030, *Base case* (MW)[65]



Source: Jacobs analysis

Based on projections in AEMOs 2016 NEFR, rooftop PV is expected to continue to grow over the study period, increasing from approximately 1,500 MW in 2016 to approximately 5,000 MW in 2030[66]. In terms of large-scale renewables, Jacobs' model projects that approximately 1,500 MW of new wind and large-scale solar PV will be installed in Queensland up to 2020 through the support of subsidies under the existing LRET. This represents approximately 20% of total new capacity installed under the LRET as shown in Figure 20.

Figure 20: Share of new RET capacity 2016-2020, *Base case* (MW)



Source: Jacobs analysis

This is based on Jacobs' assessment of the least-cost pathway to meeting the LRET, taking into account the Jacob's projected wholesale prices in each region, Jacob's view of available renewable projects across Australia, and the comparative wind and solar resource in Queensland and other regions. No additional subsidy is provided by the Queensland Government for these projects. The Panel notes this is broadly consistent with the volume of renewable projects in the pipeline in Queensland. However, the Panel also notes that the delivery of individual projects is not a given. It is contingent upon securing finance, land and connection agreements which has not been factored into the model, as well as the relative advantages and disadvantages of individual projects, technologies and transmission connection points. Queensland's share of the RET could therefore be higher or lower than considered in these modelled scenarios; the Panel has further reviewed near-term opportunities for Queensland in Chapter 5.

[65] In this and subsequent charts, "solar" and "rooftop PV" refers to the definitions in Section 4.1.
[66] Section 10.5 considers how the integration of this distributed generation will be managed in the grid.

No additional state based policies (such as the series of reverse auctions for CFDs proposed by the Victorian government) were included in the modelling. Significantly, despite the modelling of the assumed emissions intensity trading scheme in this *Base case*, there is no further projected investment in new large-scale renewable energy in Queensland and only approximately 1,100 MW of new renewable capacity projected across the NEM between when the LRET is met in 2020 and the end of the study in 2030. This suggests that the proxy emissions reduction cost assumed in the model is not sufficient to drive significant new investment in renewable energy in the electricity sector before 2030. In the absence of stronger emissions reduction targets or new renewable energy focussed policies, this could lead to a "boom and bust" scenario for the renewable energy industry, following the significant build required to meet the RET in 2020, resulting in some economic adjustment as the resources that have been deployed to support the LRET are redeployed.

8.3. Renewable energy requirements under the target

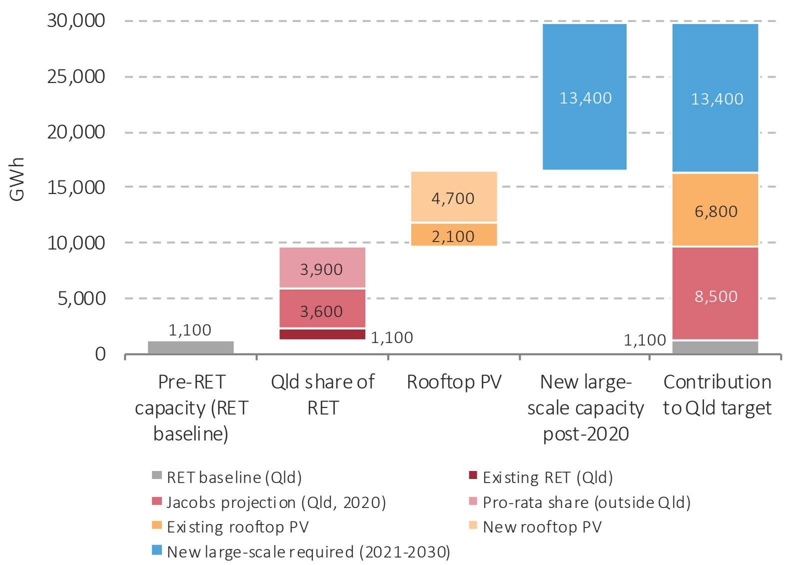
Total electricity consumption in Queensland is forecast to reach around 60,000 GWh in 2030[67]. Therefore, in order to achieve a 50% renewable energy target by 2030, Queensland is projected to require around 30,000 GWh of electricity from renewable energy sources by 2030.

Achieving this target in Queensland by 2030 comprises the following elements:

- Generation from small-scale renewable energy systems in Queensland, as defined in Section 4.1.1
- Generation from large-scale renewable energy projects built in Queensland prior to the RET, up to their historic baselines
- Queensland's pro-rata share of renewable energy generation built under the LRET, which includes:
  - Generation from projects built in Queensland
  - Generation from projects build outside of Queensland
- Generation from large-scale renewable energy projects built in Queensland post 2020 outside of the LRET.

Figure 21 illustrates the projected contribution of each element in achieving 50% renewable energy generation in Queensland by 2030. It shows that Queensland is projected to require up to 13,400 GWh of new large-scale renewable energy generation over and above what may be achieved under both the RET (LRET and SRES) and expected growth in rooftop PV.

Figure 21: Requirements for the 50% renewable energy target in Queensland (GWh)



Source: Jacobs analysis

[67] Includes small-scale and Mount Isa

The Panel notes that the projected requirement (13,400 GWh) for new renewable generation post-2020 is subject to a range of uncertainties, including:

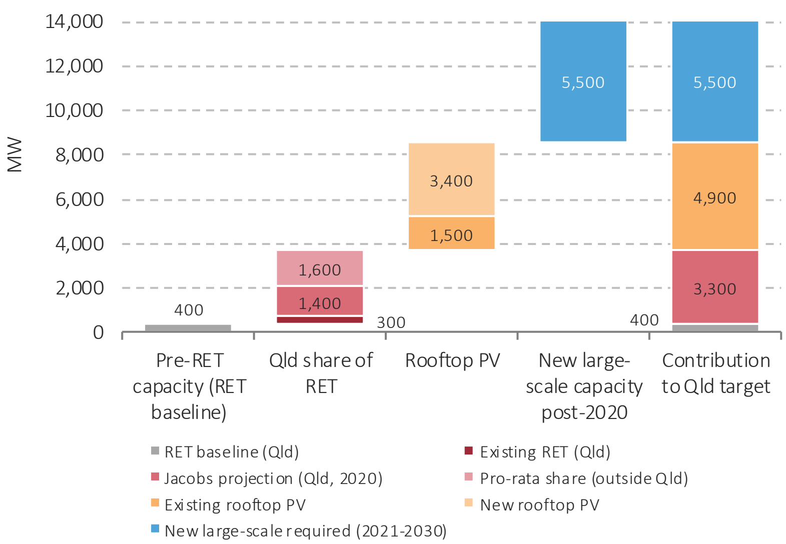
- *Residential and commercial load:* Higher or lower energy consumption in Queensland will change the requirements to meet the 50% target. In particular, greater uptake of energy efficiency would reduce the effort required.
- *Industrial loads:* The development of the LNG export industry has resulted in significant demand growth for Queensland. Further development in the future could increase Queensland's demand and requirements under the target. Conversely, the closure of existing large industrial loads could significantly reduce the required new renewable generation.
- *Rooftop solar PV:* As small-scale solar systems are included in the target, a higher or lower uptake of rooftop solar would directly decrease or increase the large-scale target requirements.
- *Electric vehicles:* A significant uptake of electric vehicles would increase Queensland's electricity consumption and hence the requirement for new renewable generation.

These uncertainties can be managed under the policy options proposed in Chapter 7, by adjusting the size of renewable energy auctions over time as greater certainty over requirements in 2030 is obtained. The specific action required by the Queensland Government will also depend on the outcomes of any national schemes that might incentivise renewable generation in Queensland.

Including Queensland's pro-rata share of the LRET within the target does not assume all this generation is built in Queensland. Rather, it highlights the amount of large-scale renewable energy generation that Queensland electricity consumers are expected to subsidise through the LRET by 2030. However, the Panel does recommend in Chapter 5 leveraging opportunities for renewable energy investment under the LRET through a Queensland reverse auction process.

Figure 22 shows the indicative capacity installed in Queensland and the new capacity required to meet the target, allowing an assessment of the potential capacity build in Queensland. The Panel notes that the electricity generation capacity (in MW) needed to produce the renewable energy requirement under the 50% target depends on the capacity factor of the renewable energy generator. This depends on a range of factors, including the choice of technology, the underlying renewable energy resource (e.g., wind speed or solar insolation) at each site, and technology improvements over time (such as larger wind turbine blades for wind farms or more efficient boilers at biomass plants). Auctions could be adjusted over time in response to historical performance.

Figure 22: Requirements for the 50% renewable energy target in Queensland (MW)



Source: Jacobs analysis

8.4. Technology cost assumptions

While the cost of renewable energy is currently higher than fossil fuel generation plant, costs of renewable energy technologies have declined significantly in recent years. According to the International Energy Agency, between 2008 and 2015, the average cost of land-based wind decreased by 35% and solar PV by almost 80%[68] (effectively 4.5% and 9% compound reductions per annum respectively).

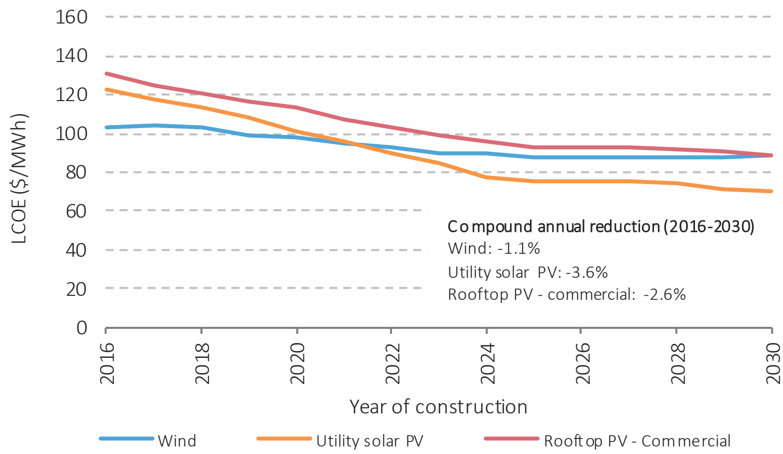
Similar cost reductions are also evident in Australia. For example, the ACT Government's solar reverse auction held in 2012 realised a CFD price of $186/MWh for the Royalla solar farm. In contrast to this and noting that yields in Northern Australia would be significantly higher than in Canberra, Origin has indicated solar projects could now be supported at a much lower price, potentially as low as $80/MWh[69] (noting that the shape of annual payments may be different between these projects).

CSIRO[70,71] has projected indicative cost reductions learning rates (annual reduction in capex) by:

- Wind: 2% per year
- Solar: 4% to 5% per year
- Batteries: 6% to 7% per year.

As noted in Figure 23, it is anticipated that further reductions will be achieved over the 2020 to 2030 period.

Figure 23: Indicative levelised cost of generation from new power stations of different technologies ($/MWh)



Source: Mid-point technology cost from Australian Power Generation Technology Report, 2015

It is also recognised that there are likely to be improvements in efficiency of different technologies including:

- Improved capacity factors for wind turbines (from the modelled capacity factor of approximately 30-35%) as a result of larger-scale turbines, increased heights of hubs and possibly improved efficiencies of blades
- Improved capacity factors for stationary and tracking solar PV (from the modelled capacity factor of approximately 26-28%) as a result of technology improvements.

[68] https://www.iea.org/publications/freepublications/publication/NextGenerationWindandSolarPower.pdf
[69] https://www.originenergy.com.au/content/dam/origin/about/investors-media/presentations/160504%20Macquarie%20Conference%20Presentation_FINAL.pdf, p11
[70] Australian Power Generation Technology Report, 2015
[71] CSIRO Future Energy Storage Trends report to the AEMC

In response to the Draft Report, some stakeholders queried whether network connection costs were included in the modelling. The technology cost estimates used in the modelling incorporate an allowance for the cost of connecting to the network. However, this assumes that large-scale renewable energy projects are located in relatively close proximity to the network. The Panel considers this to be a reasonable assumption in the short term given the extent of available network capacity, the location of the renewable energy resources, and the current pipeline of projects in Queensland. Projects that locate further away from the existing network could incur higher network connection costs, but these projects would only proceed if they were competitive in the market.

The electricity market modelling for the Panel assumes a modest rate of uptake of small-scale battery systems over the period to 2020 and notes that this is consistent with the projections used by AEMO. However, the Panel notes that these assumptions could change significantly if the costs of battery technologies were to reduce faster than expected.

The Panel notes that the performance of batteries and hence their benefits and uptake will not just be driven by cost reductions, but by the development and implementation of more advanced control systems that are capable of optimising short and long term usage and maximising battery lifespan and safety.

The Panel considers that the payback period[72] can be a reasonable indicator of the potential uptake of battery systems. During the consultation process, stakeholders provided a range of views about the current payback period for batteries with some suggesting that it could be up to 15 years. At these rates, the Panel does not consider that uptake rates will be high.

However, consistent with other technologies, as payback periods fall below the 10 and 5 year thresholds, uptake rates will likely accelerate. The Panel considers that it is important that the Queensland Government monitors the potential uptake of battery storage and how this influences the level of small-scale renewable energy.

These declining technology costs and improved efficiencies are likely to result in gradual reductions in the level of financial support required to deliver renewable projects post 2020.

8.5. Outcomes of credible pathways

8.5.1. Summary of outcomes in Queensland

Table 15 and Table 16 present the key modelled outcomes under the *Linear* and *Ramp* pathways. The Panel notes that the *Linear* pathway targets equal renewable energy (GWh) constructed each year, which results in slightly less capacity from 2021-2025 compared to 2026-2030 due to some higher capacity factor wind being utilised instead of solar PV.

[72] The time it takes to recover the upfront capital investment

Table 15: Summary of projected generation (GWh) and capacity (MW) outcomes by 2030

	Generation (GWh)			Capacity (MW)		
Key input	*Base*	*Linear*	*Ramp*	*Base*	*Linear*	*Ramp*
Existing renewables: Small-scale Large-scale	 2,100 2,200	 2,100 2,200	 2,100 2,200	 1,500 700	 1,500 700	 1,500 700
Total existing renewables	4,300	4,300	4,300	2,200	2,200	2,200
Total new small-scale (2016-2030)	4,700	4,700	4,700	3,400	3,400	3,400
QLD share of RET (large-scale 2016-2020): Inside QLD Outside QLD	 3,600 3,800	 4,800 2,600	 4,800 2,600	 1,400 1,500	 1,900 1,000	 1,900 1,000
Total new large-scale (2016-2020)	7,400	7,400	7,400	2,900	2,900	2,900
New large-scale after RET (2021-2030): 2021-2025 2026-2030	 0 0	 6,700 6,700	 4,000 9,400	 0 0	 2,700 2,800	 1,600 3,900
Total new large-scale (2021-2030)	0	13,400	13,400	0	5,500	5,500
Total new renewables (2016-2030)	12,100	25,500	25,500	6,300	11,800	11,800
Total renewables in QLD	16,400	29,900	29,900	8,500	14,000	14,000
Total QLD consumption[73]	60,000	60,000	60,000			
Total QLD installed capacity[74]				20,500	26,000	26,000
% renewables in QLD[75]	27%	50%	50%	41%	54%	54%

Source: Jacobs analysis

The Panel notes that in the event of further reductions in Queensland demand, such as through greater energy efficiency or the closure of industrial loads before 2030, the requirements under the target would be reduced. For example, modelling for the QPC[76] considered the effect of the closure of a large industrial load in Queensland, reducing consumption by 7,500 GWh per annum. The Panel notes that this would reduce the 2021 to 2030 renewable capacity requirement in Queensland to around 4,000 MW.

Table 16 outlines the change in electricity tariffs and electricity sector emissions relative to the *Base case*, averaged over the period 2020 to 2030 under the *Linear* and *Ramp* pathways. Emissions outcomes refer to NEM electricity sector emissions.

[73] Queensland consumption derived by Jacobs based on AEMO demand projections and includes Mt Isa load, consumption met by embedded rooftop PV, and the price elasticity of demand based on the scenario specific outcomes.
[74] Installed capacity counted towards Queensland includes Queensland's pro-rata share of the LRET.
[75] Modelled outcomes do not achieve exactly 50% energy (based on the reported outcomes) due to tolerances within Jacobs' market modelling software.
[76] Queensland Productivity Commission, 2016

Table 16: Summary of pricing and emissions outcomes relative to *Base case*

Relative to *Base case*	*Linear* pathway	*Ramp pathway*
Retail electricity prices		
Residential tariffs: Average price change (2020-2030)	-1.1%	-1.2%
Commercial tariffs: Average price change (2020-2030)	-1.2%	-1.3%
Industrial tariffs: Average price change (2020-2030)	-0.7%	-1.5%
Greenhouse gas emissions		
Reduction in 2030 QLD electricity sector emissions (% relative to *Base case*)	20%	20%
Cumulative QLD electricity sector emissions reduction (2016 to 2030 relative to *Base case*)	62 Mt CO_2-e	45 Mt CO_2-e
Cumulative NEM electricity sector emissions reduction (2016 to 2030 relative to *Base case*)	81 Mt CO_2-e	59 Mt CO_2-e
Average emissions reduction cost	\$47/t CO_2-e	\$34/t CO_2-e
Effective marginal price of emissions reduction under the policy[77]	\$67/t CO_2-e	\$54/t CO_2-e

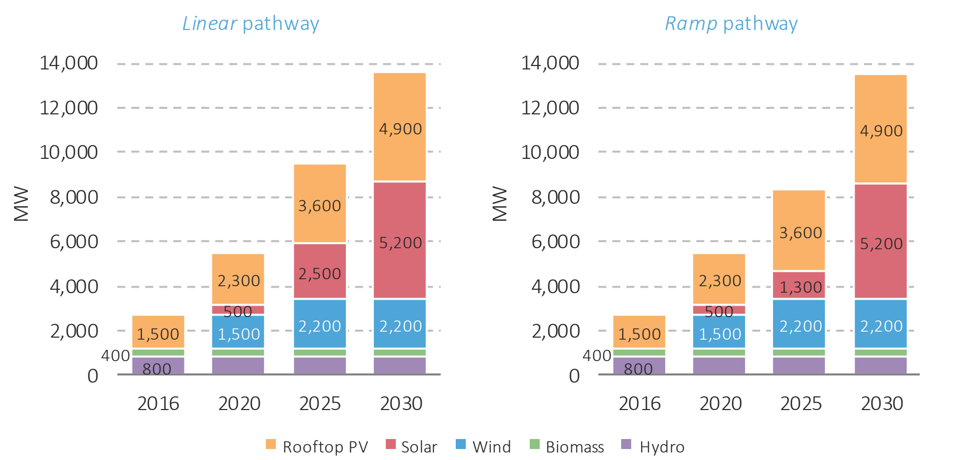
Source: Jacobs analysis

8.5.2. Renewable capacity

Under the *Linear* and *Ramp* pathways, an additional 13,400 GWh of large-scale renewable generation is assumed to be produced in Queensland to meet the 50% target in the period between 2021 and 2030. Some of this energy is projected to offset existing coal production, but additional projected electricity exports to New South Wales reduce the effect on existing Queensland generators.

The technologies chosen by the model to produce this energy are determined by a range of factors including the relative technology costs and their learning rates over time, the available resource, and the Queensland demand profiles. Figure 24 show the projected growth in renewable capacity (MW) in Queensland over time[78].

Figure 24: Queensland renewable capacity (MW) (*Linear* and *Ramp* pathways)



Source: Jacobs analysis

[77] Each of the policy credible pathways considered already includes a carbon price imposed on the electricity sector. The policy imposes additional abatement costs in each case. The effective carbon price of abatement reflects estimates the all in marginal cost of abatement through combining the underlying assumed carbon price emissions intensity cost with the additional abatement cost in each case.

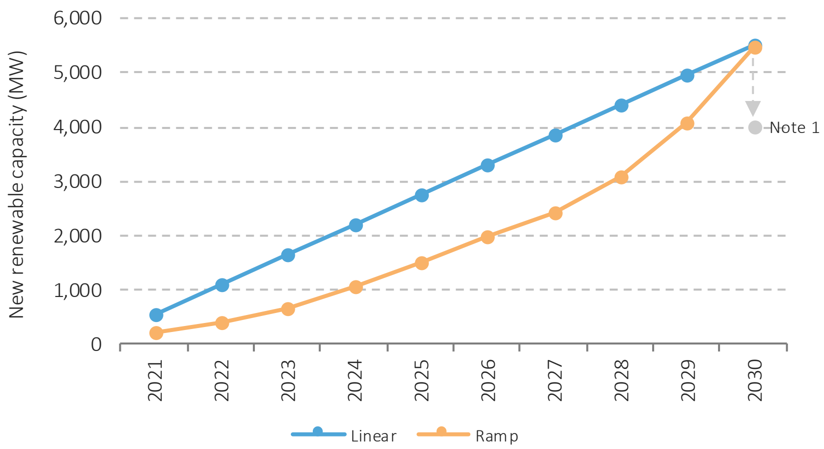
[78] Note that some figures may not sum to totals provided elsewhere due to rounding.

The modelling suggests there are significant opportunities for both wind and large-scale solar PV to contribute to Queensland's 50% target. It is projected that Queensland could reach 2,200 MW of wind, 5,200 MW of large-scale solar PV, and 4,900 MW rooftop PV by 2030, including 5,500 MW of new large-scale capacity built after 2020. This is less than the indicative renewable resource that could be developed in Queensland in the near-term (Section 0), and the Panel does not expect there to be fundamental renewable resource constraints in meeting the 50% renewable energy target by 2030 but further development of the viability of these potential resources is required.

Build rates (Linear and Ramp pathways)

Figure 25 shows the projected rate of new large-scale capacity installed under the *Linear* and *Ramp* pathways.

Figure 25: Large-scale renewable energy capacity delivered under the *Linear* and *Ramp* pathways (MW)



Note 1: Large-scale renewable generating capacity to meet the 50% target could be lower than 5,500 MW depending on future Queensland load requirements. For example, an uptake in rooftop PV or energy efficiency measures by consumers at rates higher than AEMO's forecast, or significant changes in Queensland industrial load could impact the requirements for new large-scale renewable capacity.

Under the *Linear* pathway, approximately 550 MW of capacity is constructed each year. Under the *Ramp* pathway, the build rate is increased from approximately 200 MW per year in 2021 to approximately 1,500 MW in 2030, allowing more time for industry capability to grow in the early years but requiring greater growth in overall industry capability by 2030.

However, the actual requirements under a floating 50% target could vary significantly. As discussed in Section 8.5.1, the closure of large industrial loads before 2030 could reduce the target by 1,500 MW. The *Ramp* pathway may provide greater flexibility to respond to such closures, as more capacity is scheduled to be built later when there is greater certainty around conditions in 2030.

