

Low Emissions Technology Statement 2022 consultation
Department of Industry, Science, Energy and Resources
By email: technologyroadmap@industry.gov.au

8 February 2022

Re: Low Emissions Technology Statement 2022

Dear Sir or Madam,

Engineers Australia is the peak body representing the engineering profession in Australia. We are the voice of over 100,000 individual members working in nearly every sector of the economy, with expertise across all disciplines and branches of engineering.

Our outlook on climate change is guided by an engineering approach to problem-solving – paying full regard to the scientific evidence, the risks to communities and natural systems, and the needs of both present and future generations. This perspective compels us to recognise the profound threats to societies, economies, and the natural world presented by climate change. Engineers Australia advocates urgent and large-scale actions in every sector to mitigate the causes of climate change, and to adapt and achieve resilience.

Engineers Australia welcomes the opportunity to provide input to the Department of Industry, Science, Energy and Resources (the Department) on the Low Emissions Technology Statement 2022 (LETS 2022). Australia's Long-Term Emissions Reduction Plan states that action mandated and coordinated under the Technology Investment Roadmap must account for half of the remaining abatement required to achieve net zero emissions by 2050.¹ Thus the roadmap (and the technology statements as its constituent parts) is by some distance the most important element of Australia's emissions mitigation strategy.

However, the roadmap in its current form is, in nearly every respect, inadequate to support the emissions reductions required of it. If it is to occupy such an important role in the national abatement program, LETS 2022 must represent a marked departure from its predecessors – introducing a new strategic vision, more numerous and generous supports, new and amended technology priorities, and more effective coordination and evaluation. Nothing less will suffice.

To this end, Engineers Australia is pleased to provide the following recommendations and comments for the Department's consideration.

Summary of recommendations

Recommendation 1: LETS 2022 should provide a new vision statement focused on reducing greenhouse gas emissions in a manner consistent with meeting Australia's net zero emissions target.

Recommendation 2: LETS 2022 should expand and calibrate support for priority technologies to ensure the Technology Investment Roadmap supports the realisation of Australia's net zero emissions target.

Recommendation 3: LETS 2022 should provide for substantially increased investment in all priority technologies, by leveraging higher private sector investment and/or increasing government investment.

Recommendation 4: LETS 2022 should provide demand-side interventions to increase uptake of priority technologies. These should include incentives for expanded uptake by both consumers and businesses, and concessionary access to government procurement.

Recommendation 5: LETS 2022 should identify and remove regulatory and policy barriers to the uptake of priority technologies.

Recommendation 6: LETS 2022 should include biofuels produced from waste biomass as a priority technology, and provide supports focused on expanding output and uptake of biofuels.

Recommendation 7: LETS 2022 should deprioritise support for carbon capture and storage, relative to solutions of greater importance to realising Australia's net zero emissions target.

Recommendation 8: LETS 2022 should prioritise support for hydrogen produced using renewable energy and electrolysis.

Recommendation 9: LETS 2022 should address barriers to increasing soil carbon sequestration unrelated to measurement technologies.

Recommendation 10: LETS 2022 should adopt a whole of emissions lifecycle approach to assessing and allocating supports to priority technologies.

Recommendation 11: LETS 2022 should ensure that all supported actions are consistent in their approach and objectives, and clearly support the Technology Investment Roadmap's vision and key objectives.

Recommendation 12: LETS 2022 should include a program logic model for the Technology Investment Roadmap.

Recommendation 13: LETS 2022 should include the first annual assessment of the efficacy of the Technology Investment Roadmap.

Recommendation 14: The evaluation framework utilised in LETS 2022 should centre on emissions abatement outcomes attributable to actions under the roadmap, related costs, and progress towards Australia's net zero emissions target.