Technology options

Jacobs' model did not install other renewable technologies to meet the target, based on the projected costs assumed in the modelling. However, the Panel notes that there is the potential for specific projects based on other renewable energy sources to contribute to the target if costs are competitive. This may be particularly relevant for technologies with more controllable dispatch (e.g. biomass or solar thermal with storage) as these projects could command higher revenues in the market by scheduling their dispatch for high price periods. A mix of technologies will also provide for a diversity of renewable energy supply which may assist with managing the variability in renewable generation output. The Panel also notes there may be demand for ancillary services such as inertia and spinning reserve in the NEM as additional renewable capacity comes on line as discussed in Chapter 10.

Notably, the utilisation of higher capacity factor renewable units would result in a lower capacity of renewable generation required for the same energy. For example, if the target could be met with 35% capacity factor wind alone, only 4,400 MW of capacity would be required post-2020 (to produce approximately 13,400 GWh). In the modelling, solar PV is projected to be more economical despite its lower capacity factor because of its generation profile and diversity with respect to wind generation.

Capacity build complementary to the LRET

In the period up to 2020, the *Linear* and *Ramp* pathways assume that the Queensland Government undertakes additional policy action prior to 2020 to attract a greater share of the LRET into Queensland, as discussed in Chapter 5. In each pathway, 400-500 MW of new large-scale renewable capacity is built in Queensland prior to 2020 above the *Base case*, and this capacity is assumed to be incentivised through CFDs or through market demand. These projects are assumed to contribute to meeting the LRET and receive the LGC revenue stream which in part offsets the cost of the CFDs.

As this capacity forms part of Queensland's pro-rata share of the LRET, the additional capacity does not affect the target in 2030, but the eligibility of these projects for at least 10 years of the LRET would allow investment to be procured in Queensland at comparatively lower cost as described in Section 5.3. Action prior to 2020 to drive a greater share of the LRET in Queensland can also assist in the development of renewable energy industry in Queensland and develop experience with the Queensland auction process, both supporting the target to be met by 2030.

8.5.3. Subsidy payments to renewables

To support the new large-scale renewable generation under the target, particularly beyond the LRET, additional subsidy is required until 2030. This subsidy represents the additional revenue required by renewable generators in addition to the wholesale market revenue and any additional revenue secured through selling permits under the modelled emissions intensity scheme.

The subsidy payments are outlined in Table 17. The subsidy payments under the *Ramp* pathway are lower than under the *Linear* pathway. This is because the cost of new renewable generation is expected to fall over time, reducing the cost of meeting the target. Additionally, the assumed proxy carbon emissions reduction cost rises over time, such that deferring action can mean projects are economically viable earlier in their project lifetime, and require less subsidy overall. This is consistent with the discussion in Section 7.1.2.

Table 17: Subsidy to renewable generation (NPV)

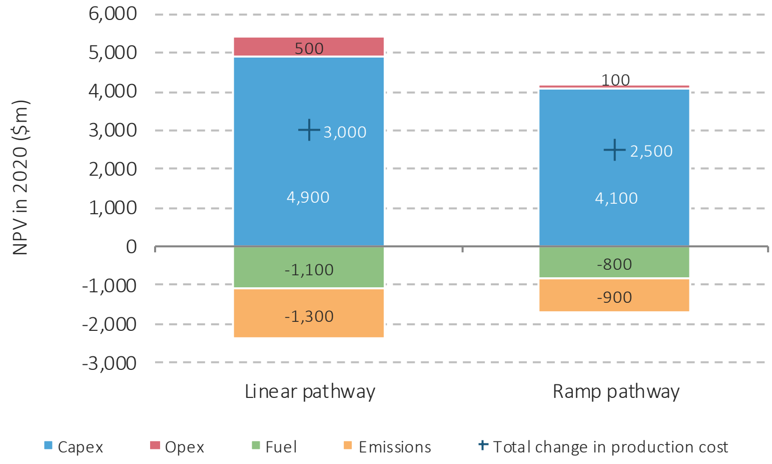
	Linear pathway	*Ramp* pathway
Subsidy to renewables	$900 million NPV	$500 million NPV

Source: Jacobs analysis

8.5.4. Resource cost outcomes

Transitioning to higher usage of renewable energy in the current low demand growth environment requires lower utilisation of existing assets, higher capital investment (new renewable assets), and potentially additional transmission investment to generate the same amount of electricity demanded by consumers. This lower level of productivity is partially offset by reductions in fuel usage and in carbon emissions (to the extent that these are valued in the market). However, in all cases there is a net increase in the factor costs of production of electricity in the NEM as shown in Figure 26.

Figure 26: Change in NEM resource costs relative to *Base case* ($m NPV)



Source: Jacobs analysis

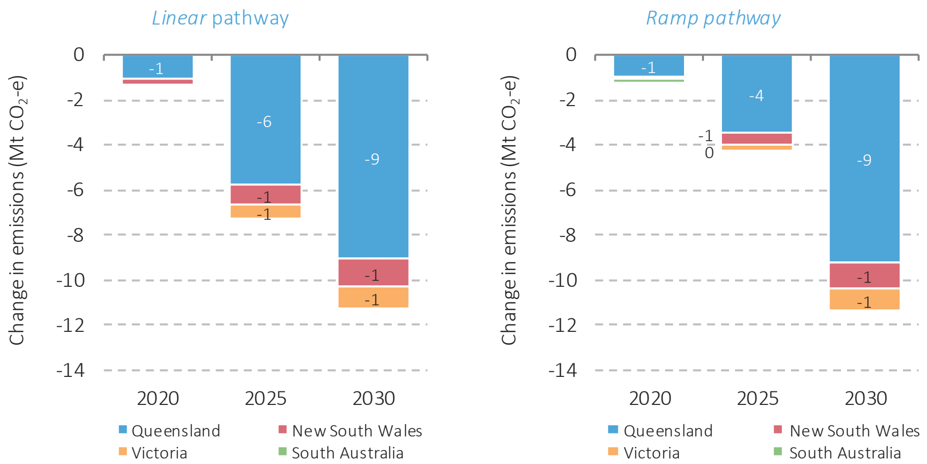
Under the *Linear* and *Ramp* pathways, the NEM electricity resource cost to 2030 is modelled to increase by between $2.5 to $3.0 billion (NPV). It is lower under the *Ramp* case because the cost of renewables is projected to fall relatively quickly to 2030 and the benefits from deferring the expenditure on new renewables in the *Ramp* case outweighs the benefit from earlier investment and additional emissions reduction in the *Linear* case (given the value of emission reductions applied in this modelling).

The Panel notes that the modelling projects that no subsidies would be required for renewable generation post-2030 under the *Linear* and *Ramp* pathways. If new renewable capacity would otherwise have been projected to be developed post-2030 (i.e., driven by the emissions intensity scheme in the *Base case*), the effect on resource costs would be projected to decline when a longer study period was considered[79].

8.5.5. Electricity sector emissions outcomes

Figure 27 illustrates the projected electricity sector emissions outcomes in the NEM in each pathway relative to the *Base case*.

Figure 27: Change in NEM electricity sector emissions by region relative to *Base case* (Mt CO_2-e)



Source: Jacobs analysis

[79] If new renewable capacity were built even in the *Base case* post-2030, the additional capital expenditure contribution to the resource cost would be a product of the higher capital costs of building before 2030 and the costs of bringing forward investment determined by the assumed discount rate.

In 2030, Queensland electricity sector emissions under the *Linear* and *Ramp* pathways are projected to be approximately 20% lower than the *Base case* Queensland electricity sector emissions in 2030, and 25% lower than the modelled 2016 Queensland electricity sector emissions. This represents a 6% reduction on Queensland's overall emissions relative to 2016 levels.

Across the NEM, the *Linear* pathway results in reducing total greenhouse gas emissions by 3.9% between 2016 and 2030 relative to the *Base case*. Due to the slower uptake of renewables under the *Ramp* pathway, the total NEM emissions reduction due to the Queensland target between 2016 and 2030 is lower at 2.8% reduction. Therefore, although both pathways achieve similar emissions outcomes in 2030, the choice of trajectory would have implications for Australia's carbon budget beyond 2030 (Section 6.2.2).

Table 18: Summary of emissions outcomes

	Base case	*Linear* pathway	*Ramp* pathway
2030 QLD Electricity sector emissions (% reduction from 2016)	-6%	-25%	-25%
2030 QLD Electricity sector emissions (% reduction from *Base case*)	-	-20%	-20%
2016-2030 NEM Electricity sector aggregate emissions (% reduction from *Base case*)	-	-3.9%	-2.8%

Source: Jacobs analysis

While the modelling suggests that meeting the 50% renewable energy target can have a significant effect on emissions, this is not certain. The modelling projects that demand increases moderately over the 14-year study period which means that new renewable energy is also meeting new demand rather than simply offsetting coal capacity. Under higher demand growth scenarios, lower emission reductions relative to current levels would be observed in the pathways considered here.

Emissions reduction cost

The Panel considers that calculating the effective emissions reduction cost of these avoided emissions is most appropriately done with reference to the overall change in resource costs resulting from the policy (excluding emissions costs). This requires considering emission reductions over the life of the project, as the full capital cost of new renewable generation is incurred in the year of construction (up to 2030) but emission reductions continue for the life of the plant.

Indicative long-term modelling from Jacobs from 2020 to 2040 was used to estimate average carbon emission reduction costs for each pathway as shown in Table 19.

These prices represent the average emissions reduction cost achieved by the policy, defined as the increase in resource cost in this scenario (excluding emissions costs) divided by the reduction in emissions, with both cost and emissions reduction calculated relative to the *Base case* and discounted.

Separately the Panel considers it important to also report the effective marginal emissions reduction cost under each of the pathways because this is generally used to compare policies and mitigation action on a global basis. Each of the pathways assumes an emissions intensity scheme which includes an effective carbon emissions reduction cost, which is embedded in each MWh of electricity. A reasonable approximation of the effective carbon price for each tonne of CO_2-e abated is to add the embedded carbon price ($/t CO_2-e) to the incremental emissions reduction cost for each pathway (t CO_2-e). This is also provided in Table 19.

The lower cost of emissions reduction in the *Ramp* pathway reflects the overall benefit from delaying investment closer to 2030 because of the expected rapid fall in renewable generation capital costs over the period.

Table 19: Average carbon emission reductions cost (levelised \$/t CO_2-e from 2020 to 2040)

	Linear pathway	*Ramp* pathway
Average carbon emissions reduction cost	\$47/t CO_2-e	\$34/t CO_2-e
Effective marginal carbon emissions reduction cost	\$67/t CO_2-e	\$59/t CO_2-e

Source: Jacobs analysis

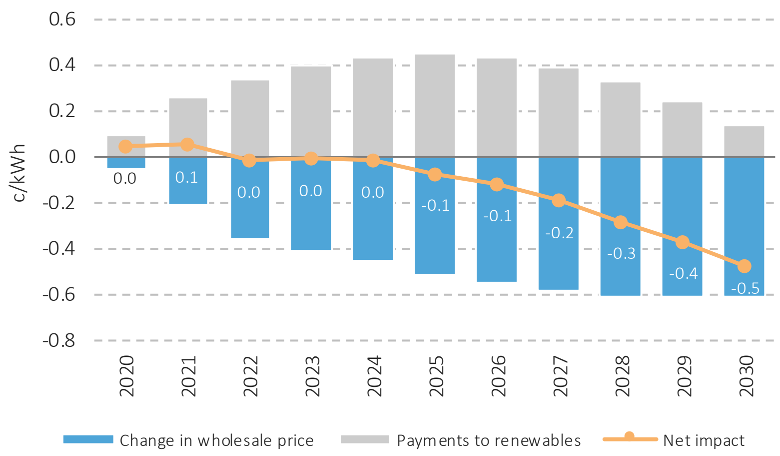
8.5.6. Consumer outcomes

Typically, the introduction of renewables in the market has two opposing effects on retail prices. First, as renewables are subsidised into the market, they enter earlier than they would on a commercial basis and create excess supply which tends to depress wholesale pool prices due to their low short run costs relative to coal and gas-fired generation[80]. Second, to the extent that these subsidies are funded through electricity market mechanisms, this creates upward pressure on retail prices.

Under both the *Linear* and *Ramp* pathways, projected reductions in wholesale pool prices in Queensland generally outweigh the subsidy payments to new renewables, leading to slight projected savings on retail bills over time as higher penetrations of renewable generation are introduced. Average retail prices for residential, SME and industrial customers are projected to decline by approximately 0.1% per annum on average, relative to the *Base case*.

For example, Figure 28 illustrates the projected change in the wholesale price (for a typical residential load) and projected payments to renewables under the *Linear* pathway (compared to the *Base case*) over time. Under the *Ramp* pathway, retail bills are slightly lower due to the reduced subsidy cost.

Figure 28: Queensland wholesale pool price and payments to renewables (c/kWh) (*Linear* pathway relative to *Base case*)



Source: Jacobs analysis

The expectation that greater levels of renewable energy can be approximately cost-neutral to consumers is consistent with NEM-wide modelling undertaken by other consultants for the 2014 review of the RET[81, 82], as well as indicative modelling conducted for the QPC on a 50% renewable energy target for Queensland[83]. However, it is based on the assumption that all existing coal and gas-fired plant will be willing to continue to operate at reduced profit levels despite the portfolio benefits of closing some of this generation. The Panel notes that the experience in the NEM to date indicates that, given the long-term nature of generation investments, individual power stations may be willing to continue to operate during sustained periods of depressed wholesale prices. The key consideration is whether an individual power station can continue to meet its short-run costs, including "stay-in-business" capital costs.

[80] This holds to the extent that new renewables do not displace incumbent coal or gas generation.
[81] ACIL Allen Consulting 2014
[82] ROAM Consulting 2014
[83] Queensland Productivity Commission 2016a

Closure of even one significant coal-fired generator would be expected to lead to higher wholesale prices and the erosion of some or all of the wholesale price benefits. The Panel notes that there are a range of factors that contribute to the decision to close a power station. Based on information from AEMO, around 2,600 MW of coal-fired generation has exited the NEM since 2012 due to factors such as profitability, age of plant, availability of fuel resources and closure of associated large industrial load. It also noted that a further 3,600 MW of coal-fired generation has been announced to be closed in the NEM by 2022.

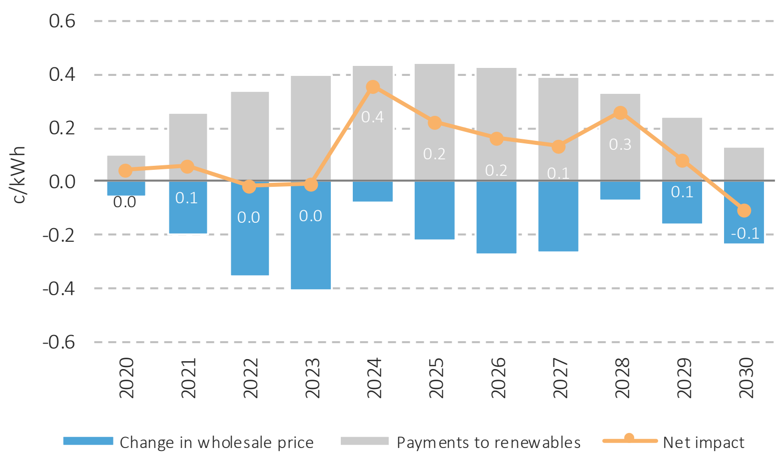
Most recently, on 3 November 2016, ENGIE announced its intention to close its 1,600 MW Hazelwood coal-fired power station at the end of March 2017. According to ENGIE, its decision to close Hazelwood is part of a broader strategy to gradually end its coal activities and focus expenditure on lower emission technologies. It is understood that “difficult market conditions” also played a factor in its decision to close the plant[84].

During consultation on the Draft Report, a number of stakeholders queried the modelled outcomes of no coal-fired plant closing under the *Linear* and *Ramp* pathways. While the Panel considers the findings of the modelling presented in the Draft Report as credible, in response to the feedback from stakeholders, the Panel has undertaken further analysis to understand the sensitivity of prices to coal-fired power station retirement.

To prepare this analysis, Jacobs modelled the forced closure of 1,400 MW of coal-fired generation capacity from Queensland (700 MW in 2024 and 700 MW in 2028) under the *Linear* pathway, representing around 17% of Queensland’s existing coal-fired generation capacity.

Figure 29 outlines the projected change in the wholesale price and projected payments to renewables under the *Linear* pathway taking into account the forced closure of this capacity. It shows that the forced closure of coal-fired generation is projected to increase wholesale prices relative to *Linear* pathway. However, this effect is projected to be marginal by the Jacobs’ modelling, with the overall outcome for retail bills projected to be broadly cost neutral[85].

Figure 29: Queensland wholesale pool price and payments to renewables with forced closure of coal-fired generation (c/kWh) (*Linear* pathway relative to *Base case*)



Source: Jacobs analysis

The Panel notes that the outcomes in the market under any of the pathways are also sensitive to a range of other factors, including specific weather conditions, the extent to which wholesale price changes are immediately passed on to residential and SME consumers (taking into account the presence of long-term contracts, including with renewable generators) and the market strategies employed by generators in the future.

[84] ENGIE 2016
[85] The Panel considers broadly cost neutral to mean no change within the certainty of the modelling.

The Panel also notes that the modelling projects that no further subsidies would be required by projects beyond 2030. As such, while the schemes would likely deliver further benefits to consumers beyond the study period, the Panel notes that the generation mix would be expected to adjust to the presence of renewables such that wholesale prices would be similar in all pathways and the merit order effect caused by subsidised oversupply would not be expected to result in significant reductions in consumer bills longer term.

Total retail bills could also be further reduced by supporting energy efficiency measures especially through the improvement of information to consumers about zero, negative[86] and low cost opportunities. The benefit of this type of energy efficiency is that it can deliver a reduction in consumption which both reduces the volume of purchases on retail bills as well as decreasing the need for new renewable generation to meet the target (due to lower overall consumption), further reducing scheme costs. The Queensland Government would be expected to continue to facilitate educational programs on energy efficiency for consumers, especially around zero, negative and low cost opportunities.

8.5.7. Incumbent generator outcomes

Under *Linear* and *Ramp* pathways, output from existing Queensland coal generators is projected to decrease, being replaced primarily by new renewable generation. Under these pathways, coal generation is projected to decline by approximately 20% by 2030, relative to the *Base case*.

The Panel has used the outcomes of the Jacobs modelling to assess the overall financial effect of the *Linear* and *Ramp* pathways on the coal and gas-fired generators below. However, operating cash flow for generators are highly sensitive to wholesale price outcomes, such that a small increase in wholesale prices can significantly increase a generator's net revenue if a generator was already recovering its short-run costs.

The Panel has therefore drawn on projections from both the Jacobs modelling and a previous analysis undertaken for the QPC which featured a similar trajectory to the *Linear* pathway but with different input assumptions.

The NPV effect on the operating cash flow of existing Queensland coal generation of the *Linear* and *Ramp* pathways relative to the *Base case* is projected to be a reduction of between $600 million and $1,100 million.

The Panel notes that the closure of coal-fired generation in Queensland would likely lead to higher wholesale prices and the remaining generators would receive greater profits; this reflects a strong first-mover disadvantage. As an owner of around two-thirds of Queensland generating capacity, the Queensland Government has the opportunity to manage any closures and ensure a smooth transition of the Queensland system while maintaining reasonable profits from the plant that remain in service.

The Panel recognises that while any revenue effect on these generators is outside the scope of the Panel, these effects should be considered by the relevant Shareholding Ministers.

8.5.8. Transmission requirements

The Jacobs modelling included the co-optimised development of new transmission infrastructure where it was determined to be part of the least-cost generation mix. All pathways, as well as the *Base case*, include a projected upgrade of the QNI interconnector between Queensland and New South Wales before 2023, increasing the maximum allowed flows in both directions by 400 MW (approximately 30% of the southerly QNI power transfer limit). The growth of additional renewable generation in Queensland justifies a second projected interconnector upgrade in each of the credible pathways in approximately 2028.

[86] Negative cost opportunities are ones where the energy efficiency is achieved with net benefits to the consumer – it can often involve simple behavioural changes.

The Panel notes that developing substantial interconnector upgrades is a complex process and would require coordination with New South Wales (or another region such as South Australia if more significant investment in interconnection were to be considered). Consultation with Powerlink indicated that while some additional capacity could be procured through upgrades of the existing QNI, the 330 kV lines between the Hunter Valley and northern NSW may also be required to support the modelled transmission flows, which may be more costly than the nominal costs included in the model. Longer term, an additional circuit (transmission line) may be required to support the modelled flows (with corresponding upgrades in northern NSW).

To ensure the credibility of the modelling, the Panel commissioned Jacobs to conduct sensitivity analysis of the *Linear* pathway (which requires the earliest build of renewable generation in Queensland) without transmission upgrades in their model. The modelling indicated that this would have only a marginal effect on the outcomes, increasing the resource costs of the NEM by 0.4% over the period 2020 to 2030. A lack of additional interconnection was not modelled to effect the development or production of renewable energy in Queensland, but would slightly reduce the volume of coal generation (as Queensland coal-fired generation would be unable to be exported to New South Wales).

Within Queensland, Jacobs modelled three key regions – North, Central and Southern Queensland. The Panel consulted with Powerlink to consider the credibility of transmission flows between each of these regions. In general, higher southerly transmission flows were observed in Queensland in the modelled pathways compared to current levels, driven by the growth of renewable energy in north and central Queensland. In general the flows were considered credible in most periods, but Powerlink noted that there may be the need for some augmentation at times of high renewable generation to avoid curtailment.

Powerlink noted that the modelling resolution was insufficient to allow a detailed assessment of all transmission paths in Queensland, and localised outcomes would depend on which specific renewable projects were developed and the behaviour of incumbent generators. However, no fundamental barriers or prohibitive additional costs were identified to achieving the modelled pathways.

The Panel notes that Powerlink's long-term investment decisions over the study time frame will be influenced by the likely scenarios for the generation sector between now and 2030. This includes decisions as to whether to preserve the existing transmission capacity between, and within, key regions of Queensland as transmission assets reach the end of their technical life. A decision to reconfigure the transmission network, where the existing power transfer capacity is currently underutilised, to have a lower capacity may reduce operational costs in the near-term, but could result in higher long-term costs if there is significant growth of renewable energy (particularly in North Queensland).

Providing long-term certainty over the Queensland target will assist Powerlink to better plan the Queensland network, although the specific locations and technologies of new projects and the response by existing generators could significantly influence the location and timing of investment decisions. Maximising transparency around potential projects may assist in reducing some of these uncertainties.

8.5.9. Stakeholder views on pathways

During consultation on the Draft Report, most stakeholders did not express a preference on the relative merits of the pathways. Of those stakeholders that commented on the pathways, there was a preference toward the *Linear* pathway, with a number of environmental organisations, community advocacy groups and private citizens supporting this approach based on higher level of greenhouse gas reductions that could be delivered relative to the *Ramp* pathway[87]. Some stakeholders also suggested that early action under the *Linear* pathway may enable Queensland to better capture supply chain opportunities[88].

[87] Australian Solar Council, Community Power Agency, Energetic Communities, Environmental Defenders Office, John Fuller (individual submission), Kerry Brady (individual submission), Lee Terrell (individual submission), Peter Nisbet (individual submission), Sustainable Queensland Forum, Wanda Grabowski (individual submission), William Norfolk (individual submission), World Wildlife Fund

[88] Energetic Communities, Kerry Brady (individual submission), Lee Terrell (individual submission), Mackay Conservation Group

One submission supported the *Ramp* pathway recognising that this approach could deliver renewable energy at a lower cost[89].

8.6. Sensitivity pathway: *Stronger National Action*

The Panel notes that there are a range of possible futures which could affect the magnitude of the policy action required by the Government to meet the 50% target. In particular, the Panel considered in Chapter 6 that there is the potential for additional national action to address electricity sector emission reductions, either through a higher emissions reduction target or stronger national targets for renewable energy (such as through an extension of the LRET).

The Panel notes that following a pathway of stronger national action is not directly within the Queensland Government's control. However given that this is a credible outcome, the Panel considers that it is important to understand the extent to which the Queensland Government 50% renewable energy target will be delivered through increased national action and to identify any potential action required by the Queensland Government under such a pathway.

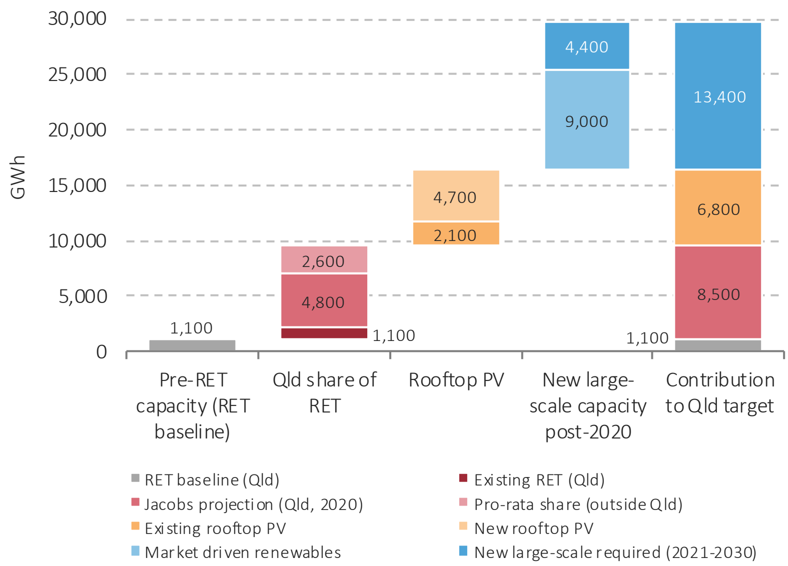
The Panel has considered the outcomes under a stronger carbon emissions reduction target. This is modelled to be implemented through a scheme targeting a 45% reduction in electricity sector emissions by 2030 relative to 2005 levels. This is broadly consistent with the lower band of the Climate Change Authority's analysis. A higher value on emissions reduction is projected in the *Stronger National Action* pathway, starting at \$50/t CO_2-e in 2020 and rising to \$80/t CO_2-e by 2030.

Meeting the 50% target in Queensland under the Stronger National Action pathway

The stronger emissions intensity scheme is projected to result in 3,600 MW of new large-scale renewable capacity in Queensland from 2021 to 2030. This would result in 41% of Queensland consumption from large-scale renewable generation, compared to 46% across the NEM. The modelling therefore suggests that giving preference to renewable generation in Queensland over other regions is less efficient from a national perspective when seeking national emissions reduction outcomes.

Figure 30 and Figure 31 shows the projected pathway to meeting the Queensland target in this scenario based on GWh of production and MW of installed capacity. The total requirement for new renewable generation between 2021 and 2030 is consistent with the *Linear* and *Ramp* pathways.

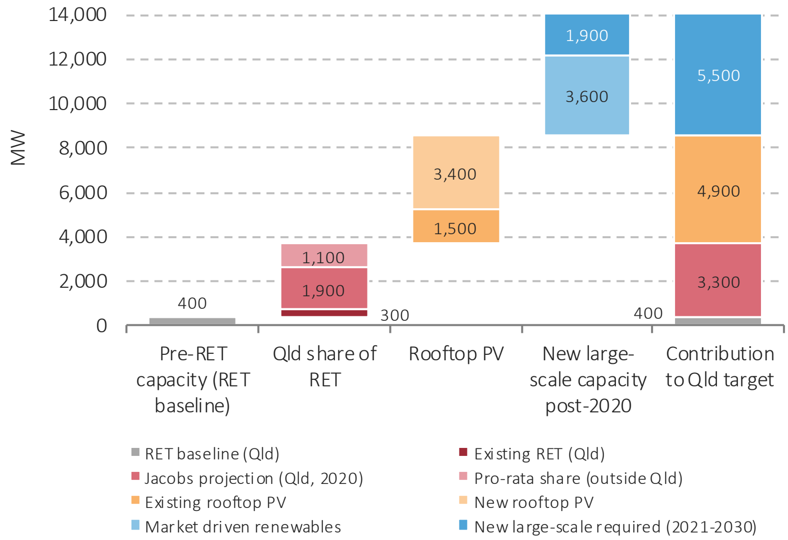
Figure 30: Requirements for the 50% renewable energy target in Queensland, *Stronger national action* pathway (GWh)



Source: Jacobs analysis

[89] Rio Tinto

Figure 31: Requirements for the 50% renewable energy target in Queensland (MW) (*Stronger national action* pathway)



Source: Jacobs analysis

The role of the Queensland Government in meeting the target would be significantly reduced under this pathway, with an additional 1,900 MW of capacity projected to be required to meet the 50% renewable energy target in Queensland. This capacity was modelled to be developed through reverse auctions for CFDs, with projects commissioning between 2026 and 2030 (reflecting the greater certainty at that time for the level of Queensland Government intervention required). This is significantly less than the 5,500 MW of CFD supported projects required in the *Linear* and *Ramp* pathways.

These projects are projected to only require $50m (NPV) in subsidy (compared to $500m to $900m in the *Linear* and *Ramp* pathways). The lower required subsidies is due to:

- The smaller volume of projects requiring CFDs
- Greater support from the stronger emissions intensity scheme
- Deferral of projects until later in the study period, when costs are lower (as with the *Ramp* pathway).

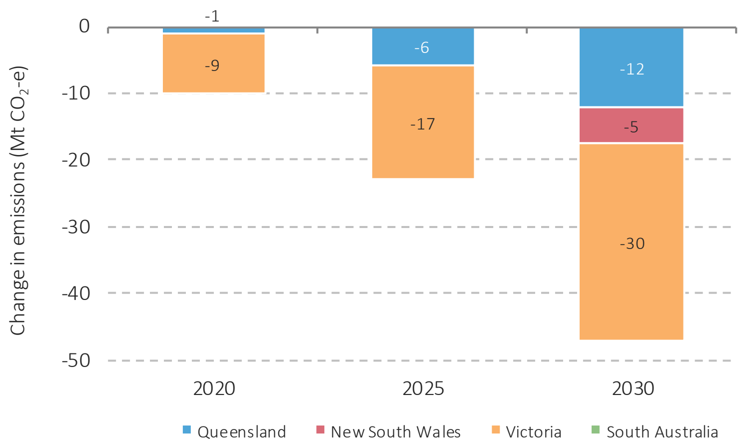
Consistent the *Linear* and *Ramp* pathways, procuring these additional projects in Queensland is again projected to be cost neutral to consumers (noting the caveats identified in Section 8.5.6).

Electricity sector emissions outcomes

The modelling projects a closure of approximately 1,500 MW of coal-fired generation in Queensland under the *Stronger National Action* pathway. However, the Panel notes that this outcome is driven by the stronger emissions reduction targets under this pathway, rather than the delivery of 50% renewable energy. Approximately 500 MW of new gas-fired generation is also projected to be required in the final years of the study period to meet peak demand following the exit of Queensland coal-fired generation.

Under this pathway, a slightly higher level of emissions reduction is projected in Queensland than under the *Linear* and *Ramp* pathways (31% reduction in 2030 Queensland electricity sector emissions relative to 2016, compared to 25% projected under the *Linear* and *Ramp* pathways). However, significantly higher emissions reductions are projected for the NEM (12% reduction in total NEM emissions between 2016 and 2030, compared to 3-4% reduction projected in the *Linear* and *Ramp* pathways).

Figure 32: Change in NEM electricity sector emissions by region relative to *Base case* (*Stronger national action* pathway*)*



Source: Jacobs analysis

9. Facilitating large-scale renewable energy projects

Findings

- Given the number of projects required to achieve the 50% target, there will be an increased requirement on local government authorities, state agencies and network service providers to undertake project approvals and electricity network connections. Due to the progressive investment requirements and the nature of renewable energy resources, project approvals and connection processes are likely to occur concurrently and potentially for projects in similar locations.
- While the project planning and approvals processes in Queensland are considered generally appropriate, there are likely to be benefits from a more coordinated approach to assist project developers as well as the entities assessing projects. Similarly, there may be benefits in the Government providing additional support and resources to local government authorities in approving projects.
- The network businesses will be critical in enabling the implementation of the Queensland Government's 50% renewable target. Most new large-scale renewable plant will need to connect to either a transmission or distribution network or will otherwise impact the operation of a network.
- Stakeholders raised concerns with the network connection process for renewable energy projects in terms of timeframes and costs, and suggested that additional resourcing for the network businesses and more streamlined processes for network connection would assist projects.
- There is a range of technical information that can be provided to assist developers in the early stages of the connection process and there are positive indications Queensland’s network service providers are working to improve information provision.
- As there are likely to be a number of individual generators seeking to connect to the electricity network, there are likely to be benefits from co-ordinating connections. There will be some natural constraints to co-ordination but there is merit in considering the development of renewable energy hubs or zones.

Recommendations

- The Panel recommends the Queensland Government assess options to provide focused and centralised information about project planning and approvals processes to assist both project developers and those entities assessing proposals. These options could include the development of dedicated web-based resources and the creation of centralised facilitation roles, similar to the NSW Renewable Energy advocate.
- The Panel recommends that the Queensland Government work with the network businesses to ensure that the business have adequate internal resourcing and implement appropriate workflow planning measures to be able to manage the expected increase in connections for renewable generators under the 50% renewable energy target.
- The Panel recommends the Queensland network businesses consider options to improve the process for network connection. This should be considered in the context of a likely increase in the volume of renewable related network connection inquiries. It should also consider the open provision of information to assist early stage assessment and the co-ordination of network connections.
- The Panel recommends the Queensland Government and the Queensland network businesses continue to consult with ARENA in the development of its AREMI mapping tool, to ensure accurate and up to date information is included in the map.
- The Panel recommends that the concept of developing renewable energy hubs or zones should be investigated further in Queensland, with the potential for this to form part of a future reverse auction process.

As part of its terms of reference, the Panel is required to identify:

- Any existing policy and regulatory barriers that need to be addressed to enable the achievement of a Queensland renewable energy target, and
- How Queensland can better foster private sector investment in large-scale renewable projects.

In addressing these aspects of the Terms of Reference, the Panel has considered how renewable energy projects are developed and how these processes might be improved to facilitate greater investment in renewable energy in Queensland.

9.1. Project development process

The development process for a renewable energy project is similar to other energy generation projects. Figure 33 outlines a generic process for a project development, with indication of timeframes and relative costs incurred at the different stages of the process. The timeframes refer to a new large-scale solar project[90]. A wind project could be expected to have longer timelines due to a range of factors, including gathering of on-site wind resource data, and wider scope of impact assessment to support the planning application.

An individual project proponent's risk appetite will also influence the pace of the development and costs they are prepared to incur to progress to the next stage.

Figure 33: Project development process (large-scale solar)

STAGE 1 Site identification	STAGE 2 Feasibility	STAGE 3 Development	STAGE 4 Construction and commissioning
3 months	3-6 months	6-18 months	12-18 months
Limited internal costs	Increasing internal and external costs	Significant costs, and grid securities	Full project costs

Source: DEWS analysis

Through stakeholder consultation and submissions, the Panel has identified project approval processes and network connection processes as key areas of focus for improved facilitation of renewable energy projects.

9.1.1. Project planning approvals

Like other infrastructure developments, the development of renewable energy projects are subject to local, state and national planning instruments. The relationships between these instruments, as well as the tiered legislative and planning framework of local, state and national requirements, can complicate the approval process. Project proponents will typically engage expert advisors to assist them through the process and compiling suitable approval and permitting packages.

In Queensland, the *Sustainable Planning Act 2009* (SPA) is the primary planning legislation[91]. Under the SPA, there are four types of state planning instruments:

- *State planning regulatory provisions*: Used to regulate development and can apply to all or part of the state

[90] Department of State Development (Government of South Australia) 2014

[91] A new Planning Act was legislated in May 2016, alongside other planning instruments, and will come into effect in 2017 (refer to: http://www.dilgp.qld.gov.au/planning-reform).

- *State Planning Policy:* Sets out 16 state interests that must be addressed through local government planning schemes, regional plans and when designating land for community infrastructure
- *Regional plans:* Plans that are intended to balance and integrate state government policy for each region
- *Queensland Planning Provisions:* Used to facilitate consistency in planning schemes across the state.

The State Planning Policy (SPP) is a key component of Queensland's land use planning system and provides a comprehensive set of principles which underpin Queensland's planning system to guide local governments and the state government in land use planning and development assessment.

Rather than mandate prescriptive processes, the SPP has a strong emphasis on finding solutions which are regionally, locally and site appropriate. The SPP facilitates this by outlining the outcomes that must be achieved in relation to state interests, while enabling local government to determine how best to do this for their particular community.

A renewable energy project will typically be assessed by the local government authority against the local government planning schemes. An application might be referred to the State if they trigger any requirements under State legislation. In Queensland, the State Assessment and Referral Agency (SARA) is the single lodgement and assessment point for all applications referred to the State.

There are currently over twenty acts and activities that could have a referral impact on an application depending on project technology and selected project site including required easements.

In addition, different types of renewable energy technologies are also subject to different processes. Wind farm developments can be challenging due to a wide range of planning and other considerations, including visual amenity and aviation safety.

The Panel notes the recent release of the State Wind Farm Code, which was developed to provide a consistent state-wide approach to assessing wind farm proposals through the SARA. Wind farm applications are the only renewable energy projects to be assessed against a specific and dedicated code and are referred to the State for consideration through one of three approval pathways. A project proponent typically decides the pathway under which they wish to proceed considering each pathway's criteria of application, dedicated processes and possible timeframes to achieve completion.

In contrast, solar farms and other type of renewable energy projects such as biomass conversion or geothermal power plants are potentially less controversial which means the development assessment process can be simpler and shorter. Typically, these projects are assessed by the relevant local government.

There may also be other permitting and approval processes outside of the SARA process at the state or national level that a project proponent might have to comply with. Examples of additional requirements might relate to state government owned corporations or the national *Commonwealth Environment Protection and Biodiversity Act 1999* which affects mostly wind projects.

The Queensland Coordinator-General

Under Part 4 of the *State Development and Public Works Organisation Act 1971* (SDPWO Act), Queensland's Coordinator-General may declare a project a "coordinated project" based on one or more of the following:

- Complex local, state or Commonwealth approval requirements
- Strategic significance to the locality, region or State
- Significant positive or negative effects on infrastructure, the economy or the social or physical environments.

There are two types of coordinated project declarations under Part 4 of the SDPWO Act:

- Coordinated projects requiring an environmental impact statement (EIS)
- Coordinated projects requiring an impact assessment report (IAR).

For either process, the Coordinator-General manages an extensive coordinated assessment of the project involving State Government agencies, Local Government, the Commonwealth Government and the public.

At the completion of the impact assessment process for a coordinated project, the Coordinator-General is required to write a report evaluating the EIS or IAR. The conditions of approval stated in the report gain legal effect when they are attached to a statutory approval given under other specific legislation and do not relieve the coordinated project proponent of its obligation to obtain all other necessary approvals.

Once the Coordinator-General recommends that a project can proceed, assistance to proponents is provided in the ongoing delivery of their obligations for social, economic and infrastructure impacts.

9.1.2. Network connection

Most new renewable generation projects will need to connect to either a transmission or distribution network.

Securing grid connection is usually a critical path item for projects as it can take multiple years to allow for the completion of connection studies and construction of network infrastructure. In addition, network connection can be a significant component of project costs.

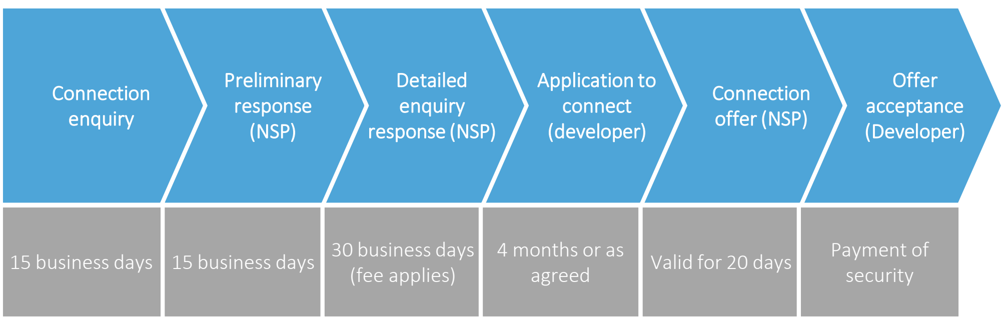
To access the electricity grid, a project proponent is required to liaise with either the transmission or distribution network businesses depending on project location and size. The grid access process is highly regulated through the National Electricity Rules (NER) under which the network businesses operate. The AER administers the NER and regulates the activities of the network businesses.

Chapters 5 and 5A of the NER addresses the rights and obligations of all parties involved in gaining access to the electricity grid in the NEM. The NER also cover principles for cost recovery as well as technical standards of operation for the network businesses.

Network businesses have a regulatory obligation to ensure any connection is undertaken in a manner that maintains the safety, security and reliability of electricity supply. In addition, while there are minimum and automatic standards for connection, connection of generation facilities usually require a negotiated standard, a number of which standards require approval by AEMO.

The process to obtain grid connection is similar for the transmission and distribution networks and can be summarised in Figure 34 (the timeframes and process below apply to a distribution business[92]).

Figure 34: Grid connection process



Source: DEWS analysis

[92] The Connection process for transmission connection is set out in Chapter 5 of the National Electricity Rules. The process is similar and includes Connection Enquiry, Connection Enquiry Response, Application to Connect, Offer to Connect and Commissioning. Timelines for transmission connection are broadly similar, but not the same.

Preliminary Enquiry Responses normally address whether there is sufficient capacity on the network where the project intends to connect. Assessments completed after the preliminary enquiry stage normally require the network business to undertake planning, scoping and estimating studies, which attract a fee.

Although the NER provide time limits on certain connection interfaces between a project proponent and a network business, in practice, timeframes can be significantly affected if the level of information provided by the project proponent to the network business is not sufficient to allow the network business to perform an adequate impact assessment on the system.

The Detailed Enquiry Response details the works required to enable the connection at the required location, including works to the network if needed with cost and timeframe estimates for the specified connection.

Project proponents typically try to locate as close to the connection point as possible. However, if land, easements and approvals are to be secured by the network business to connect to the facility, it can take up to a year to acquire land and up to three years to secure approvals depending on the process required.

9.2. Options to facilitate renewable energy projects

Until recently, Queensland local government authorities, state agencies and network businesses have only been involved with a limited number of large-scale renewable energy projects. However, there is now stronger interest for large-scale renewable energy developments in Queensland, with retailers and developers actively pursuing new development opportunities under the LRET.

The level of project activity is likely to significantly increase with the implementation of a 50% renewable energy target in Queensland. This will likely result in a further requirement for development approvals and connection assessments to be undertaken concurrently and in some cases, in similar locations. The Panel has considered a number of measures that could assist government authorities and network businesses in managing this increased volume of project approvals and connection assessments. These are discussed below.

9.2.1. Improving the planning approval process

During the Panel's consultation, no systemic issues have been identified in relation to the project approval process in Queensland and the Panel notes that submissions in response to the Issues Paper were generally positive about the approvals process in Queensland[93].

Importantly, the Panel highlights the recent finalisation of the State Wind Farm Code, bringing Queensland into line with other Australian states that have promulgated codes or guidelines for wind farm development. The Queensland Code provides wind farm proponents with details on the assessment criteria for a wind farm development application and acceptable options available to the proponent to satisfy the criteria. The Code sets out clear assessment requirements for the design, construction and operation of new or expanded wind farms.

The Panel notes that while processes for approval of individual projects are considered adequate, project proponents and those assessing project development applications are not always able to access all the information they require in a fully comprehensive, timely and consistent manner.

In order to support the expected significant increase in the number of projects being developed under a Queensland renewable energy target, the Panel is of the view there is a need for the Government to provide focused and centralised information about the project approval processes applicable to renewable energy generation projects in Queensland. This is expected to help attract investment into Queensland from project developers who may have experience in other jurisdictions but no current experience with Queensland processes. This view was supported by submissions in response to the Issues Paper[94]. Stakeholders also noted in submissions on the Draft Report that approvals processes should be flexible enough to accommodate changes in renewable energy technologies or project modifications[95].

[93] Energy Australia, ESCO Pacific and a confidential submission
[94] Adani
[95] Clean Energy Council, DP Energy

The Panel notes that the South Australian Government has a dedicated website for the development of renewable energy in the state, providing detailed information to assisting investors interested to develop projects there. New South Wales has appointed a renewable energy advocate who is a central point of contact for Australian and overseas investors about what NSW energy projects and infrastructure may be best suited to their plans. The creation of a similar role in Queensland was supported by the Clean Energy Council and the Department of State Development in their submissions to the Panel's Issues Paper.

There may also be a role for the Government to provide further guidance and planning policy directions via the SPP and regional planning schemes in support of renewable energy project developments. This could include identifying of areas of interest to the State or prospective community infrastructure designation for project sites, or other supporting infrastructure such as transmission or distribution network.

At a more local level, the Panel met with a number of local councillors and local council employees during the public forums and was encouraged by the facilitative approach being taken by many councils. These stakeholders were interested in seeing projects developed in their local authority areas and were also actively considering the issue of renewable energy approvals as part of their broader planning considerations. This was supported by industry consultation, with specific project developers indicating that they were generally positive about the approval processes undertaken, particularly the approval of solar projects at the local council level. The Panel notes that ESCO Pacific indicated in its submission on the Issues Paper that there may be some differences in the processes for assessing renewable energy projects and that a more standardised process would assist developers as well as assessors.