Vision

Engineers Australian suggests that, to date, the roadmap has been burdened with a deficient and conflicted guiding vision. As befits its importance to achieving Australia's emission reduction target, the Commonwealth labels the roadmap the 'cornerstone' of its abatement commitments.² However, the project's vision statement is akin to an economic development initiative, with emissions abatement a secondary or even incidental objective. LETS 2020 and LETS 2021 provide that the roadmap intends to support "A prosperous Australia, recognised as a global low emissions technology leader".³ They do not state whether or how a prosperous Australia – even one which has attained leadership in the development and provision of some relevant technologies – would meet its decarbonisation objectives. As a result, even if the roadmap's vision were realised, Australia's goal of achieving net zero emissions by 2050 may not be reached (or may not be reached as efficiently as possible).

Furthermore, the technology statements published to date focus heavily on the export potential of priority technologies - so much so that the capture of new export markets is one of four key challenges listed as informing its vision.⁴ This too suggests an approach more akin to economic development policy. Per the Commonwealth's own approach to emissions measurement,⁵ and according to its obligations under the United Nations Framework Convention on Climate Change,⁶ Australia's formal mitigation obligations are to reduce its domestic emissions. The Commonwealth's outlook on mitigation, as expressed in other forums, reflects exactly this: It regularly defends the export of highly emissions-intensive commodities by arguing that the combustion of these fuels abroad does not impact Australia's mitigation obligations.⁷

We do not suggest there is no merit in the pursuit of such objectives, nor that climate action and economic development cannot be complementary. Engineers Australia recognises that mitigation will deliver substantial

economic opportunities across regions and sectors.⁸ However, as prosperity, technology leadership and larger export markets do not necessarily entail reduced emissions, they are ill-suited to driving abatement outcomes.

LETs 2022 should address these contradictions by scrapping the roadmap's current vision statement in favour of one befitting the cornerstone of the nation's emissions abatement program. Accordingly, this vision should focus directly on reducing domestic greenhouse gas emissions. At a minimum, this should reflect Australia's current commitment to achieve net zero emissions by 2050 (though the science also calls for a highly ambitious 2030 target, and may warrant an earlier net zero target to halt average warming to 1.5°C). The following formulation may suffice: *'Australia as a global leader in emissions mitigation – pursuing abatement at pace and scale through the deployment and development of low emissions technologies'*.

Recommendation 1: LETs 2022 should provide a new vision statement focused on reducing greenhouse gas emissions in a manner consistent with meeting Australia's net zero emissions target.

Supporting initiatives

LETs 2021 states that the Technology Investment Roadmap intends to support its vision by “[accelerating] the development and commercialisation of new and emerging low emissions technologies to reach cost parity with existing high emissions technologies”.⁹ As the designers and managers of all low emissions technologies and systems, engineers recognise that an expansive rollout of existing and prospective technologies will underpin the transition to net zero emissions. Further, the priority technologies highlighted in LETs 2020 and 2021 will play a role in Australia's journey to net zero emissions, and many are highly complementary.

Nonetheless, Engineers Australia holds several concerns as to the efficacy of the approach to increasing uptake supported by the roadmap. Broadly, the Commonwealth nominates target commercial prices for priority technologies, and delivers moderate investments in those technologies in the form of R&D, early-stage commercialisation, enabling systems and related activities.¹⁰

It appears highly uncertain that Australia can affect the reductions in prices that the roadmap requires. Australia represents just 1.5% of the global economy¹¹ and is a net technology taker. For all priority technologies, a very large, heterogenous global market exists, or will emerge as global mitigation efforts increase. Australia is not well positioned to strongly influence prices in such markets. Likewise, it is unclear that government support of the scale pledged in the roadmap is sufficient to enhance Australia's influence on prices. LETs 2021 commits to around AUD\$2 billion in support each year across all priority technologies. Notwithstanding that quantum is not a lone determinant of an investment's impact, it appears highly unlikely that investment of that scale could meaningfully impact what are often multi trillion-dollar target markets at any stage of commercialisation.¹² Though LETs 2021 states that government investment will catalyse a further AUD\$6 billion in private financing each year,¹³ this claim is not substantiated.