Given the positive sentiment towards the existing approach, the Panel does not consider any significant changes are warranted in the immediate future. However, as the Panel has noted, there is likely to be an increase in the number of project approvals in Queensland, in turn increasing the resourcing requirement on local councils to undertake assessment of these approvals. While the Panel anticipates that new projects will be located across the state, some councils may expect higher volumes of applications given the nature of the renewable energy resources in their area or other characteristics of their region. The Panel is of the view that the Queensland Government should consider how it might best support local councils in managing with this increased volume of assessments in consultation with the Local Government Association of Queensland.

This support could take the form of providing coordination resources, financial assistance to increase knowledge and expertise, developing guidelines or facilitating knowledge sharing across councils. Similarly, the coordinated project assessment process under the SDPWOA may assist proponents to negotiate the approvals process under a number of different levels of government.

9.2.2. Improving the network connection process

The Panel notes that network connection was a key area of concern for some project proponents, generally relating to timeframes and cost. Submissions in response to the Issues Paper suggested that timeframes may be longer than planning approval timeframes.

Approval timeframes

The Panel notes that while there are prescribed timeframes for the network connection process in the NER, there are a number of factors that can contribute to these timeframes becoming drawn out in practice.

Importantly, it has been observed that not all connection applications are undertaken as a continuous series of activities. Due to a range of factors, including lack of regulatory certainty, planning approval challenges or lack of certainty of commercial outcomes, some project proponents may choose to delay undertaking paid detailed connection enquiries until such time as the project has a higher probability of commercial viability. This stop-start approach can delay or, in some cases, prevent proponents gaining access to the network at the requested location. This may contribute to a view that the timeframes for completing a connection agreement are elongated.

The Panel notes that there are a number of complex technical factors that must be addressed in the process of finalising a connection agreement. The network businesses assess each connection application in accordance with the NER, having regard to the technical and operational characteristics of the network, the applicant's facilities at the desired location and the safety, security and stability of the wider system they operate. The majority of connection assessments for electricity generation connection require input and assessment from Powerlink and AEMO. Both of these entities have a regulatory duty to ensure that the proposed connection is compatible with the safe and reliable operation of the energy system they operate.

In addition, the electricity network is a dynamic system. A connection study is generally only useable as long as the system remains consistent with when the study was undertaken. Any other change in network connection, whether it is a load (customer) or a generator, has an effect of the wider system which might make an earlier connection study invalid. The expediency of the network studies and the immediate commitment of project developers to the connection are important to limit delays and complications in the process, in particular where multiple projects are interested to connect to the same portion of the network.

It is understood that the network businesses have a dedicated but limited set of internal resources with the requisite capabilities to undertake these complex connection assessments. Given the increased volume of network connection inquiries in the past 12 months and the further increase in volumes required to achieve a 50% renewable energy target in Queensland, this may result in resource constraints across the network businesses.

While recognising the factors that contribute to increased timeframes for processing connection applications, the Panel considers there is scope for the network businesses to review their processes, with a specific focus on timeframes and providing easier access to network capacity information[96]. Further, the Panel acknowledges the increased strain on resources that the network businesses will face as connection requests increase.

Powerlink advised the Panel that it conducted a workshop on renewable connections at its July 2016 Transmission Network Forum to seek guidance and understanding from connecting parties to ensure that the connection process is enhanced for all users. Powerlink has made publicly available a summary of feedback received at the Forum and will use it to identify the next steps in evaluating and refining the connection process for renewable generation. Similarly, submissions in response to the Issues Paper suggested that a benchmarking review could assist in determining performance against other network businesses[97]. In the first instance, the Panel considers that it may be beneficial for the Queensland Government to encourage the network businesses to track and share with the Government vital statistics about performance for generation connections at both large-scale and small to medium-scale[98].

In addition to reviewing processes, the Panel is of the view that the network businesses should consider the increased future requirements for connecting renewable energy generation projects in their forward resource planning. This should include strategies to retain existing staff with the appropriate technical capabilities to undertake the necessary assessments, and attracting new staff that can fulfil these requirements. The network businesses should also consider investigating opportunities to improve information sharing with industry and network businesses in other NEM regions.

Costs associated with network connection

Throughout the consultation phase, stakeholders have raised concern with the costs of undertaking the connection application, as well as the costs associated with constructing connection assets.

[96] In its submission to the Draft Report, Energy Queensland Limited acknowledged that the connection processes for larger scale embedded generation could be improved, noting that it has made an initial range of changes to its processes in light of recent AEMC rule changes on connecting embedded generators.

[97] Confidential submission

[98] Subject to NER Confidentiality Requirements in Rules 5.3.8 and 8.6.1

In terms of the cost associated with a connection application, the Panel notes that the assessment of a network connection is complex and it is important that applicants provide a financial contribution in order to ensure that the businesses are able to appropriately resource the assessment process. It also helps to avoid speculative applications where a proponent may make an application without any real intention to proceed in the short to medium term.

While some proponents may consider the cost of connection application as a barrier to investment, the Panel considers that this is appropriate and will help to limit speculative applications that may tie up resources to the detriment of more credible projects. The Panel understands that the costs associated with the application process will not be recovered if the project does not proceed. However, this is a normal risk associated with project development.

Overall, the Panel is of the view that the costs of the application process are reasonable to ensure that connection applications can be properly assessed and that the effects of the new plant on the network are appropriately considered.

In relation to physical connection, the Panel notes that this can be a significant component of project costs and improved transparency and contestability is desirable.

While it is understood that part of the works required to connect can be undertaken by the project developer via an accredited entity, some project developers have noted that this involved foregoing some cost saving compared to contracting this work outside of the network business. In its submission on the Issues Paper, Equis Australia suggested that increasing the level of competition with respect to grid connections, "*…would greatly reduce the timeframes and costs for the construction of grid connections for renewable energy projects*".

Rule change request - Transmission Connection and Planning Arrangements

The Panel notes that many of the issues raised in this section are being considered as part of National Electricity Amendment (Transmission Connection and Planning Arrangements) rule change request currently being undertaken by the AEMC, aimed at improving the transparency and contestability under a connection to the transmission network[99].

In its Discussion Paper released on 26 May 2016, the AEMC noted:

> *…the connection experience can be unpredictable, vary across transmission network boundaries and can result in unsatisfactory outcomes in terms of cost and timeliness. We recognise that connecting parties have had different experiences with the connection process, with this being driven by the culture and practice of the individual TNSP. Making the NER clearer and simpler should make it easier for connecting parties to know exactly what assets and services they are negotiating for, enhance their ability to negotiate on more equal terms with TNSPs, and result in a more predictable connection experience across transmission network boundaries.*

The Panel considers this rule change as an important process that recognises the general need for improving the manner in which the connection process is undertaken. The Draft Rule Change is due by November 2016, with the Final Rule Change expected in March 2017.

In consultation on the Draft Report, AEMO and the Clean Energy Council outlined support for the introduction of contestability in the provision of network connections, as a way of promoting more efficient connection to the grid. As noted by AEMO:

> *AEMO welcomes reforms that allow contestable providers to build, own, operate and maintain the contestable part of the shared network. AEMO has seen and continues to see the delivery of connections in a more cost effective and timely manner in Victoria where competition for the provision of connections is business as usual.*

[99] AEMC 2016

9.2.3. Improving the provision of technical information

To assist in the early stage project development, project proponents require information about the available renewable energy resource, the location of the existing network and the capacity available in the network at specific points. Ideally, project proponents should be able to access this information in a consolidated form. To date only a preliminary meeting with the relevant network business can give an indication of available capacity, after one or multiple potential sites have been identified.

At present, there is some information available on the Queensland government websites regarding energy resource and land access, but the data provided is unlikely to be granular enough to assist project proponents in their screening of high potential sites.

However, the Panel notes that there are positive signs that access to technical and other relevant information is improving.

In its submission on the Issues Paper, Powerlink highlighted:

> *…it is important to openly provide information to assist large-scale renewable generators during their assessments of the most cost effect outcomes and where possible coordinate the timing of renewable generation development to provide lower cost outcomes overall.*

The Panel notes Powerlink's efforts in this regard, with its most recent Transmission Annual Planning Report (TAPR) including a map overlaying solar energy resources with the location of its network and identifies 20 potential connection points that could accommodate large-scale renewable projects of significant size.

Similarly, ARENA in collaboration with Data61 is compiling an online "one-stop-shop" mapping tool, called "AREMI", to assist developers in the early stage of project siting and scoping including renewable resources and network infrastructure[100]. The project has recently incorporated information on grid connection opportunities in collaboration with the network operators.

As electricity networks are dynamic systems it is important to dedicate resources to ensure the quality and currency of the information is maintained to assist developers with screening sites with high potential for connection and land access.

9.2.4. Renewable energy zones or hubs

As discussed above, the Panel has identified the cost of network connection as a key area of concern for stakeholders. The cost of the physical network connection can be a significant proportion of overall cost of a project. As a result, project proponents will generally only invest in the development of infrastructure to a level sufficient to enable the connection of their project. This may result in the duplication of network infrastructure or less efficient network outcomes as subsequent projects seek to develop their own separate network connections.

Further, network capacity in areas of good renewable energy resources may be limited and may only be able to accommodate a single project, while there may be a number of projects that may seek to connect in the area. This can result in subsequent projects being crowded out, or the initial projects suffering financially because under the NER they are unable to secure "firm" access to the network.

During the consultation process, a number of stakeholders suggested that there could be benefits from identifying specific areas of good renewable energy resources and co-ordinating the connection to the grid of projects in these locations to improve efficiency – effectively the concept of renewable energy zones or hubs. As noted by Ergon Energy in its submission on the Issues Paper:

> *…a significant opportunity exists, as part of a coordinated transition plan, to identify priority areas for renewable energy grid connection. These locations or "corridors" could be specifically developed to enable the quick and economic connection of new generation.*

[100] ARENA 2016

The Panel notes that these issues have been previously considered, most notably, by the AEMC in its 2011 Rule Change Determination on Scale Efficient Network Extensions[101]. The AEMC noted that there should be some incentive for generators to coordinate connection where there are economies of scale. However, the AEMC conceded that in practice, this might be unlikely given the commercial sensitivities associated with projects co-ordinating and that an individual project would be reluctant to have their project limited by the timeframes of another project.

In addition, an individual generator or network business would be unlikely to commit to incur the additional costs in oversizing a particular connection on the basis of a subsequent project connecting in the future, given the risks associated with that project not proceeding.

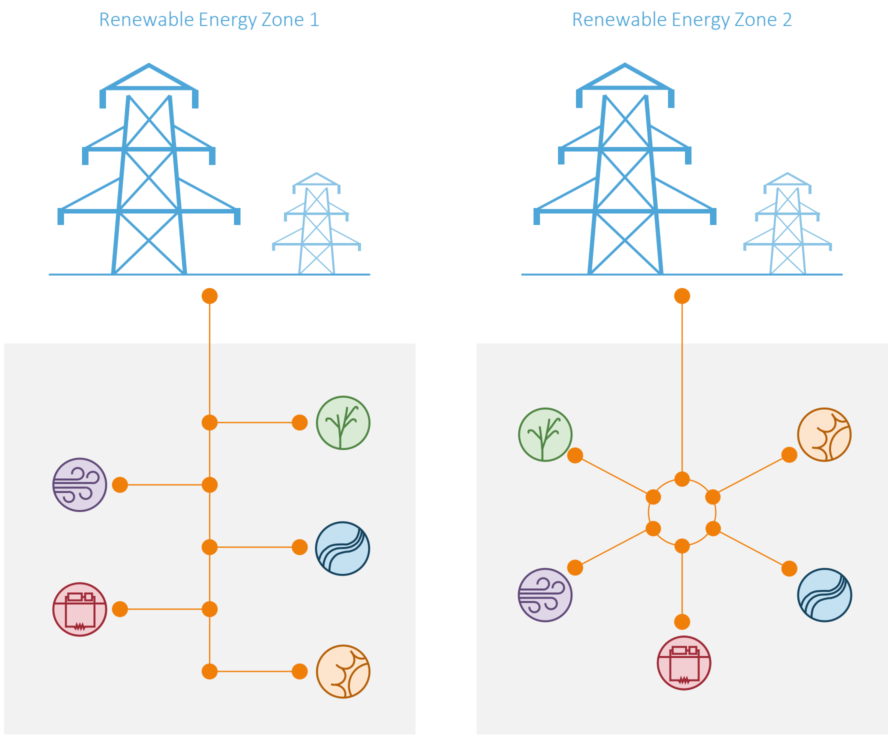
The AEMC considered that there was the potential for increasing the efficiency of network connections and that this should result in lower overall costs. The AEMC also noted that renewable energy generators were likely to be smaller in size than traditional generation, resulting in an increased number of connections and that multiple parties were likely to seek to connect in similar locations. The final rule change placed a new obligation on transmission businesses to undertake a study (on request) to identify the potential efficiency gains from co-ordinating the connections of multiple generators. However, to date, no studies have been completed in Queensland.

Powerlink offered some further commentary on this coordinated approach to network expansion in its 2016 TAPR through the development of renewable energy zones. Under this concept, Powerlink has indicated that economies of scale could be realised through expanding the network into areas where renewable energy projects might co-locate. Powerlink has considered two models for the development of a potential renewable energy zone.

- The construction of a high capacity transmission line enabling connection of a number of projects over the length of the line
- The construction of a dedicated connection hub for projects within a similar location.

These models are depicted in Figure 35.

Figure 35: Conceptual overview of renewable energy zones



Source: Adapted from Powerlink[102]

[101] AEMC 2011

[102] Powerlink Queensland 2016, p135

Similarly, the Panel notes that Transgrid is investigating the feasibility of a Renewable Energy Hub in the New England region of New South Wales. Transgrid has indicated that the existing transmission line can accommodate around 120 MW of generation, while the development of a hub could increase the connection capability to around 700 MW.

The Panel considers that the concept of developing renewable energy hubs should be investigated further in Queensland, particularly given the extent of new project connections required to achieve a 50% renewable energy target in the state. The Queensland Government may be able to facilitate the development of a renewable energy hub through one of the post-2020 reverse auctions, given the likely requirement for multiple projects to be delivered over the same timeframe. The overall cost of the required network connections could be identified through the auction design process and be factored into the bids, overcoming the financial barriers identified above. In its submission on the Draft Report, AEMO noted the benefit of energy hubs, suggesting that a hub "*may be a more efficient way to build shared connection assets…rather than with a separate terminal station for each new generator*".

In addition to the potential for improving network efficiency, the planned siting of renewable energy hubs may have potential to contribute positively to maintenance of network security and reliability, as discussed further in Chapter 10.

10. Integration of renewables into the National Electricity Market

Findings

- Queensland electricity consumers must continue to receive reliable power supply during the transition to 50% renewable generation. Analysis by Jacobs does not identify reliability issues in Queensland, due to significant controllable thermal electricity generation retained in service to 2030.
- AEMO has undertaken analysis of the integration of renewable energy in the NEM and has not identified any fundamental barriers to achieving higher penetrations of renewable generation in Queensland provided complementary measures are in place. AEMO will continue to monitor the integration of renewable energy across the NEM.
- AEMO is also analysing the likely impact on overall system security and reliability and the potential need to expand some parts of the FCAS market in particular. This is also the subject of a current Rule Change proposal before the AEMC.
- While the high penetration of renewable energy in South Australia was a contributor to the closure of the local coal-fired power station and higher electricity prices, other factors such as the level of market concentration, heavy reliance on gas-fired generation, rising gas prices, the availability of pipeline capacity and retailer strategies in the South Australian retail market have also had a significant influence on higher prices.
- Modelling indicates the 50% renewable energy target for Queensland can be met while maintaining the required reliability standard in Queensland. In contrast to the South Australian experience, coal-fired generation is expected to continue to play a significant, but reduced role in Queensland to 2030 under a 50% target.
- The Panel understands the Queensland Government is currently investigating options to address the regulatory and commercial constraints to greater uptake of small and medium-scale solar PV, particularly at the commercial-industrial scale.
- The Queensland Government, through participation in the COAG Energy Council, is supporting a range of measures under the National Energy Productivity Plan, which are expected to facilitate uptake of small and medium-scale solar PV.

Recommendations

- The Panel recommends that the Queensland Government works proactively with AEMO to assist with efficient policy development, particularly in regard to system security and the development of ancillary services markets. Elements of this co-operation could include:
  - Joint analytical activities monitoring the effect of renewable energy uptake in Queensland, incorporating state and national data to identify potential challenges early on
  - Leveraging AEMO studies such as the National Transmission Network Development Plan to inform the technical requirements of delivering the target, and stress testing potential policy options as state and federal policies evolve
  - Exchanges of AEMO and Queensland Government staff to maximise information transfer between the two agencies.
- The Panel recommends the Queensland Government facilitate the collection and disclosure of relevant data on embedded systems to assist AEMO in managing power system security and reliability, to the extent this data is not collected by other organisations such as the Clean Energy Regulator.
- The Panel recommends that the Queensland Government continue to explore ways to work co-operatively with other State and Federal Governments on measures to enhance customer uptake of renewable energy systems, so as to avoid duplication of effort and inconsistent approaches across jurisdictions.
- The Panel recommends that the Queensland Government investigate the use of solar PV on state-owned buildings, where it is cost effective to do so.

The Panel considers that a 50% renewable energy target must occur in an environment in which the grid remains reliable (able to supply the required demand) and secure (sufficient redundancy is available in the system to ensure that the grid can continue to operate even if a generator or transmission line fails).

10.1. Grid management with high penetrations of renewable generation

The impact that higher penetrations of renewable generation, particularly intermittent renewables, have on the grid has been the focus of considerable domestic and international studies. A number of issues have been identified as becoming significant when the instantaneous penetration of renewable generation becomes high. This is distinct from the share of renewable generation over a year; achieving 50% of annual energy from renewable generation could potentially result in nearly 100% of Queensland energy being supplied from renewables in some hours, as has been seen in South Australia.

In general, studies by grid operators and academic institutions have found these issues have been found to be manageable through careful planning[103,104], even at relatively high renewable penetrations. However, this can be highly dependent on the specific attributes of different parts of the grid, and the specific technologies employed, as discussed below.

The Panel notes that as Queensland is starting with a relatively low level of renewable generation, there is the opportunity to learn from domestic and international experience to ensure that the future Queensland grid is sufficiently robust.

10.1.1. Reliability

A key element of the power system is to ensure that sufficient capacity is available to meet supply at all times. In practice, power systems usually impose a reliability standard that balances the cost of providing 100% reliability with the expectations of the community; consumers have typically expressed a willingness to accept rare outages if this were cost effective. In the NEM, the reliability standard requires that unserved energy must be no more than 0.002% of annual demand, averaged over ten years. Multiple submissions on the Issues Paper (such as by Engineers Australia QLD Division, Australian Energy Council and Ergon Energy) noted that current reliability standard should be maintained.

Wind and solar PV rely on the underlying weather resource for generation. As such, their available capacity varies over time and cannot provide firm capacity in the market without associated energy storage. Therefore, there is an ongoing role for existing generators or renewable energy with storage at times of low renewable resource or high demand. This is similar to how peak demand periods are currently managed, where peaking capacity is brought online when insufficient output from baseload coal generation is available.

However, conventional generators typically require time to be brought online, ranging from five minutes to several hours. Therefore, AEMO provides forecasts of likely market demand to allow market participants to decide whether they are likely to be required. AEMO utilises weather forecasting models which can predict wind and solar generation minutes to hours in advance. High quality forecasts will be critical for ensuring capacity is available for reliable supply. AEMO is continuing to seek opportunities for improving large-scale renewable energy forecasts.

However, in some locations wind and solar technologies may complement each other, with wind generation stronger in the evening and overnight when solar generation is not available. For example, developer Windlab has received development approval for a combined wind and solar project near Hughenden in Queensland[105] noting strongly complementary wind and solar resources. Figure 36 shows indicative wind and solar production for the North Queensland area based on AEMO data used in their National Transmission Network Development Plan (NTNDP) modelling[106], highlighting the potential for wind in this region to balance solar on average. Combining the diversity of wind and solar output should reduce the system wide effects of the higher penetration of renewable energy under the 50% renewable generation target.

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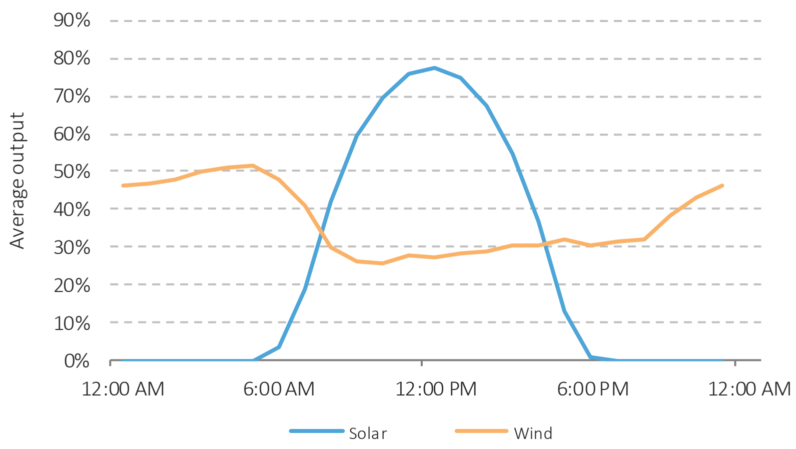
[103] Riesz, J Elliston, B Vithayasrichareon, P, MacGill I 2016
[104] AEMO 2013
[105] Windlab 2016
[106] AEMO 2016d

Figure 36: Average time of day production of North Queensland wind and solar in AEMO NTNDP modelling



Source: AEMO 2016d

The Panel notes that other technologies, such as biomass or solar thermal with storage, are dispatchable technologies (within limits) and would be available at times of high demand or low supply. In their submission on the Issues Paper, Mackay Sugar stated the following:

> *Sugarcane is an effective solar energy collector, with the advantage of having the energy converted into biomass which can be used to generate electricity when the grid requires it. Biomass is essentially a low-cost battery.*

Increased penetration of rooftop PV (in particular) or other distributed generation not directly visible (or controllable) by AEMO can make forecasting demand more challenging. Digital meters that provide real-time generation information for distributed generation could significantly improve AEMO's forecasting capabilities. Increased uptake of digital meters and other monitoring systems for embedded generation could facilitate greater penetrations of renewable generation in the future.

In AEMO's submission on the Issues Paper, it outlined a requirement for improving the mechanism for collecting and managing data on distributed energy resources[107]. Similarly, Ergon Energy noted in their submission on the Issues Paper:

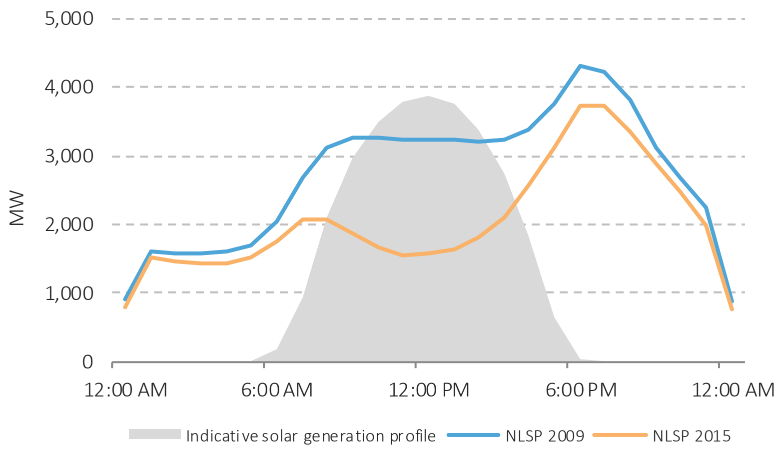
> *It is Ergon Energy's view that another key requirement, and a key enabler of demand and energy management in a renewable supply system, is distributed control. As generation becomes increasingly distributed, the control systems to monitor and control this generation, to ensure reliability and stability, must also become increasingly distributed.*

10.1.2. Wholesale price effects

The Panel notes that a greater penetration of variable renewable generation could lead to volatile prices. For example, solar PV output decreases as evening demand increases; as the penetration of solar PV increases, this will result in the need for a rapid increase in the output of coal and gas generators. Figure 37 shows the change in the average Energex load profile from 2009 to 2015 (averaged over a full year), overlayed against an indicative solar generation profile. While not necessarily representative of the interconnected system wide peak which determines the overall need for generation dispatch, it demonstrates how the profile is expected to become more variable with a longer ramping requirement as the system moves to the evening system peak.

[107] Refer to AEMO's submission to the Issue Paper

Figure 37: Average Energex net system load profile comparison by time of day



Source: AEMO 2016e

If demand forecasts become less accurate, either in the medium-term (hours ahead, such as due to uncertain wind production) or short-term (minutes ahead, such as due to intermittent cloud cover affecting solar production), this could lead to short-term requirements for more expensive generation and potentially higher prices. Higher renewable generation at other times would tend to pressure prices to thermal plant short run marginal costs (especially coal-fired plant) or even to zero or negative prices. These swings in prices from very high to very low prices as renewable generation varies is what is expected to cause increased price volatility with the increased penetration of renewable generation.

The Australian Energy Council noted in their submission on the Issues Paper and Draft Report that higher volatility can result in higher prices for financial products that hedge against risk, which could increase consumer costs unless new contracting methods evolve over time. The Panel notes that this reflects the higher risk premium in financial products where prices exhibit higher volatility.

10.1.3. System security

System security refers to the ability of the grid to be managed within technical parameters and to withstand credible contingency events, such as the loss of a major generator, the loss of a large load, or the failure of a transmission line[108]. These events can lead to supply and demand being out of balance, causing the system frequency to change. If the frequency goes too high or too low, generators or loads will be forced to disconnect from the network to avoid damage, potentially resulting in significant blackouts.

To respond to contingency events or short-term changes in supply and demand, AEMO ensures reserves are available by procuring FCAS which includes generators and loads who are paid to be available to adjust their output up or down in response to real-time conditions (ranging from seconds to minutes). FCAS providers also respond to normal variations in supply and demand between re-dispatching all generators every five minutes.

In general, frequency control is managed at a national level. However, AEMO may place specific requirements on individual regions if the risk of separation (disconnection of that region from the rest of the NEM) is considered credible, to ensure that the region remains secure should a separation occur.

In more extreme circumstances, AEMO will re-balance supply and demand by shedding load, resulting in some localised blackouts. This is done automatically through under frequency load shedding (UFLS) where load is automatically disconnected in blocks as the frequency drops (signalling a lack of supply) to rebalance the system.

[108] Credible contingency events are events that are considered as reasonably likely to occur in normal operation of the electricity supply system, including the trip of any single item of plant. AEMO must prepare the power system to be secure should the event occur. Non-credible contingency events are considered to be events that are less likely to occur such as the loss of a multiple items of plant at the same time – these include the loss of double circuit transmission lines or multiple generating units.

In addition to managing the grid frequency, there are other technical issues that apply in local areas of the grid. This includes managing the transmission grid voltage within specified limits and to maintain voltage stability. AEMO is conducting ongoing studies into these issues, which have been identified as potential limits to large-scale renewable generation penetration in some areas[109].

Impact of high penetrations of wind and solar PV

Renewable generation can impact on the management of the grid frequency in a number of ways. Wind and solar PV power stations cannot typically increase their output unless they are curtailed to below their available resource, which would result in lower energy yields across the year and impact their financial viability. (This is also true for conventional generators, although it is more common for such generators to operate below their effective maximum.) Therefore, if wind and solar PV sources displace conventional generation across the NEM, fewer sources of FCAS will be available unless these are incentivised to provide these services. In the near-term, the capacity required for these services is relatively small and can be supplied by generators anywhere in the NEM. However, FCAS may eventually need to be provided by higher cost sources (which could include curtailed wind and solar or energy storage systems).

Wind and solar PV plants typically connect through inverters and do not provide inertia to the system; this contrasts with power stations with spinning turbines such as coal, gas, hydro, biomass and solar thermal. If wind and solar PV displace other generators, this can create situations where the grid frequency can change too fast to control if there was a sudden unexpected change of generation or load. This is likely to place limits on the maximum penetration of renewables in any hour[110], but inertia can be shared across the grid through AC interconnectors.

New flexible generators, energy storage and demand side response could all provide FCAS in the future. Some renewable technologies, such as biomass and solar thermal technologies, would also be able to provide inertia, and may therefore have additional value to the market in the future. This revenue would be in addition to (for example) a government backed CFD for energy, providing a market signal for dispatchable technologies under a series of reverse auctions. The Government could also consider directly incentivising dispatchable renewable generation to provide additional market support.

There are also emerging technologies, such as synthetic inertia for wind farms that allow renewable generators to participate in existing and potential future FCAS markets. The Panel considers that the Government could encourage new renewable projects to incorporate such capabilities as a form of knowledge and capability building.

10.2. South Australian experience

South Australia has already achieved high penetrations of renewable generation, achieving approximately 40% of its generation from large-scale renewable energy, plus generation from rooftop PV systems. The Panel has therefore reviewed the South Australia experience, the similarities and differences between the South Australian and Queensland grids, and potential findings for Queensland.

10.2.1. Reliability

The Panel notes that AEMO has not identified any impact on system reliability as a result of the high penetration of renewable generation to date. Despite the greater variability of renewable generation, periods of low renewable generation has not resulted in supply shortages, nor have other outages been linked to higher penetration of renewable generation[111].

[109] For example, AEMOf 2016 Victorian Annual Planning Report
[110] Digsilent 2010
[111] In November 2015, the Heywood interconnector disconnected, resulting in load shedding and extreme prices. However, this was not triggered by renewable generation.

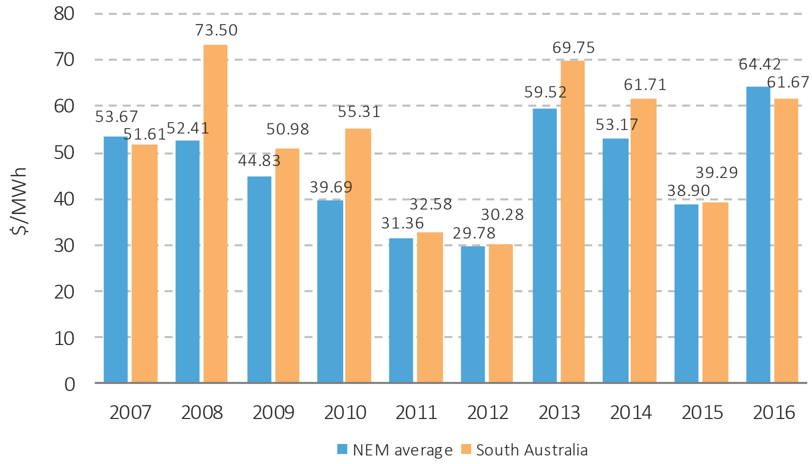
Longer term, AEMO has identified the potential for reliability issues in South Australia if emissions reduction policies lead to the closure of coal-fired power stations in neighbouring regions, reducing the capacity available to export energy from Victoria to South Australia[112]. AEMO notes that there may be reliability concerns at times when high demand in both South Australia and Victoria coincides with low local wind and rooftop PV generation, unplanned generation outages, or low levels of imports.

Additional intermittent generation may not address these reliability concerns, which would then require either additional peaking capacity or new developments in storage or demand-side management opportunities.

10.2.2. Wholesale prices

The average wholesale prices in South Australia have consistently been higher than in other regions, independent of the growth in renewable generation over time.

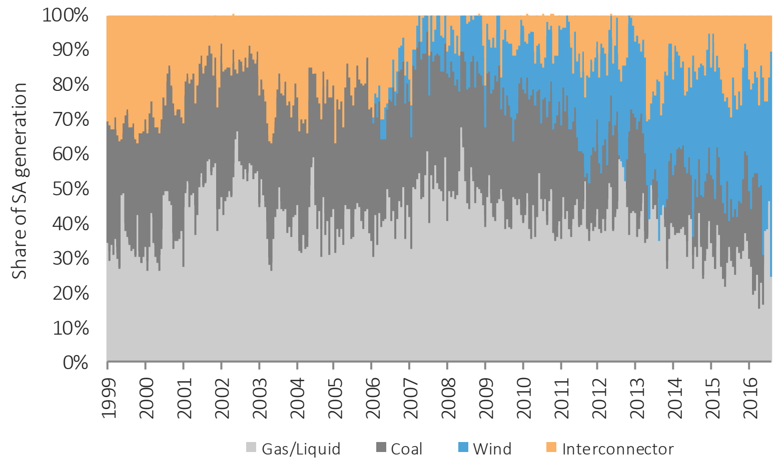
Figure 38: Average annual wholesale price in the NEM ($/MWh)



Source: AEMO 2016g

This reflects a range of drivers specific to the South Australian market, in particular a greater reliance than other jurisdictions on gas generation which has higher generating costs. The figure below shows the share of generation in South Australia from gas over time. Gas generation has typically provided 40-50% of South Australian electricity, declining to approximately 35% in 2015 as the renewable generation share has increased. In May 2016, the Northern Coal Power Station (South Australia's last coal power station) was closed, and gas generation increased to approximately 45%, in line with historical levels.

Figure 39: South Australian generation mix over time



Source: Sourced from NEM Review

112 AEMO 2016b

The current and expected increases in gas prices are also likely to be a significant driver of electricity futures prices in South Australia, as gas generation is expected to be the wholesale market price setter in a majority of periods.

More recently, the growth of renewable generation has contributed to the closure of South Australian coal generation, reducing available supply (and increasing gas generation to historical levels), contributing to higher prices. The Panel notes that while the timing of coal closures were likely brought forward by the growth of renewable generation, South Australia's coal assets were aging (30 to 50 years old) and public reports indicated that the Leigh Creek coal mine would be closed in 2017[113] unless a lower quality coal seam was accessed and developed[114] (which Alinta was actively investigating). Even if successfully utilised, this resource would have presumably entailed some additional costs, and may have placed some upwards pressure on wholesale prices. Alternatively, if these plants had exited the market in the absence of renewable generation, it is expected that either gas or a combination of renewable and gas-fired generation would have been built to replace them.

The Panel also notes that despite the high prices, Pelican Point remained offline, with only two generation owners providing the majority of dispatchable generation over that period. The panel understands that the owners of Pelican Point faced with the variability in demand for its capacity as renewable penetration increased in South Australia, made the commercial decision to sell its gas to the LNG industry[115]. In July 2016, Pelican Point resumed operation at the request of the South Australian Government, presumably supplied through spot or short term contracted gas but the plant is expected to shut down again once the short term conditions associated with the interconnector upgrade abate.

Other factors affecting the South Australian wholesale market include the limited number of market participants, the highest peak demand relative to energy consumption in the NEM, and limited interconnection to other regions. This year, a colder than expected winter resulting in higher than expected demand, and partial outages on the interconnector to Victoria contributed to short-term higher prices.

10.2.3. System security

In South Australia, the penetration of non-synchronous generation has sometimes exceeded South Australian demand, with additional energy being exported to Victoria. AEMO has found South Australia can be operated in a secure state provided that South Australia remains connected to the remainder of the NEM via the Heywood interconnector to Victoria and sufficient synchronous generation is operating. Under these conditions, sufficient inertia is available to slow the rate of frequency change and enable replacement generation (or, at worst, temporary localised load shedding) to be activated.

If a disconnection of Heywood is considered credible (for example if one of the two Heywood lines is offline for service), then AEMO imposes additional constraints on the South Australian network, including sourcing some FCAS services locally within South Australia. This would increase the cost of managing the South Australian grid at those times. The Panel notes that current FCAS costs are very low in the NEM, typically 0.5% of the corresponding energy costs. In 2015-16, South Australian FCAS costs increased to 5% of energy costs, due to an extended period of work on the South Australian Heywood interconnector in October to November 2015[116].

In general, AEMO has not identified fundamental barriers to integrating intermittent renewable generation, provided appropriate complementary measures are available. AEMO noted in response to the closure of South Australia's last coal power station[117]:

> *AEMO has not identified any system security challenges that cannot be managed through existing processes and procedures.*

[113] Changarathil 2013
[114] Parliament of South Australia 2013
[115] McConnell and Sandiford 2016, p31
[116] Panel analysis of data published by AEMO
[117] AEMO 2016f

More generally, ERM Power, in their submission on the Issues Paper, stated that:

> *…we maintain that the NEM is currently providing adequate investment signals that will allow markets to continue to operate efficiently under higher proportions of non-synchronous renewable energy generation. As such, no change is needed in the short term.*

However, AEMO has observed that the growth of intermittent generation in South Australia, particularly large-scale PV, may lead to higher FCAS requirements in the future[118]. At the same time, there are currently only three registered FCAS providers within South Australia, and all units are required to be online to supply the local FCAS requirements. Therefore, the market may be required to deliver additional sources of FCAS in the future.

10.2.4. Black System event in South Australia

On Wednesday 28 September 2016 at 4.18pm, South Australia experienced a "Black System" event, resulting in the loss of all generation and supply to consumers in South Australia. According to AEMO, the restoration of electricity load commenced at 7.00pm on 28 September 2016, and by midnight the majority of the State's load was restored.

Since the event occurred, AEMO has published two reports outlining its initial views on the cause of the event[119]. Based on AEMO's reports, it is understood the loss of supply was the result of a sequence of events that was initially triggered by extreme weather over large parts of South Australia, including destructive winds, widespread thunderstorms, damaging hail and heavy rainfall. A recent report by the Bureau of Meteorology into the storm concluded that the weather was one of the most significant and severe thunderstorms in recent decades[120].

According to AEMO, the weather caused five transmission system faults within a period of 88 seconds which led to six voltage disturbances. While generation initially rode through the system faults (and resulting voltage disturbances), the frequency of the faults caused the disconnection of 445 MW of wind generation across nine wind farms in South Australia.

The rapid loss of wind generation increased the flow of electricity on the Heywood interconnector, which resulted in the interconnector overloading and tripping. Ultimately this led to South Australia separating from the NEM and losing 900 MW of electricity supply. The sudden loss of supply caused the system frequency in South Australia to collapse, resulting in the loss of electricity generation and supply in the State.

Implications for wind generators

Wind turbines, like other thermal generation types, are designed with "fault ride-through" capability that allows the generator to remain connected to the grid during short periods of low voltage in the network. This capability ensures wind turbines are able to contribute to the stability of the electricity system during system faults. Typically, a wind turbine's control system will take action of if the number of ride-through events exceed a pre-set limit.

While investigations are ongoing, AEMO has determined that nine of the thirteen wind farms in South Australia disconnected from the grid due to number of fault ride-through events exceeding their pre-set limits, as shown in Table 20.

118 AEMO 2016b
119 AEMO 2016h, AEMO 2016i
120 Bureau of Meteorology 2016b

Table 20: South Australia wind farm responses to voltage disturbances on 28 September 2016

Wind farm	Pre-set limit to ride-through events in 120 seconds	Number of times wind turbines activated ride-through mode	Last state of wind turbines prior to system voltage collapse	Output pre-event at 16:18:07	Reduction in output
Wind farms with higher ride-through settings					
Canunda	9	1	Operational	27.7 MW	0.5 MW
Lake Bonney 1	5-9	0	Operational	77.7 MW	1.2 MW
Lake Bonney 2, 3	9	0	Operational	171.9 MW	13.2 MW
Waterloo	9	5	Operational	96.6 MW	23.7 MW
				373.9 MW	**38.6 MW**
Wind farms with lower ride-through settings					
Clements Gap	2	3	Disconnected	14.5 MW	15 MW
Hallet	2	3	Most turbines disconnected	34.5 MW	32.8 MW
Hallet Hill	2	3	Most turbines disconnected	41.3 MW	21.8 MW
Mt Millar	Not known	5	Stopped operation	67.0 MW	64.2 MW
North Brown Hill	2	3	Most turbines disconnected	85.5 MW	74.5 MW
Hornsdale	5	6	Stopped operation	83.9 MW	85 MW
Snowtown North	5	6	Stopped operation	65.5 MW	66.3 MW
Snowtown South	5	6	Stopped operation	42.1 MW	43.3 MW
The Bluff	2	3	Most turbines disconnected	41.9 MW	42.2 MW
				476.2 MW	**445.1 MW**

Source: Adapted from AEMO[121]

As noted in AEMO's reports, voltage ride-through settings are unique to each wind farm, and are established by the wind farm operator in consultation with the turbine manufacturer. In light of the Black System event, it is understood the wind farm operators and turbine manufacturers are working to propose improved voltage ride through settings for consideration by AEMO and a number of wind farms have already implemented changes.

It is understood the prior to the event, the simultaneous loss of these wind farms was not considered as a credible contingency event by AEMO. Following the event, the simultaneous loss was reclassified as a credible contingency event. The Panel notes that where credible contingencies exist, AEMO will incorporate these in its approach to managing system security.

[121] AEMO 2016i

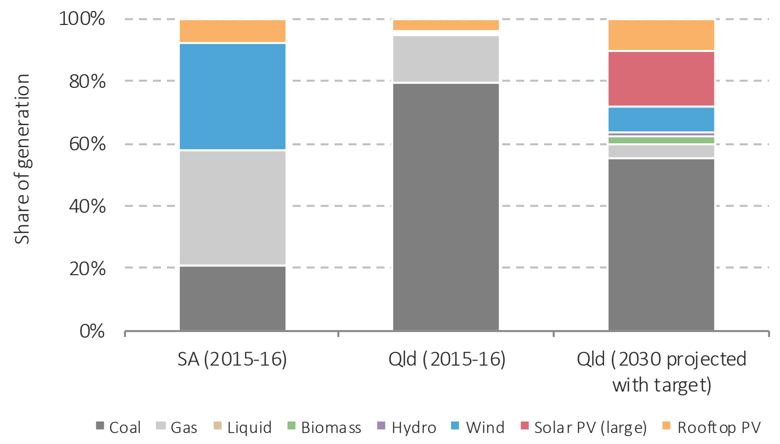
10.3. Outcomes for Queensland

In contrast to the South Australian experience, in Queensland coal generation is expected to continue to play a significant role to 2030 under a 50% renewable energy target. Modelling from Jacobs has projected that 50% of Queensland's energy can be supplied by wind and solar technologies (plus existing biomass and hydro technologies) by 2030, while meeting or exceeding today's reliability standard in Queensland. AEMO does not project any reliability concerns for Queensland in a scenario meeting Australia's emissions reduction targets, but not including Queensland's 50% renewable energy target[122].

It is expected that the existing coal and gas generation fleet will continue to provide significant value to the grid. No closures are projected in Jacobs' modelling as the result of the introduction of a 50% renewable generation target in Queensland, and only 1,500 MW of Queensland coal generation is projected to close to meet the target of a 45% reduction in NEM emissions relative to 2005 levels in the *Stronger National Action* pathway (see Section 7.2.1).

Gas generation is expected to only contribute 5% of Queensland's annual generation under the *Linear* and *Ramp* pathways to 50% renewable energy, primarily in a peaking role. This limits the effect of rising gas prices on Queensland wholesale NEM prices, and introducing renewable generation is projected to reduce Queensland wholesale prices, although prices are sensitive to a range of factors, including any additional closures of coal-fired plant[123].

Figure 40: Generation mix in South Australia and Queensland, historical and projected in 2030 (*Linear* pathway to 50% renewable energy[124])



Source: NEM Review and Jacobs analysis

During times of low wind and solar output, Queensland's energy is expected to continue to be supplied by existing coal and gas generation as well as by hydro power stations and potentially also by a modest amount of newly constructed behind-the-meter battery storage.

The value of existing capacity will be increased if plant operators can operate in a more flexible fashion, ensuring their availability at times of high demand or low availability of renewable generation. For example, the United States National Renewable Energy Laboratory is undertaking a research program into operating coal power stations at lower output and with more efficient cycling[125], delivering positive NPV outcomes for generators.

[122] AEMO 2016b

[123] Gas generation supplies up to 20% of Queensland generation under the Stronger national action scenario where additional emissions abatement across the NEM is targeted

[124] This figure describes only generation within Queensland and does not include Queensland's pro-rata share of the RET or consider Queensland electricity imports and exports. It is therefore not directly comparable with the 50% renewable energy target.

[125] Cochran, J Lew, D Kumar, N 2013

When the loss of the QNI interconnector to New South Wales is not considered a credible contingency, there are unlikely to be fundamental barriers to achieving high instantaneous penetrations of renewable generation in Queensland, based on AEMO's analysis of the South Australian grid. If there is a risk that the QNI interconnector will be unavailable, AEMO may need to source FCAS locally within Queensland, which could represent a higher cost at those times. This point was highlighted by a number of stakeholders in consultation on the Draft Report[126], including suggestions that these costs should be made explicit.

The Panel acknowledges that AEMO will continue to monitor and investigate system security issues across Queensland and the NEM, and will apply appropriate constraints if required to ensure system security.

Impact of coal closures

Jacobs' modelling does not project coal closures over the study period under the *Linear* and *Ramp* pathways. However, the Panel notes that there could be additional drivers not captured within the modelling, such as strategies for improving overall portfolio revenue or the need for additional capital expenditure to maintain plant lifetimes, that could result in the closure of additional coal units by 2030. In addition, more stringent emission reduction policies (as modelled under the *Stronger National Action* pathway) could all influence the closure of coal units. The Panel expects that such additional closures would be limited, as closures would improve revenue outcomes for the remaining generators.