We acknowledge that the roadmap's priority technologies are determined with reference to a purported comparative advantage possessed by Australia in each technology area, and by the likely impact of government investment.¹⁴ However, LETs 2021 does not make clear why government investment has the potential to elicit greatest impact in the chosen areas, and the comparative advantages identified are sometimes unsubstantiated. For instance, in relation to soil carbon, the 2021 statement states only that Australia “has untapped potential” in the space,¹⁵ and “is a world leader in carbon soil measurement.”¹⁶

Even if Australia were able to influence price reductions as required, including with investment of the modest scale pledged, the roadmap fails to explain how this would drive half of the remaining abatement needed to reach net zero by 2050. LETs 2021 states that, once target prices are reached, priority technologies “will be adopted at large scale across the economy, significantly reducing emissions...”¹⁷ Thus, mitigation under the roadmap is incidental, and achievement of our abatement goal is left to the assumption that best-case uptake can and will occur. In reality, while reduced costs usually induce higher usage, uptake will not necessarily be of sufficient pace and scale to effect large

emissions reductions. Price notwithstanding, uptake depends heavily on investment cycles, propensity to adopt, and access. Some sectors, such as transport, remain highly price inelastic to new innovations. For instance, despite continual improvements in efficiency (as well as safety and user experience) the average light vehicle remains in the Australian fleet for over 20 years.¹⁸

In light of its questionable base assumptions, modest investments, and an unclear relationship to Australia's abatement goal, the roadmap's approach to driving emissions reduction is inadequate. LETS 2022 must abandon this approach for much more ambitious, wide-ranging actions. Just as the roadmap's vision must focus on supporting Australia's emissions reduction objective, actions under the plan must drive abatement of a scale sufficient to ensure Australia meets that target.

Substantially increased investment would aid this process. Depending on the solution in question and the market for the same, this could be realised by leveraging increased private investment and/or higher government support. As regards government investment, LETS 2021 commits to \$20 billion to 2030, where approximately \$10.5 billion was provided in the decade prior.¹⁹ Against recent scientific advances and the current climate policy discourse – not least the unequivocal need for urgent and large-scale action to ensure the Paris Agreement's objectives can be met²⁰ – this increase appears deficient.

Also necessary are demand side interventions. Businesses and consumers should be offered concessions and other incentives to drive faster uptake of priority technologies. Government should also make better use of its procurement budget. As government procurement represents over 12% of Australia's GDP,²¹ affording priority to target technologies is a potentially powerful means of facilitating greater demand.

We recognise that demand side interventions conflict with the 'technology not taxes' approach.²² However, we suggest there is no reason to rule out interventions purely on the grounds that they constitute taxation, or are seen as akin to taxation. Both the Commonwealth's current approach and potential alternatives come at a public cost, through direct taxation or increased spending funded by other taxes. Potential measures to drive emissions reductions should be assessed chiefly against their capacity to efficiently support that goal.

It is also necessary to support a broader suite of technologies; see '*Choice of priority technologies*', below.

Lastly, LETS 2022 should identify and remove regulatory and policy barriers to the uptake of low emissions technologies. These may hinder uptake of low emissions solutions - even those available at low cost.

Recommendation 2: LETS 2022 should expand and calibrate support for priority technologies to ensure the Technology Investment Roadmap supports the realisation of Australia's net zero emissions target.

Recommendation 3: LETS 2022 should provide for substantially increased investment in all priority technologies, by leveraging higher private sector investment and/or increasing government investment.

Recommendation 4: LETS 2022 should provide demand-side interventions to increase uptake of priority technologies. These should include incentives for expanded uptake by both consumers and businesses, and concessionary access to government procurement.

Recommendation 5: LETS 2022 should identify and remove regulatory and policy barriers to the uptake of priority technologies.

Choice of priority technologies

Australia's overarching abatement commitments would be better served by a recalibration of some priority technologies in LETS 2022 and onward. This should include an adjusted focus on some technologies and a new focus on others.