In its submission on the Draft Report, AEMO notes that market modelling of this nature tends not to fully capture the constraints on the physical operation of coal-fired generators. These constraints may include minimum generation levels or the ability for coal-fired plant to respond to changes in output from renewable energy generators. AEMO suggests that these constraints could make coal-fired generators being less profitable than projected under conventional market modelling, potentially leading to earlier exit from the market.

While the Panel has considered the effect on wholesale prices due to early retirement (Chapter 8), the Panel acknowledges that additional modelling should be undertaken to understand the physical operation of coal-fired generation as the penetration of renewable energy (specifically intermittent generation) increases in Queensland.

In the broader NEM, if the market experienced a sudden and unexpected exit of existing generation capacity, this could result in insufficient capacity being available during some periods, or significantly higher prices. This could be considered a credible risk if the market did not anticipate plant closures and there was insufficient certainty to justify investment in new generation. However, the Panel expects that given the spread and ownership (including government ownership) of Queensland generation, the sudden and unexpected exit of large amounts of generation is unlikely.

10.4. Future work and emerging solutions

The Paris Agreement requires signatory countries to increase their emission reduction commitments over time. This and other factors may lead to greater Federal and state action to reduce emissions in Australia. The cost of renewable energy technologies is projected to decline over time, while much of Queensland's coal generation capacity will be over 30 years old by 2030 and some of it will be approaching the end of its operating life. The Queensland Government could consider in advance how the demands on the electricity market will change and ensure this policy facilitates managing larger proportions of renewable energy beyond 2030. This could include support for research and development, or creating incentives for the development of technologies that balance the intermittency of solar and wind.

While this Report is focused on the period up to 2030, the Panel is conscious that the outcomes of any Queensland renewable energy policies will have implications for the Queensland energy system well into the future. Given the likely outcomes of increased renewable energy in Queensland and across the NEM, there is a substantial body of work that is being undertaken to ensure that system security and reliability will be maintained.

[126] AGL, Aurizon, Energy Users Association of Australia, Electrical Trades Union, Origin, Powerlink

10.4.1. AEMO's Future Power Systems Security Program

The Panel is aware that AEMO is undertaking significant work to further investigate the system security issues and associated risks as part of their Future Power Systems Security program. Potential solutions under consideration by similar markets around the world include:

- Sourcing contingency services that can respond on even shorter timeframes (within 500ms), particularly energy storage
- Implementing markets to incentivise generators able to provide inertia to be available at key times
- Sourcing "synthetic inertia" from wind farms, which temporarily draws extra kinetic energy from the wind blades; this feature is not currently enabled in Australia, and requires specially designed systems
- Limiting the operation of renewable generation during some periods to ensure sufficient inertia from conventional generators is available
- Encouraging synchronous renewable generation such as biomass, solar thermal and hydro power
- Installing synchronous condensers that provide inertia[127]
- Building additional interconnection which would further reduce the credibility of a disconnection (islanding) event.

Many of the issues identified for integrating renewable generation only become significant when higher penetrations of renewable energy are achieved. The Panel is confident that AEMO currently has the power and systems to ensure that adequate amounts of ancillary and security services will be procured where it is available. In the longer term the market and AEMO may need to develop new markets for services such as inertia and voltage control to maintain a stable system voltage both pre and post contingency. Explicit markets will allow developers to price and value such services and would be expected to encourage innovative solutions to some of the more unique issues that may arise as the penetration of renewable generation increases.

10.4.2. Review of Australia's National Energy Market

On 7 October 2016 it was announced that Dr Alan Finkel, Australia's Chief Scientist, will chair a review of Australia's National Energy Market. The review is expected to deliver a preliminary report to the COAG by December 2016, and a final report in early 2017.

Following the release of the Draft Report, the Panel met with the Dr Finkel and members of the review panel to discuss the work program and potential implications for Queensland. The Panel is aware that the Queensland Government is supporting the Finkel review and considers the Queensland Government should consider the outcomes of the review at its completion.

10.5. Options to enhance uptake of small-scale renewable energy generation

As noted in Chapter 5, further growth in small-scale (predominantly household) renewable energy is expected in Queensland with recent market modelling projecting Queensland could reach over 5,000 MW of rooftop PV by 2030[128] (an effective tripling of Queensland's current rooftop PV capacity).

The Panel notes there are some areas of the Energex and Ergon Energy's networks which already support very high rates of rooftop PV penetration, such as the Glasshouse (58%), Redlands (56%) and Caloundra (53%) regions[129]. Should growth in rooftop PV eventuate in Queensland, the distribution networks will be required to manage higher rates of solar penetration across more elements of the distribution network.

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[127] In its submission to the Panel's Issues Paper, Aurecon highlighted that a new market is emerging in the United States for the conversion of coal-fired generators into synchronous condensers. According to Aurecon, this provides a market service that can compensate for system reactive changes and maintain the required system voltage set point with high penetration of renewables and withdrawal of coal generation.

[128] Jacobs 2016

[129] Australian PV Institute 2016

10.5.1. Technical integration issues

The rapid uptake of small-scale renewable energy systems in Queensland has effected the operation and management of the distribution networks. As noted by Energex in its 2015-20 Regulatory Proposal[130]:

> *The increased penetration of Solar PV is leading to a large number of distribution transformers with high solar PV penetration, 11 kV feeders with very little load during the middle of the day and in some cases, 11 kV feeders experiencing reverse power flow…. Energex has traditionally relied on maximum demand indicators to identify limitations on distribution transformers. The growth in solar PV and the increasing levels of reverse power flows between the LV and 11 kV networks means this approach is no longer adequate. Energex has initiated the roll out of distribution transformer monitoring to enable the collection of measured data including demand and voltage.*

Despite these challenges, throughout the public forums stakeholders consistently raised issues associated with connecting small to medium-scale renewable energy to the network. In particular, stakeholders cited onerous assessment processes and limitations on export capabilities. In addition, a number of submissions on the Issues Paper noted the need for improvements to the regulatory framework to facilitate improved levels of uptake at the small and medium-scale.

The Panel understands the Queensland Government is currently investigating options to address the regulatory and commercial constraints to greater uptake of small and medium-scale solar PV. The key initiatives include:

- Aligning Queensland's statutory voltage limits with international standards so that Energex and Ergon Energy's networks can host more solar PV without driving additional network augmentation costs
- Introducing best practice technical requirements for grid connection of solar PV in order to better balance the operating needs of the network, with lower connection costs for solar customers
- Simplifying grid connection information about contracts, processes, costs, and timeframes and customer responsibilities
- Considering the efficiency, costs and benefits of a framework where accredited solar installers self-assess low risk grid connections work.

Collecting and storing data on embedded generation

As noted in Chapter 4, AEMO has identified the limited visibility of embedded generation as a key challenge in operating the network. As noted by AEMO in its submission on the Issues Paper:

> *When [Distributed Energy Resources] supply a large proportion of the total electricity demand, they displace scheduled generation and therefore reduce the level of operational control that AEMO has to manage events. While individually small, in aggregate DER can be significant contributors to generation and load shifting.*

In its submission on the Issues Paper, AEMO also highlighted the importance of ensuring that data is collected and stored on new embedded generation systems (including the location, size and technical capabilities). By having a better understanding of how small-scale renewables are being used, AEMO considered it would be able to better manage security and reliability under different conditions.

[130] Energex 2014

On this basis, the Panel is of the view the Queensland Government should facilitate the collection and disclosure of data on embedded systems to assist AEMO in managing power system security and reliability, to the extent this data is not collected by other organisations such as the Clean Energy Regulator.

The role of battery storage

The role of battery storage was raised consistently throughout the Panel's consultation process. While batteries may not necessarily increase the overall level of renewable energy in the system, they could play a critical role in how renewable energy interacts with the grid. Importantly, the deployment of battery storage technologies can help to utilise the electricity produced by small to medium-scale renewables at times of peak demand, which is beneficial to the operation of the grid.

The electricity market modelling for the Panel assumes a modest rate of uptake of small-scale battery systems over the period to 2020 and notes that this is consistent with the projections used by AEMO. However, the Panel notes that these assumptions could change significantly if the costs of battery technologies were to reduce faster than expected. Further, the Panel reiterates the cautions outlined in section 8.4 regarding uncontrolled uptake of distributed batteries without appropriate recognition of the control system problem, and the necessary regulatory and standard reform to prevent considerable negative unintended consequences.

The role of control systems

Further to the role battery storage could play in the electricity market and the potential issues associated with uptake and integration of small-scale and commercial/industrial-scale renewable energy across Queensland's distribution networks, the Panel notes the important role advanced control systems could play in the continued deployment of small-scale renewable generation. Control systems are a combination of software and hardware that allow households or businesses to control, manage and monitor their energy usage and make more efficient use of energy resources.

At the household level, the optimisation of solar-PV and battery systems is the focus of these developments. Further, advanced control systems allow for the aggregation of a large number of individual networks into a smart grid which can optimise the dispatch of distributed energy resources, linking retail to wholesale markets. Finally, control systems create opportunities for distributors to better manage grid stability across their individual networks, through the provision of stabilising services such as voltage and frequency control services.

Control systems technologies can also be deployed at the low-voltage distribution network level. In some cases, control systems integrated within the low-voltage distribution network can monitor and regulate the condition of the network, including improving voltage quality and frequency stability. Control systems deployed in this way have the benefit of allowing a much higher penetration of rooftop PV as they provide ancillary services on the distribution network, which does not currently occur.

10.5.2. Customer experience

Energex highlighted particular customer segments where there are barriers to market participation including rental tenants and unit dwellers[131]. Energex suggests these customers are disadvantaged as they are unlikely to have any control over the decision whether or not to install solar PV systems, as the decision either rests with the landlord or the premise has no roofline or a shared roofline.

The Queensland Government, through participation in the COAG Energy Council, is also supporting a range of measures under the National Energy Productivity Plan, some of which are expected to facilitate uptake of small and medium-scale solar PV[132]. These include:

- Ongoing network tariff reform to support better price signals for network investment, to provide greater options for consumers to manage their energy usage and to facilitate the integration of new technologies

[131] This refers to the so called problem of "split Incentives". In the case of rooftop solar, the person who owns the house and would therefore own the rooftop solar installation, does not pay the electricity bill.
[132] COAG Energy Council 2015

- Supporting customer choice by developing tools and information packages to assist customers in navigating increasingly complex energy product offerings
- Supporting vulnerable consumers (indigenous, low income earners, remote, elderly) by developing best practice voluntary guidelines for service providers to seek to reduce the barriers to vulnerable consumers effectively engaging with energy productivity measures and services
- Helping small and medium sized businesses to self-manage energy costs. The Commonwealth Government is consulting with businesses to develop options to provide further tailored information, support networks and skilled service providers in partnership with relevant business associations.

The Panel recommends that the Queensland Government continue to explore ways to work co-operatively with other State and Federal Governments on measures to enhance customer uptake of renewable energy systems, so as to avoid duplication of effort and inconsistent approaches across jurisdictions.

10.5.3. Solar PV in government sector

In terms of opportunities for facilitating future growth in small-scale solar PV in the period up to 2020, submissions from the Australian Conservation Foundation, Electrical Trades Union and Origin identified the use of solar PV on buildings owned and/or leased by government.

The Queensland Government has a substantial property portfolio across the state, which provide a wide-range of functions and services to the community. Examples of government buildings include houses and apartments, community centres, schools, TAFEs, large buildings and hospitals. Currently, around 9 MW of solar PV is installed across the Government's property portfolio.

The Queensland Government is also one of the largest electricity customers in the State, consuming around 3% of total state usage with significant electricity costs especially across the health and education portfolios.

Where it is cost effective to do so, the Panel considers there is merit in the Queensland Government investigating the use of solar PV on state-owned buildings. This has the potential to deliver a range of benefits, including:

- Providing value to Government by reducing its operating costs
- Sharing project learnings, which may assist in removing barriers to solar PV uptake particularly in commercial and industrial applications
- Assisting in the deferral or avoidance of network augmentation costs as well as supporting network services in fringe-of-grid or off-grid applications
- Contributing to meeting the Government's target of 3,000 MW solar PV by 2020.

While electricity retailers will have a range of energy product offerings available in market, the Queensland Government may consider putting aggregated government load blocks (e.g., schools) out to tender to enhance project efficiencies for both the Government and energy providers bidding for the contracts. This concept was highlighted by Aurecon in its submission on the Issues Paper, who also highlighted the potential for Government to facilitate tender processes on behalf of local councils in order to increase the volume of load procured from renewable energy sources.

The Panel also suggests that Government consider the use of solar PV on government buildings in the context of broader State and Federal Government policies designed to encourage energy productivity (efficiency) in the built environment.

11. Supporting economic development

Findings

- While achieving a 50% renewable energy target in Queensland represents a significant shift within the electricity sector, economic modelling indicates it does not result in a major effect across the whole economy. Based on the *Linear* pathway, GSP is projected to be 0.2% higher in 2030 compared with the *Base case* (i.e., $5.4 billion NPV higher). However, GDP is projected to remain unchanged in the period to 2030 due to reductions in GSP in other jurisdictions.
- The benefits to the Queensland economy are largely driven by the additional investment in renewable energy, estimated at $6.7 billion (NPV) to 2030, which will be captured primarily in direct construction and construction services. There is a shift from fossil fuels to renewable energy generation, with a reduction in real value added (RVA) from the electricity generation sector.
- The modelling projects a 50% target will deliver a net increase in employment in Queensland, with around 6,400-6,700 additional FTEs employed on average between 2020 and 2030 (primarily relating to construction) under the *Linear* and *Ramp* pathways (compared with the *Base case*). This increase in employment in Queensland is offset by reductions in other jurisdictions with no net projected increase in employment nationally.
- The majority of the economic benefits in Queensland are driven by the increased investment in renewable energy capacity. The modelled reduction in electricity prices contributes around 15-20% of the benefits to the Queensland economy. While the rest of Australia benefits from the modelled lower electricity prices, these benefits are more than offset by the projected loss of investment across the rest of Australia.
- While the majority of manufactured components are likely to be imported, there are opportunities for Queensland to capture an increased share of overall investment in renewable energy projects by improving the competitiveness of its relevant supply chain industries. Key opportunities exist in development and design, fabrication, construction and financing.
- Policy initiatives have been utilised in Australia and internationally to increase the competitiveness of local renewable energy supply chains, focusing on improving the skills and capability within local businesses, ensuring local businesses have opportunities to participate in the development of projects and incentivising international businesses to establish operations in local markets.
- The unique characteristics of Queensland's electricity supply system means that Queensland businesses may be well placed to export expertise and services relating to fringe-of-grid and isolated network applications, including medium-scale renewable plant and more advanced network solutions for high penetration of distributed renewables.
- The transition to renewable energy would, over the long term, have implications for communities that currently rely on fossil fuel generators for direct and indirect employment and income. However, it is likely that future investment in renewable energy will occur in regional Queensland to offset some of these effects.
- The Government has a role to play in supporting the communities and industries through the transition. Primarily, the Government can influence the pace of the transition, but also has a role in working with relevant bodies to develop the future workforce requirements and shaping the regulatory environment.

Recommendations

- The Panel recommends Queensland Government engage with Queensland secondary and tertiary education institutions to identify opportunities for research in relevant renewable energy supply chain industries.
- The Panel recommends the Government includes consideration of local content as part of any reverse auction process to ensure that local businesses are provided the opportunity to compete for the development of renewable energy projects in Queensland.
- The Panel recommends the Government seek to promote investment opportunities in the Queensland renewable industry through its international partnerships and agreements, including developing incentives for attracting international firms to the state.

As part of its Terms of Reference, the Panel is required to identify:

- What complementary policy instruments could be implemented to support the development of Queensland's renewable energy economy
- How a target and any complementary policy measures can be co-ordinated to maximise the benefits to the Queensland economy - this should include specific reference to:
  - Job creation and skills development
  - Local manufacturing
  - The ability to export products and skills.

In addressing these requirements, the Panel has examined how increased investment in renewable energy projects may flow into the Queensland economy. This assessment has a focus on the changes in employment that might result and in a more qualitative sense, the effect on regional areas. The Panel has examined Queensland's renewable energy supply chain to identify areas where Queensland might be able to extract further economic benefit and generate additional benefit and generate additional activity.

The Panel has also assessed the need to provide specific support to affected communities and industries to assist in the transition to a lower emissions electricity generation sector.

11.1. Economic effects of renewable energy investment

While the analysis included in Chapter 8 assesses the effects of the 50% renewable energy target in the electricity sector, it is important to consider the effect of the policy through the broader Queensland economy. There are a range of factors that must be considered including the effects of direct investment in renewable energy, the changing output from existing generation and the effect of electricity price changes. These factors will influence economic activity at a national, state and industry level.

To understand the economic effects associated with the policy, the Panel engaged the CoPS at Victoria University to undertake economy wide modelling using a computable general equilibrium model (CGE). CoPS utilises the Victoria University Regional Model (VURM), which is a dynamic economic model of Australia's six states and two territories. It models each region as an economy in its own right (i.e. the model contains region-specific prices, consumers, industries). The benefit of incorporating analysis using VURM is that it allows the Panel to assess the direct and indirect economic effects of the policy. VURM is also able to incorporate the economic effects associated with the detailed electricity market modelling results from Jacobs.

As with the electricity market modelling, the Panel considers it appropriate to apply a proxy carbon emissions reduction cost across the economy as part of modelling. For consistency and to ensure that the economic modelling is isolating the effect of this policy, CoPS was requested to apply the same proxy carbon emissions reduction cost as was used in the electricity market modelling. This carbon price approximately reflects the level of emissions reduction required in the electricity sector to reduce electricity sector emissions to 26-28% below 2005 levels, consistent with Australia's 2030 commitment under the Paris Agreement. To the extent that the CGE modelling projects a shortfall in economy wide emission's reductions against the Paris Agreement commitment, the model incorporates direct and indirect effects from purchasing any shortfall via international markets using the above specified carbon price as the internationally traded price.

11.1.1. Overall effects

While achieving a 50% renewable energy target in Queensland will represent a significant shift within the electricity sector, the economic modelling indicates the economy wide effects of the policy are relatively modest. Table 21 sets out the key economic outcomes under both the *Linear* and *Ramp* pathways. The results presented are broadly similar under both pathways, reflecting the effect of the policy overall. For simplicity, the discussion in this chapter focuses on the outcomes under the *Linear* pathway, except where there are relevant differences between the outcomes.

Unless otherwise stated, all financial figures are in real July 2016 dollars, and total figures over the study period (from 2016 to 2030) are presented as discounted present values as a standard discount rate of 7%.

Table 21: Key economic outcomes for Queensland relative to the *Base case* ($, NPV 2020-2030)

	Linear pathway	*Ramp* pathway
QLD Gross State Product	$5.4 billion NPV	$5.2 billion
QLD Gross state Income	$5.3 billion NPV	$5.3 billion
QLD Real Value Add	$4.1 billion NPV	$4.1 billion
QLD peak net additional employment	10,200 FTEs	13,900 FTEs
QLD average net additional annual employment	6,400 FTEs	6,700 FTEs
QLD Investment	$6.7 billion NPV	$6.1 billion
Imports to QLD	$1.2 billion NPV	$1.2 billion

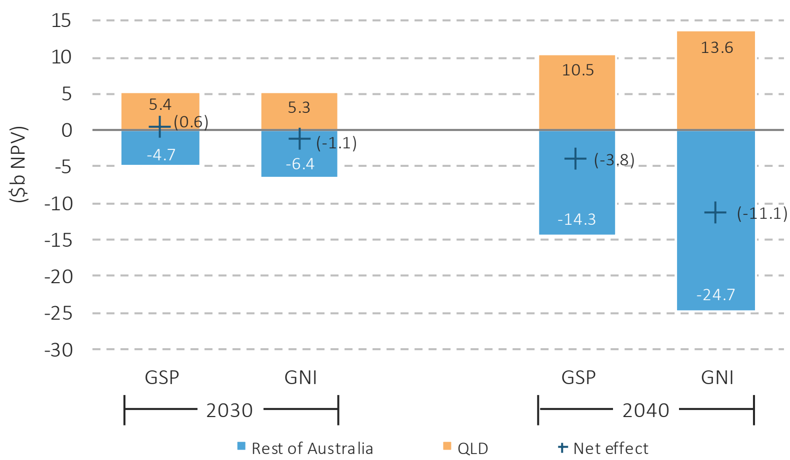
Source: CoPS analysis

Achieving the 50% target is projected to have a minor but positive effect on the Queensland economy, with GSP projected to be 0.2% higher in 2030 compared with the *Base case* (or $5.4 billion in NPV between 2020 and 2030). Similarly, Gross State Income (GSI) to the Queensland economy is projected to be around 0.4% higher by 2030 (or $5.3 billion in NPV over the period).

However, the benefits for the Queensland economy resulting from the 50% target are expected to be offset by negative effects in the rest of the Australian economy, meaning that overall GDP is projected to remain largely unchanged in the period to 2030 (increase of $0.6 billion NPV in 2030). This is due to a reduction of $4.7 billion NPV in GDP across the rest of Australia.

Similarly, Gross National Income (GNI) is projected to be around 0.1% lower by 2030 (or -$1.1 billion NPV over the period) reflecting a loss of GNI of $6.4 billion in NPV across the rest of Australia). Over the longer term, GDP is projected to be 0.01% lower (or -$3.8 billion in NPV) and GNI 0.04% lower (or -$11.1 billion in NPV) than the *Base case* by 2040. These outcomes are illustrated in Figure 41 (*Linear* pathway shown).

Figure 41: Net change in GSP and GDP (*Linear* pathway), 2016-2030 and 2016-2040 ($ billion, NPV)



Source: CoPS analysis

These results are consistent with expectations as the subsidisation of renewable energy into Queensland in effect diverts more efficient investments (from both the electricity and other sectors) from other states and territories to Queensland resulting in a gain in Queensland GSP but a loss of economic activity across the rest of Australia. Under the modelling outcomes, these subsidised investments in effect reduce capital and labour productivity over time, leading to lower incomes, investment and GDP.

The potential benefits to the Queensland economy are largely driven by the additional investment in renewable energy. As identified in Chapter 8, there is projected to be significant additions of renewable energy in Queensland on an annual basis to 2030. This is reflected in a significant increase in investment over the period to 2030 of $6.7 billion in NPV under the *Linear* pathway. The overall investment is projected to be around 10% lower under the *Ramp* pathway ($6.1 billion in NPV), reflecting the fact that investment is undertaken later in the period.

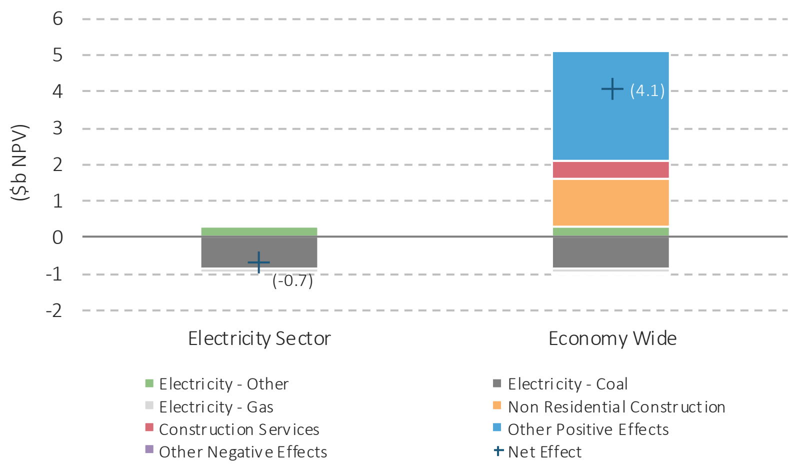
It is important to note that not all of the increased investment is captured within the Queensland economy. The modelling by CoPS indicates that imports of products and service to Queensland will increase as a result of the policy, with the value of imports projected to increase by $1.2 billion in NPV terms over the period to 2030.

11.1.2. Industry effects

While the modelling projects there will be modest effects on GSP and GSI, it projects that there will be more substantive shifts in Queensland at the industry level. Within the electricity sector, the modelling projects there would be a broad shift from coal and gas-fired generation to renewable energy generation (consistent with the policy objectives), with an overall reduction in Real Value Added (RVA) from the electricity generation sector of $0.7 billion in NPV to 2030.

However, the modelling also indicates that the capital investment in renewable energy will be captured in other industries, particularly in direct construction and supporting industries. The modelling projects an increase in RVA in the non-residential construction industry of $1.4 billion in NPV to 2030 while the construction services industry is projected to increase by $0.5 billion in NPV to 2030. The relative effects on all industries are shown in Figure 42 (*Linear* pathway shown), with key industries highlighted.

Figure 42: Real value added by industry segment in Queensland (*Linear* pathway), 2016-2030 ($ billion, NPV)



Source: CoPS analysis

Increased investment in renewable energy would also be expected to affect employment in Queensland within the electricity sector and the economy as a whole. Overall, the modelling projects a net increase in employment in Queensland between 2020 and 2030, with around 6,400 additional FTEs on average between 2020 and 2030 in Queensland compared with the *Base case* (peaking at 10,200 in 2030). It should be noted that the average additional annual employment figure will vary year-on-year but employment is projected to be higher in Queensland in each year between 2020 and 2030 compared with the *Base case*.

Given the different investment profile under the *Ramp* pathway, employment effects are also different compared with the *Linear* pathway. Queensland peak employment is higher under the *Ramp* pathway, with nearly 14,000 more FTEs projected in 2030 compared with the *Base case*, with Queensland average annual employment projected to be around 6,700 higher over the period.

It should also be noted that as with other economic indicators, this increase in employment in Queensland is offset by reductions elsewhere in the National economy with in effect no net change in jobs nationally (i.e. the policy in effect diverts employment from other states and territories to Queensland).

In line with the projected RVA outcomes, the modelling indicates that employment related to coal and gas-fired generation would reduce in-line with reduced generation output in those sectors, while employment in renewable energy generation will increase. The Panel notes that overall, there is projected to be a net reduction in employment in the electricity sector (i.e., the projected gain in renewable energy jobs is less than the projected loss of other electricity sector jobs).

Similarly, the modelling indicates a shift in employment from operational employment in the energy sector to construction and associated industries that will be required to develop projects.

11.1.3. Sensitivity analysis – electricity price effects

The Panel notes that there are two broad effects causing these results in the Queensland economy:

- The effect of lower electricity prices in the broader economy
- The effect of subsidising increased investment in renewable energy in Queensland.

The modelling undertaken by Jacobs indicates that wholesale electricity prices in Queensland would be lower as a result of the 50% target. As a result, the modelling undertaken by CoPS projects there would be positive effects throughout the economy resulting from lower wholesale electricity prices (which are in effect reflected as lower input costs to the economy). However, the Panel notes that this outcome is highly sensitive to the electricity price outcomes modelled by Jacobs. Should there be a change to this assumption, for example, an increase in wholesale prices due to the retirement of coal-fired generation capacity, these outcomes would likely be different.

Sensitivity analysis has been undertaken to remove the effects of lower electricity prices in order to understand the specific effects of the 50% policy. The headline results are presented in Table 22.

Table 22: Comparison of economic outcomes after removing electricity price effects (*Linear* pathway)

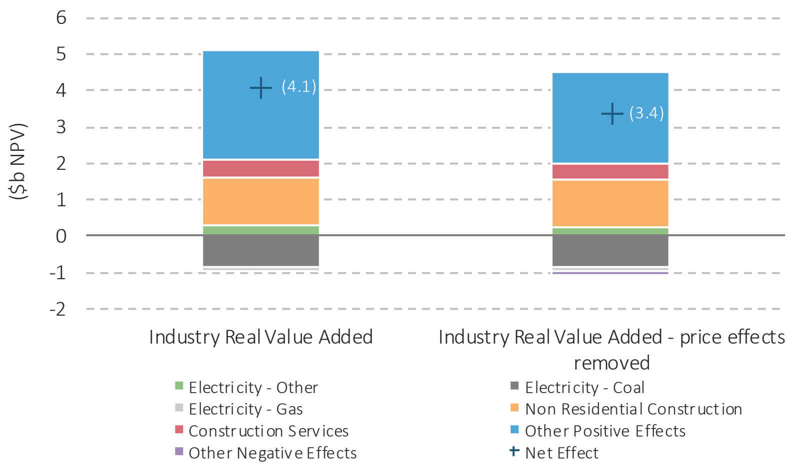
	Linear pathway	*Linear* pathway – electricity price effects removed	Difference
Change in QLD Gross State Product	$5.4 billion NPV	$4.5 billion NPV	$0.9 billion NPV (17%)
Change in QLD Gross state income	$5.3 billion NPV	$4.6 billion NPV	$0.7 billion NPV (13%)
Change in QLD Real Value Add	$4.1 billion NPV	$3.4 billion NPV	$0.7 billion NPV (17%)
QLD peak net additional employment	10,200 FTEs	7,900 FTEs	2,300 FTEs (23%)
QLD average net additional annual employment	6,400 FTEs	5,500 FTEs	900 FTEs (14%)
Change in QLD investment	$6.7 billion NPV	$6.2 billion NPV	$0.5 billion NPV (7%)
Change in imports to QLD	$1.2 billion NPV	$1.0 billion NPV	$0.2 billion NPV (17%)

Source: CoPS analysis

This analysis indicates that while the reduction in electricity prices has notable effect on the Queensland economy, the majority of the economic benefits are driven by the increased investment in renewable energy capacity. The sensitivity analysis indicates that the increase in GSP between 2020 and 2030 is projected to be around $4.5 billion (around 17% lower than under the Linear pathway), with a similar effect on GSI.

The removal of the pricing effects further highlights the sectors of the Queensland economy that are directly affected by a 50% renewable energy target. The effects in the electricity sector are largely unchanged (i.e. RVA for coal and gas-fired generation projected to reduce and RVA for renewable energy projected to increase), while the non-residential construction and construction service industries remain the primary beneficiaries. The overall effects are shown in Figure 43.

Figure 43: Comparison of Real value added by industry segment in Queensland after removing electricity price effects (Linear pathway) 2016-2030 ($ billion, NPV)



Source: CoPS analysis

11.2. Opportunities to leverage future investment

In order to understand the opportunity to leverage the future investment associated with a 50% renewable energy target, the Panel has examined Queensland's renewable energy supply chain to identify the State's ability to capture a greater proportion of the overall investment.

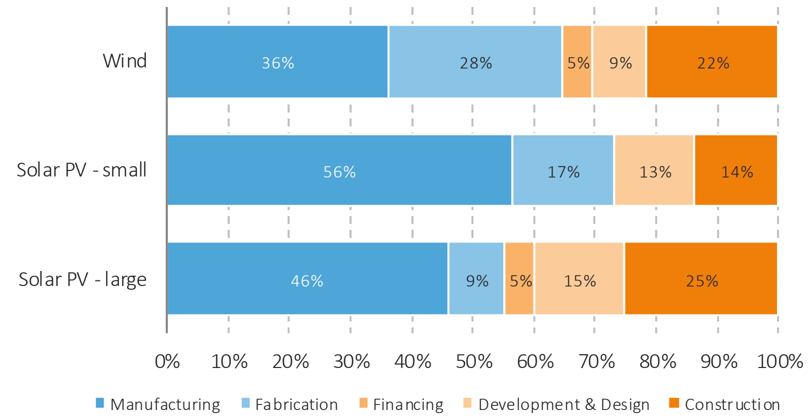
The Panel engaged KPMG to undertake an indicative analysis of Queensland's renewable energy supply chain, focusing on the development and construction of projects (i.e. upfront capital cost elements). The analysis was limited to the three primary technologies (large and small-scale solar PV as well as wind) based on the finding of the electricity market modelling prepared by Jacobs.

The KPMG analysis analysed the opportunity based upon the following renewable energy supply chain elements:

- *Development and design:* Direct development costs inclusive of resource studies, site design and planning, grid studies, land access including consideration of native title, natural heritage, and grid connection
- *Manufacturing:* Complex manufactured renewable energy technology including primary solar components, turbines, modules and inverters
- *Fabrication:* Fabrication of wind turbine towers, frames for mounting solar panels and preparation of cabling and other componentry
- *Construction:* Undertaking construction and assembly activities including civil works. This includes the labour component associated with project construction
- *Financing:* Transaction costs associated with the provision of debt and equity finance to projects. This does not include financial returns to debt and equity providers.

Figure 44 summarises the relative proportions of indicative capital expenditure along each element of the supply chain for large and small-scale solar PV along with wind energy.

Figure 44: Proportions of capital expenditure across the supply chain



Source: KPMG analysis

The Panel notes that there may be other technologies that may contribute to the Queensland target. Should this mix change then the potential for supply chain capture in Queensland would be a function of the actual technology deployed. For example, some technologies could involve greater Queensland-based construction activity while others could involve greater ongoing economic activity over the life of the asset (e.g. biomass generation from bagasse). Similarly, the potential for Queensland to generate export opportunities varies by technology with distributed generation systems being identified as a potential opportunity.

11.2.1. Queensland's current position

The ability for Queensland to capture value in each part of the supply chain will vary depending upon the technology type, location of deployment, plant size and ancillary considerations such as financing approach and electricity offtake arrangements. Although construction will take place in Queensland, the renewable energy value chain is globally diversified with main component manufacture occurring overseas. For these components, capital will flow to interstate or international companies.

KPMG has analysed Queensland industry's competitive position relative to non-Queensland industry under five categories for each supply chain element. Each category indicates the extent to which Queensland is likely to capture the renewable energy supply chain opportunity from a market leading position through to no market position:

- *Market leading position:* There are no barriers to the Queensland industry segment capturing expenditure in the supply chain and the Queensland industry segment is a leader in the category of expenditure
- *Competitive market position:* There are limited barriers to the Queensland industry segment capturing expenditure in the supply chain but the Queensland industry segment is able to effectively compete in the category of expenditure
- *Uncompetitive market position:* There are potentially challenging barriers to the Queensland industry segment capturing expenditure in the supply chain. The Queensland industry segment may not be able to effectively compete in the category of expenditure.
- *Challenging market position:* There are significant barriers to the Queensland industry segment capturing expenditure in the supply chain. The Queensland industry segment is unlikely to be able to compete in the category of expenditure.
- *No market position:* The Queensland industry segment has no participation in the category of expenditure.

At present, Queensland has a somewhat limited ability to capture the investment associated with the deployment of new renewable energy capacity. Queensland has no market position or is considered uncompetitive in manufacturing of major componentry, fabrication and financing – which comprise around 60-70% of overall capital investment. Queensland is considered to be competitive in development and design and construction, but this does not guarantee that Queensland firms will be able to capture the capital expenditure associated with these supply chain elements.

Table 23 presents the assessment of Queensland's market position along the renewable energy supply chain.

Table 23: Queensland renewable energy supply chain current market position

Element	Current Queensland position	Assessment
Development and design	Competitive	▶ A significant portion of the development and design work is undertaken within Queensland. However, certain aspects of project development are currently undertaken interstate. Some developers are establishing a presence in Queensland to reduce development costs and local consultancy support services will also be required on an ongoing basis.
Manufacturing	No market position	▶ Solar PV modules, wind turbine componentry, major solar components and PV inverters are imported from Asia with a limited stock of inverters being imported from Victoria.
Fabrication	Uncompetitive	▶ Queensland firms currently supply frames and cabling however these are currently more costly than imported products. Interstate firms are active in marketing the fabrication of wind turbine towers, however, these Australian firms are less competitive relative to imported towers.
Construction (including labour)	Competitive	▶ All construction activities will be undertaken in Queensland. Engineering, Procurement and Construction (EPC) providers may be foreign firms seeking to leverage expertise obtained in more developed renewable energy markets.
Financing	Uncompetitive	▶ The majority of providers are located interstate. The CEFC and QIC have operations in Brisbane. New entrants expressed a willingness to establish operations in Queensland due to the proximity to future projects.

Source: KPMG analysis

11.2.2. Capturing increased investment in Queensland

While Queensland has had limited investment in large-scale renewable energy, this would change dramatically if a 50% renewable energy target is implemented. While this will naturally result in increased investment in some supply chain categories, there is a significant opportunity to capture a greater share of the investment in Queensland.

KPMG's analysis indicates that by improving the competitiveness of Queensland's supply chain, around 30% of the total investment in large-scale solar PV, approximately 35% of the total investment in wind generation, and 40% of the total investment in small-scale solar PV could flow directly into the Queensland economy, in particular within the elements of development and design and construction.

It is important to note that these figures effectively represent the maximum levels of investment capture in these technologies. These figures are contingent on Queensland improving the competitiveness of the identified supply chain elements and therefore the levels of investment flowing directly to the Queensland economy may be lower in the early stages of the 50% target. As noted above, these figures also depend upon the technology mix that is ultimately deployed.

Improving Queensland's market position

Manufacturing is likely to be the largest cost component of any renewable energy project, compromising 40-60% of total capital costs. In terms of solar PV modules and wind turbines (blades and hub), the vast majority of these components will likely be imported from overseas, with Asian governments committing significant resources to ensure that they are the lowest cost producers of renewable energy technology.

Overall, it is considered unlikely that Queensland would be able to achieve the economies of scale necessary to compete in this market. This will place a clear limit on the level of overall investment that can be directed into the Queensland economy.

KPMG noted that some solar PV inverters were currently being manufactured interstate but the majority were being imported from overseas (Asian and Europe). The Panel notes that Queensland has had experience with the manufacturing of inverters and that local companies are developing advanced inverter and power systems controllers in small-scale applications. This highlights an opportunity to capture some of the expenditure associated with manufacturing.

Within all other supply chain elements, there is scope for Queensland to improve its position and capture a greater proportion of overall capital expenditure. Development and design, fabrication, construction and financing are the elements where the greatest potential exists and these are discussed in further detail.

Figure 45: Potential shift in Queensland's renewable energy supply chain market position

Supply chain element	Current market position	Potential market position
Development and design	Competitive market position	Market leading position
Manufacturing	No market position	No market position
Fabrication	Uncompetitive market position	Competitive market position
Construction	Competitive market position	Market leading position
Financing	Uncompetitive market position	Competitive market position

Source: KPMG analysis

Development and design

KPMG's assessment indicates that there is an opportunity to transition Queensland from a competitive market position in Development and Design to a market leading position.

Development and design activities in Queensland are generally undertaken by a range of firms including specialist renewable energy developers, utilities, long term investors and construction contractors. This mix of firms includes a range of international firms which have developed experience with renewable energy in other jurisdictions and have sought to capitalise on opportunities in Australia. These firms often rely upon a broad set of advisers including engineering and technical advisers, planning consultants, lawyers and financial advisers.

There are benefits to renewable energy developers associated with undertaking design and development activities in Queensland including proximity to local and state government agencies and working with local advisers (legal, planning and technical) who are familiar with Queensland's laws, regulations and technical requirements. Project developers balance these benefits against the economies of scale and flexibility of having a national or international development team.

With the growth in renewable energy in Australia, firms are seeking to enter or establish additional offices in the Australian market. Attracting these firms to Queensland would increase the portion of the supply chain captured by the Queensland economy. Policy suggestions for attracting these firms are discussed in more detail below.

Fabrication

KPMG's assessment indicates that there may be an opportunity to transition Queensland from an uncompetitive market position in certain fabrication activities to a competitive market position.

Specialist metal fabrication is utilised in two large cost items within the renewable energy supply chain. Specifically:

- Steel frames used for ground and roof mounting solar panels
- Towers for wind turbines.

Queensland firms currently manufacture steel framing for solar projects but feedback from market soundings indicated that pricing was less competitive than sourcing pre-fabricated steel framing from Asia. In Asia, steel framing is mass produced in specialist fabrication facilities whereas Queensland manufacturers are less specialised and have traditionally serviced the construction, resource extraction and agricultural sectors.

Where a suitable opportunity exists it may be possible for Queensland steel fabricators to establish economies of scale that allow them to compete with imported pre-fabricated product. This would present a significant opportunity for these firms. Policy suggestions for unlocking this opportunity are discussed in more detail below.

Given the nature of the fabricated product, a similar opportunity may exist for Queensland firms in relation to wind towers, however, this opportunity in expected to be significantly more challenging. Queensland firms currently have no market position in relation to wind turbine towers and establishing this industry would require new capacity to be established, likely by an international or interstate fabricator.

Construction

KPMG's assessment indicates that there is an opportunity to transition Queensland from a competitive market position in Construction to a market leading position.

Renewable energy construction involves three broad construction related activities:

- Engineering, procurement and construction (EPC) contracting which generally involves a suitably qualified and capitalised head contractor managing the delivery of the entire project on behalf of sponsors and financiers. The EPC contractor generally "wraps" all of the project risk in a manner required by debt financiers, including sourcing the equipment, managing ancillary risks such as foreign exchange and a suite of sub-contract arrangements (e.g. turbine supply, civil works, electrical works).
- Specialist wind turbine erection in the case of a wind farm, often undertaken by a local contractor and supervised by the turbine manufacturer and EPC contractor. Solar is significantly less complex and is generally a semi-skilled construction or assembly activity undertaken by a civil works contractor.
- Civil and electrical works including road, substations, interconnectors, foundations and accommodation construction.

EPC contractors generally charge a margin for managing the suite of contracts and risks associated with a project. In new and less competitive markets, EPC profit margins can be as high as 20% of the total construction cost with margins being as low as 5% in established, competitive markets where risks are well understood.

As a result of its strong local engineering and manufacturing capability, Queensland is expected to capture the majority of construction related activity associated with the renewable energy rollout. There are two opportunities which may allow Queensland to extend this and move towards a market leading position.

First, as experience in other international markets generally shows that local firms capable of providing EPC services are generally at an initial competitive disadvantage relative to firms who have gained experience in interstate and international markets, providing support to existing Queensland firms by increasing their awareness of the opportunity and addressing information asymmetry could increase the portion of EPC margin captured by them.

Second, international renewable energy EPC contractors are currently entering the Australian market. Attracting these EPC firms to Queensland would see a greater share of the EPC margin maintained within the Queensland economy.

Financing

Financing of renewable energy projects involves upfront spending on due diligence and legal expenses. These costs do not include the financing margins which are received by debt and equity providers over the life of the projects but do include upfront fees charged and/or incurred by these financiers.

Queensland already has a strong project finance capability as a result of the long period of intensive mining and gas development activity. This is reflected in skills sets in the banking sector as well as in the legal and consulting sector. While Queensland has not seen the level of renewable project activity that has occurred in the southern states to date, as renewable projects arise Queensland, it would be expected that the existing local project finance expertise would be deployed on those projects. Further, while historically renewable project investors have been based in the southern states, as the number of renewable projects in Queensland grows, there is evidence that some new fund investors are seeking establish the base for their operations in Queensland. Therefore, KPMG's assessment indicates there is opportunity for Queensland to transition from an uncompetitive market position to a competitive position.

11.2.3. Policy options to support supply chain development in Queensland

A range of policies have been identified that could improve the share of the renewable energy supply chain captured by Queensland firms by:

- Increasing the competitiveness of Queensland firms
- Attracting international firms to establish operations in Queensland.

These policy examples draw upon a number of international policy initiatives from other jurisdictions. For example, since 2013 the UK government has sought to enhance local supply chain capture by the offshore wind industry:

- Extensively promoting the potential opportunities associated with offshore wind through knowledge sharing initiatives
- Strengthening SME firms either in the sector or capable of entering the offshore wind industry, including provision of funding and investment
- Establishing a government body focussed on attracting inward investment in the sector and renewable energy ambassadors tasked with attracting international firms
- Providing funding for innovative local firms seeking to commercialise products which could reduce the cost of offshore wind to power users
- Targeted workforce training through the Renewables Training Network.

Numerous similar public sector interventions have been undertaken in other markets around the world aimed at strengthening the positioning of local firms and increasing inward business establishment.

During private sector market soundings South Australia was sighted as an Australian market where supply chain capture policies were effective at generating local economic benefits. In South Australia:

- RenewablesSA was established to support developers and provide a “one-stop-shop” case manager for renewable energy developers

- The South Australian Industry Participation Policy (SA IPP) was identified as generating adequate opportunities for local firms. This policy was reinforced by the support of the Industry Capability Network (ICN) which worked to provide a local procurement service to developers and thus opportunities for local firms.

Increase the competitiveness of Queensland firms

In the initial stages of deployment the opportunities associated with renewable energy may be more obvious to international suppliers and contractors who have experience in the sector in other markets.

A range of policy initiatives are available which might accelerate the competitiveness of Queensland firms, such as:

- Educating regional communities about the renewable energy opportunity, including the use of experts to educate business on capturing opportunities and risk management (e.g. EPC contracting)
- Promoting existing support networks (e.g. ICN) which support local firms
- Considering contractual arrangements as part of reverse auction design processes to ensure that Queensland based firms have adequate opportunity to participate in the development and construction of renewable energy projects. For example, requirements could include an obligation to advertise procurement locally, to undertake discussions with interested local business and provide local firms with the opportunity to bid for procurement.

Attract International Businesses

A number of international renewable energy businesses and EPC contractors are looking to establish a presence in Australia as the renewable energy industry matures. Queensland's solar resource, favourable policy outlook and lower housing and professional service costs make Brisbane an attractive location to establish a business.

Queensland could actively encourage these businesses to set up operations in Queensland by utilising strategies similar to the UK Trade and Industry ambassador programme including:

- Establishing dedicated teams tasked with attracting firms to Queensland
- Providing incentives (e.g. office hubs with discounted rental) to reduce the "switching costs" and risks associated with relocating to Queensland
- Allowing Queensland based firms to have a competitive advantage in the renewable energy sector (e.g. preferred participation in government tenders).

11.2.4. Specific opportunities for Queensland

In addition to its supply chain analysis, KPMG has also investigated other opportunities to support renewable energy development in Queensland, based around the State's existing industries or its competitive advantages.

Opportunities for the development of bagasse

KPMG has identified a potential opportunity in relation to bagasse in Queensland, given the level of existing capacity and the associated supply chain.

The analysis by KPMG indicates that on a project-by-project basis bagasse can be competitive with other mature, large-scale renewable energy technologies on a levelised cost of energy basis. However, due to the fact bagasse projects can be technically complex and are highly dependent on the availability of sugarcane as fuel, the cost of bagasse projects are generally not standardised to the same extent as wind and solar. In some cases, this means the electricity generation from bagasse can be at a relatively high cost.

For existing Queensland bagasse generation plant, a reliable fuel supply is generally available during the sugarcane crushing season, which is normally between May and December. During this period this effectively enables baseload renewable generation. However, outside of the crushing season, bagasse plants typically have low levels of utilisation.

Increasing storage capacity may allow bagasse plants to improve their utilisation beyond the sugar crushing season, but this requires capital expenditure. Based on recent press reports and comments from industry these investments are being evaluated by mill owners but the investment associated with a sugar mill upgrade projects are often larger and more technically complex than other forms of renewable generation, contributing to a higher cost of electricity generation.

In addition, the fuel resource is subject to fluctuation in the global sugar market, which can affect the availability of bagasse for electricity generation. This means the overall annual output of a bagasse plant can be variable, which makes it challenging to make long-term investment decisions.

If these challenges can be addressed, electricity generation from bagasse can provide a number of additional market benefits that may not be available from solar and wind technologies, such as:

- *Decentralised power generation:* Decentralised power generation reduces demand on transmission and distribution infrastructure. This can improve local voltage quality and could defer network augmentation, for example, where small-scale generation occurs locally removing the need for transmission.
- *Synchronous generation:* As a synchronous generator, biomass turbines can provide a range of ancillary services to regional grids, including standby capacity
- *Dispatchable renewable generation:* Bagasse generators are dispatchable[133] and not subject to intermittency issues associated with solar and wind.

Importantly, these benefits may be more valuable as the penetration of solar and wind projects increase in Queensland under a 50% renewable energy target.

The availability of these market benefits reinforces the Panel's recommendation for the Queensland Government to investigate opportunities for running specific reverse auctions for dispatchable renewable energy. This may enable other renewable energy technologies (not necessarily at lowest levelised cost) to enter the Queensland market prior to 2030.

Opportunities for the development of control systems

Investment in control systems presents a significant opportunity for the continued deployment of small-scale renewable generation and battery storage in Queensland.

There are industry participants already active in the development of control systems in Queensland, which reflects a natural progression of the state's high penetration of rooftop PV.

In addition to the continued deployment of small-scale renewable generation, the development of control systems will be driven by the continued development of smart controls and advanced household appliances. Currently, Queensland is accelerating the installation of digital meters, which are an important enabling technology for the development of smart technologies. As more of these devices are developed and deployed, the need for integration between the devices becomes more important, leading to the need for development of control systems to optimise the benefit of each individual device.

Finally, power quality issues associated with the geographically diverse nature of Queensland's transmission and distribution network may be addressed through the provision of control systems. For example, control systems that provide grid stabilising services present as a specific opportunity in areas where there is limited local generation.

11.2.5. Opportunities to export products and skills

The use of distributed energy in isolated and fringe-of-grid locations

Queensland may also have a competitive advantage in the deployment of renewable energy in decentralised or isolated applications.

[133] This is distinct from being a scheduled generator as defined by AEMO. The use the term "dispatchable" in this context refers to the ability for the generator to deliver electricity when required and in response to broader market signals, rather than only generating when available.

Queensland faces many challenges associated with providing electricity to a geographically disperse population. The costs associated with provision of electricity to regional and rural Queensland, including generation, transmission, distribution and ancillary services, are partly captured in the CSO payment (estimated at $561 million in 2016-17) which applies a uniformed tariff policy for electricity consumers across Queensland. Given these costs and challenges, Ergon Energy has been active in development of various types of distributed generation and technology.

KPMG's analysis suggests Queensland's characteristics provide an incentive for specialist distributed generation technologies to be developed and deployed in Queensland and the opportunity for this expertise to be exported globally. This could both reduce the annual CSO and provide a potential export industry for Queensland business.

Currently, Ergon Energy's regional activities involve the production of electricity from 33 isolated power stations, which are mostly run on diesel. These power stations range in generation capacity from between 0.25 MW to 10 MW. In recent years, Ergon Energy has been replacing or supplementing these plant with various renewable energy technologies, such as:

- *Thursday Island:* Combined diesel and wind generation
- *Birdsville:* Combined diesel and geothermal
- *Windorah:* Combined diesel and solar (concentrated photovoltaic dishes)
- *Doomadgee:* Combined diesel and solar (photovoltaic panels).

Supplementing diesel-fuelled generation with renewable generation has provided Ergon Energy with key learnings about how these two technologies can be used together effectively.

The opportunity available to Queensland through the increased use of distributed generation technologies is considered significant. The dissemination of distributed generation achieves a number of outcomes including:

- Value through the displacement of higher-cost energy (e.g. diesel generated power) and the reduction in costs associated with network losses
- Reduced need for installation, maintenance and augmentation of transmission and distribution infrastructure to service small, remote communities and fringe-of-grid
- Improvement in voltage quality through decentralised generation providing ancillary services to supplement grid sourced power.

Beyond Queensland

KPMG has also identified the potential opportunity for Queensland businesses to subsequently export these skills and technology solutions into Pacific Island nations and potentially the broader Asian market[134].

The Pacific islands represent a small but addressable opportunity. Pacific Island nations currently have limited access to electricity, face distinct but similar geographical constraints to regional Queensland, and currently incur high prices for electricity. Many of these nations have made pledges to renewable energy targets of some level. Based on these pledges, KPMG has assessed that up to 650 MW of decentralised renewable energy generation could be required.

Beyond the Pacific Island nations there is a significantly larger opportunity in decentralised and off-grid generation in Asia which Queensland business could be well placed to capture. Decentralised renewable energy generation costs continue to fall and in some markets could compete effectively with new build centralised generation, fossil-fuel generation. As Asian electricity demand grows, decentralised generation could become a key element of their electricity supply, representing potentially substantial opportunities for Queensland business.

[134] In its submission to the Panel, Engineers Australia QLD Division suggested there may be an opportunity to export the renewable energy expertise developed in Queensland to neighbouring countries, particularly in less developed regions.

11.3. Supporting the transition of communities and industries

11.3.1. The effect of renewable energy investment in regional communities

During the consultation on the Issues Paper, the Panel visited a number of Queensland regional centres. One of the key themes that emerged from participants in the public forums was the regional economic development opportunities associated with renewable energy.

The Panel recognises that over the longer term, a transition to renewable energy will have implications for individuals, industries and communities that currently rely on fossil fuel generators for direct and indirect employment and income. Some of these effects could be offset by the development of renewable energy projects. Based on the nature of Queensland's renewable energy resources and the locations of projects in the pipeline, the Panel considers that there is a high potential for future investment in renewable energy to occur in regional Queensland. Reinforcing this, the Panel highlights that since the release of the Issues Paper, there have been two major project commitments in Queensland (Clare Solar Farm and Mount Emerald Wind Farm) both located in regional Queensland.

In addition, the Panel considers that regional communities could have competitive advantages over urban centres, including:

- Existing skills in practical engineering disciplines
- Detailed knowledge of local resources and geography
- Connectivity between primary production, energy use and the local economy
- Lower cost labour force.

While participants in the public forums were interested in the opportunities associated with renewable energy investment, they also provided some important insights into the potential issues relating to regional economic development. Many of the communities had experience with the mining boom and subsequent downturn and were interested to understand how the same types of "boom-bust" cycles could be avoided in the transition to renewable energy.

In addition, the Australian Energy Council noted that while renewable energy projects can provide employment opportunities in the construction phase of solar and wind projects, there would not be a like-for-like replacement of ongoing employment. Some participants in the public forums noted this characteristic and were keen to understand how economic benefits could extend beyond the construction phase of projects and result in longer term opportunities. In particular, it was identified that the initial project phase of any initiative would attract skills and experience to the region and participants were interested in what might be done to retain these skills in the longer-term.

11.3.2. Supporting communities and industries

In the Issues Paper, the Panel requested feedback on the requirements for supporting communities, regions and industries that may be adversely affected by the move to 50% renewable energy in Queensland and whether policies might be required to facilitate this.

In assessing the need for support, the Panel consider that this will be influenced by:

- The rate at which traditional generation output is displaced by renewable energy
- The extent of any plant closures as a result of the policy
- The extent to which affected employees are able to transition to alternative employment (either in the renewable energy sector or elsewhere).

Supporting the transition of communities

In terms of the rate of change, the Australian Energy Council agreed that the rate of change from fossil fuels to renewables would be a key consideration in how communities could respond to the change. The Panel has identified three credible pathways that vary in terms of the pace and timing of the transition to renewable energy (see Chapter 8).

The rate of deployment of renewable energy projects will influence changes in employment. This is reflected in the economic modelling by CoPS which suggests that employment in coal-fired generation would decrease by around 20% over the period to 2030 under the *Linear* pathway, compared to the *Base case*. A similar overall effect by 2030 is projected in the *Ramp* pathway but employment effects are delayed and largely occur post 2025.

In terms of plant closures, modelling by Jacobs for the *Linear and Ramp* pathways projected that coal-fired generation would have reduced output but no coal plant was modelled to retire. The Panel notes that under the *Stronger National Action* pathway, there is projected to be the retirement of around 1,500 MW of coal-fired generation. However, this is driven by the requirement to meet stronger emission reduction targets rather than the effect of the increase in renewable energy requirements. Further, the Panel has indicated it does not see a need for the early retirement of coal-fired generation in Queensland in order to achieve a 50% renewable energy target (see Chapter 7).

The ETU's submission on the Issues Paper suggested there is a need for the development of a comprehensive policy package to enable a "just transition" for workers from affected industries and communities. The ETU proposed this package should include measures (including financial incentives) to help workers to re-skill and re-train, along with job guarantees and guarantees for benefits and entitlements.

The Panel does not see any immediate requirements for structural adjustment policies or actions. Given the effects on Queensland's coal generation fleet are unlikely to be immediate and more likely post 2025, the Queensland Government has time to understand the extent of the impact and what type of response may be required. However, the Queensland Government could give consideration to the need for structural adjustment polices as part of the implementation of its overall climate policy framework, particularly if there are any requirements for the early retirement of coal-fired generation as part of this framework.

The Panel considers that the Government should set a clear pathway to greater renewables and the way the generation mix will change over time. The Government has the ability to influence this through the way that annual targets are set in order to achieve the overall target. The Panel has presented two pathways (*Linear* and *Ramp*) in this regard and the Government can influence the pace at which the transition occurs based on these pathways.

Supporting the transition of workers

In terms of opportunities for workers to transition to other employment, the Panel notes that there will be a shift in the type of employment from operational roles in existing generation to construction roles for new projects. It is recognised that job transition may not involve a "like-for-like" substitution, and some affected workers may re-skill in other growing sectors of the Queensland economy such as agriculture or health and aging services.

In response to the Issues Paper, the Clean Energy Council identified that deploying renewable energy would require the development of specific skills, while Engineers Australia considered that there were clear opportunities for a transition of skills from existing to new industries. The submission from the Australian Conservation Foundation highlighted a need to ensure that appropriate knowledge and skills training are incorporated into secondary and tertiary education curriculum.

This view is supported by the work by KPMG in relation to supply chain opportunities. This assessment noted that Queensland has a strong engineering presence (and related occupations) due to its mining sector. Given the recent mining downturn, there is the potential for an available workforce with skill-sets that could be transferrable to the renewable energy industry.

KPMG also identified that Queensland has a strong tertiary education system, with a track-record of providing the labour market with a steady stream of qualified graduates to support the mining industry. These skills cover technical engineering skills and those required to implement the commercial, financial and legal aspects of the industry. These disciplines will also be relevant to the renewable energy industry.

It is recognised that there will need to be a re-focusing of curriculum to ensure that programs focus on the skills that are relevant to current and emerging technologies and are adequately developed across the entire spectrum of skill levels. There are a range of examples of universities and TAFE colleges around Australia that have sought to fill this gap.

The Panel considers that the Queensland Government has a role in supporting the development of skills and industries that will be required. The Government could consider how it can partner with relevant bodies (secondary and tertiary education, industry and employer groups) to facilitate the training necessary to develop the future workforce required to support the industry and to enable existing workers to transition into new employment opportunities.

Glossary of key terms

A	
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ARENA	Australian Renewable Energy Agency
AUD	Australian dollar
Australian Government	Australian Government – A common usage term used to refer to the Federal Government or Commonwealth of Australia.
B	
Base load generator	Refers to a power station that usually has high capital costs and low variable operating costs that is operated all hours throughout the year.
C	
CCA	Climate Change Authority
CEFC	Clean Energy Finance Corporation
CER	Clean Energy Regulator
CFD	Contract for Difference
CO_2-e	Carbon dioxide equivalents – a measure of greenhouse gas emissions
CPI	Consumer Price Index
E	
ERF	Emissions Reduction Fund
EV	Electric vehicle
G	
GHG	Greenhouse gases – There are six greenhouse gases reported under international agreements being Carbon dioxide ($C0_2$), Methane (CH_4), Nitrous oxide (N_20), Hydrofluorocarbons (HCFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6). The gases have different relative intensities and are reported in standardised carbon dioxide equivalent terms. The relative intensities in carbon dioxide equivalent terms are $C0_2$ (1 times), CH_4 (25 times), N_20 (298 times), HCFCs (varies from 92 to 14,800 times), PFCs (varies from 7,390 and 12,200 times) and SF_6 (22,800 times).
GJ	Gigajoule – one thousand million joules, which is the typical measure of energy in fuel as an input to power stations
Gross Domestic Product	Measure of economic output of a country, including net overseas income
Gross National Income	Measure of economic output of a country
Gross State Income	Measure of economic output of a state
GW	GigaWatt – one thousand MegaWatts, a unit of electrical power
GWh	GigaWatt hours – one thousand MegaWatt hours, measure of electrical energy typically used to measure annual aggregate usage across a sector or the economy as a whole
I	
IPCC	Intergovernmental Panel on Climate Change
K	
kWh	kilowatt hours – one thousand Watt hours
L	

LFG	Landfill gas – methane produced from urban landfill sites.
LGC	Large Scale Generation Certificate – renewable energy certificates generated from large-scale renewable energy projects under the LRET scheme
LNG	Liquefied Natural Gas
LRET	Large-scale Renewable Energy Target
LRMC	Long run marginal cost
M	
MLF	Marginal loss factor
Mt	million tonnes
MW	Mega Watt – one million Watts. Typically power stations are measured in MW capability and typically range from a few MW to several thousand MW.
MWh	Mega Watt hour – one million Watt hours
N	
NEFR	National Electricity Forecasting Report
NEM	National Electricity Market covering the states of Qld, NSW, ACT, Vic, Tas and SA.
NPV	Net present value
NSLP	Net System Load Profile
P	
PJ	Petajoule – one million gigajoules
POE	Probability of exceedance
PPA	Power Purchase Agreement
PV	Photovoltaic
Q	
QNI	Queensland – NSW interconnector
R	
Real Value Add	Additional economic value created
REC	Renewable Energy Certificate
RET	Renewable Energy Target
RPP	Renewable Power Percentage – when multiplied by all energy purchased in MWh by a liable entity, it determines the number of LGC that must be remitted by the liable entity. The total energy projected to be purchased reach year by all liable purchasing entities multiplied by the renewable power percentage equals the annual target under the LRET scheme.
S	
SGU	Small generation unit
SRES	Small-scale Renewable Energy Scheme
SRMC	Short run marginal cost
STC	Small-scale Technology Certificates – generated by small-scale renewable systems under the SRES.
SWH	Solar water heater
SWIS	South west interconnected system – refers to the power system in south west Western Australia

Synchronous condensers	A spinning turbine that provides inertia but not energy to the grid
Synchronous renewable generation	Renewable generators with spinning turbines that provide inertia to the grid
Synthetic inertia	The short term extraction of additional kinetic energy stored in rotational parts of wind turbines
T	
TAPR	Transmission Annual Planning Report
W	
Watt	A unit of electrical power defined as one joule of energy per second. A typical house light would be between 25 and 100 Watts.
Watt hour (Wh)	A unit of electrical energy which is a measure of electrical power aggregated over time as energy in which one watt of electrical power is used for one hour. A typical house would consume between 500 and 5000 Wh each hour of the day depending on the time of day.
WACC	Weighted average cost of capital
WCMG	Waste coal mine gas

Appendix A: Expert Panel

Panel member	Biography
Colin Mugglestone 	In 2014, Colin retired from Macquarie Capital after a 22 year investment banking career in Australia, UK and south-east Asia. Colin was Head of Energy & Utilities completing a large number of renewable transactions including wind, hydro and solar projects. Prior to joining Macquarie, Colin had nine years engineering experience working on projects in Australia, UK and Norway. Overall, Colin has over 30 years of experience in the infrastructure sector. Colin is currently Chairman of Intoll Group, a roads infrastructure group with assets in Sydney and Toronto, and a board member of BAI Communications Pty Ltd and Pacific National Pty Ltd. He is also member of the Australian Institute of Company Directors.
Allison Warburton 	Allison is a leading private and government sector advisor across the energy, resources and power generation industries. Prominent in the climate change and clean energy legal space, Allison co-heads Minter Ellison's national climate change practice. Her extensive experience in climate change projects and on greenhouse compliance issues, includes advising on the Commonwealth Clean Energy Scheme, Mandatory Renewable Energy Target Scheme, National Greenhouse and Energy. Allison is a member of the Law Council of Australia's Climate Change committee.
Paul Hyslop 	Paul is Chief Executive Officer of ACIL Allen Consulting and leads the company’s energy practice. He has more than twenty years experience in the sector either within corporations or advising government and corporations. With ACIL Allen Consulting, Paul has consulted extensively on energy industry matters and across a broad range of assignments including assessments and analysis of renewable energy investment under the expanded RET scheme, and the impact of government climate change policies on existing assets and potential investments.
Amanda McKenzie 	Amanda McKenzie is an environmental leader and Chief Executive Officer of the Climate Council. In her time as CEO of the Climate Council, Amanda has overseen a rapid expansion of Council, helping it build a reputation as Australia’s “go-to” organisation for information on climate change and renewable energy. In 2014, Amanda was recognised as one of Westpac’s 100 Women of Influence in recognition of her commitment to putting climate change on the public agenda.
Prof Paul Meredith 	Paul is a Professor of Physics at the University of Queensland and Director of UQ Solar. He manages a $50 million portfolio of solar PV and concentrated solar thermal research spanning fundamental technology development, systems-level integration and policy issues. Paul is a current member of the ARENA Technical Advisory Board, the Australian Solar Thermal Initiative Strategic Advisory Board, the Australian Centre for Advanced Photovoltaics Management Board, and is also co-Director of the Centre for Organic Photonics and Electronics at UQ.

Appendix B: Terms of Reference

Objectives

The objectives of the inquiry are to:

1. Investigate and report on the costs and benefits of adopting a target of 50% renewable energy in Queensland by 2030.
2. Determine how the adoption of a renewable energy target and other complementary polices can drive the development of a renewable energy economy for Queensland.

Context

Queensland has led Australia in the uptake of small-scale solar but has had limited uptake of large-scale renewable energy projects under the Renewable Energy Target.

The Queensland Government has a commitment to increasing the uptake of renewable energy with the objectives of industry development (create new jobs and attracting investment), helping the environment (through cost effective carbon pollution reduction and the potential for energy resilience as the climate changes) and delivering customer and government value whilst allowing for efficient operation of the energy market.

Scope

The Government is seeking advice from the Expert Panel on the costs and benefits of achieving a target of 50% renewable energy in Queensland by 2030. The scope of the inquiry will be broad to ensure that all relevant issues are covered. The enquiry should also be guided by and test the Queensland Government's renewable energy objectives that include:

- One million solar households or 3,000MW of solar energy
- Assessing and establishing a credible pathway for up to 50% renewable energy generation by 2030
- Promoting short and long term benefits for energy consumers
- Protecting the environment (including reducing carbon pollution)
- Creating jobs and economic growth
- Providing value for the Queensland Government, and
- Integrating smoothly and equitably with well-functioning energy markets.

This inquiry will likely have clear linkages to the proposed Queensland Productivity Commission investigation into the role of the State in promoting renewable energies, opportunities for lifting productivity and the benefits of localised renewable generation in a decentralised State.

Renewable energy is also a focus of the *Advance Qld Science and Innovation Policy*.

Specifically, the Government is seeking advice on:

- A credible pathway for up to 50% renewable energy generation by 2030;
- The impact on electricity prices arising under different scenarios and their distribution across customer groups;
- The impact on Queensland's greenhouse gas emissions under different scenarios;
- The key design features of a target - this should include advice on:
  - Should a target be legislated?
  - Should a target apply to the electricity sector only or more broadly?
  - How should a target be measured?
  - Which technologies should be eligible?
  - Should small-scale generation count towards the target?

- Any existing policy and regulatory barriers that need to be addressed to enable the achievement of a Queensland renewable energy target;
- How Queensland can maximise/leverage Federal support schemes (i.e. the Renewable Energy Target, the Australian Renewable Energy Agency and the Clean Energy Finance Corporation);
- How Queensland can better foster private sector investment in large-scale renewable projects in Queensland;
- The impact absence of Federal support schemes would have on a target and what role should the State then take on;
- What complementary policy instruments could be implemented to support the development of Queensland's renewable energy economy;
- How a target and any complementary policy measures can be co-ordinated to maximise the benefits to the Queensland economy - this should include specific reference to:
  - Job creation and skills development
  - Local manufacturing
  - The ability to export products and skills; and
- Assessment of the target against the Queensland Government's renewable energy objectives.

Stakeholder engagement

The Panel will conduct comprehensive public consultation with all relevant stakeholders, including public hearings throughout Queensland. At a minimum the Panel must consult with consumer groups, peak bodies, relevant government agencies, the Queensland Productivity Commission, energy businesses and unions.

The Panel should invite written submissions on its Issues Paper and Draft Report. The Panel must consider any submissions received within the consultation period and make them available to the public, subject to normal confidentiality considerations.

Timeframes

Issues Paper: The Panel must publish an Issues Paper outlining the issues associated with its investigation.

Draft Report: The Panel must publish a Draft Report.

Final Report: The Panel must publish a Final Report no later than 10 months after the Expert Panel is established.

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