Biofuels

Engineers Australia advocates that the Commonwealth adopt biofuels produced from waste biomass as a priority technology in LETS 2022. These fuels could address a range of technical obstacles to achieving net zero emissions, as well as complementing both the roadmap and other policy initiatives.

Biofuels will likely be critical to achieving abatement in areas where other prospective solutions are unlikely to be viable in the timeframe required to meet Australia's abatement commitments - particularly shipping and aviation. Road transport is also relevant: Given the slow rate of attrition in the road vehicle fleet, the shift to zero emissions alternatives will almost certainly occur over decades. Increased biofuel use in internal combustion engine vehicles could support lower emissions in the lengthy interim period.

Processing waste biomass into biofuels allows the embodied energy to be consumed in place of fossil fuels. This production and consumption process translates into lifecycle emissions reductions of up to 90%.²³

Australia also possesses a competitive advantage in the biofuels space. The nation generates over 78 million tonnes of waste agriculture feedstocks suitable for biofuels each year, and the CSIRO projects that this will rise to 98 million tonnes by 2030.²⁴

Biofuels also offer ancillary benefits. For instance, while the volume of municipal solid waste produced in Australia represents an increasing waste management challenge,²⁵ these materials may be utilised as a biofuel feedstock. Onshoring production of some transport fuels through biofuels manufacturing could also help address longstanding fuel security challenges.²⁶ The potential for biofuels production to facilitate positive economic outcomes is also well-established: The Australian Renewable Energy Agency's recent *Bioenergy Roadmap* states that bioenergy could support 26,200 new jobs and facilitate AUD\$10 billion per annum of investment by 2030.²⁷

While the Australian Renewable Energy Agency has provided around AUD\$131 million to 38 energy-related projects over the last decade,²⁸ this has often supported industrial policy goals rather than emissions mitigation. Future support for biofuels under the roadmap should be consistent with its new vision - that is, to reduce greenhouse gas emissions in a manner consistent with Australia's net zero emissions target.

We acknowledge the challenges associated with biofuel production. Notably, large emissions may be associated with the transport of biomass to production plants. This may give rise to concerns as to the lifecycle emissions profile of the resulting fuels (though this must be assessed against avoided emissions such as those associated with alternative outcomes for biomass waste). Government must also be cognisant of the need address potential water use and other non-emissions issues.

Given these challenges, as well as the technical readiness of many biofuels, support in LETS 2022 should focus on expanding output and uptake and addressing obstacles, rather than early-stage activities.

Recommendation 6: LETS 2022 should include biofuels produced from waste biomass as a priority technology, and provide supports focused on expanding output and uptake of biofuels.

Carbon Capture and Storage

Engineers Australia suggests that the current roadmap places undue emphasis on carbon capture and storage (CCS) technologies – supporting a substantial, sub-optimal reliance on these technologies in Australia’s future net zero emissions economy.

LETs 2021 affirms that CCS is a priority technology in its own right. In addition, the statement supports hydrogen manufactured through steam methane reforming and coal gasification with CCS. Further still, LETs 2021 provides that “Australia’s existing thermal [electricity] generation fleet will continue to play an essential role in providing affordable and reliable power in the decades ahead.”²⁹ Notwithstanding serious commercial issues around such an approach,³⁰ any heavily protracted timeframe for the phase out of thermal generation, consistent with Australia’s decarbonisation commitments, would only be possible with CCS.

We are cognisant that CCS may well play a role in Australia’s net zero emissions economy. While engineering insight, investment and deployment incentives are often required to overcome cost barriers, many CCS technologies are technically proven.³¹ These appear best suited for rollout where alternatives appear technically unfeasible or not cost effective – for instance, industrial applications such as cement production. However, the case for CCS in many other applications appears less compelling, particularly in advanced economies well-placed to adopt solutions that do not generate emissions needing capture. We further acknowledge that, over the long and very long term, some CCS applications offer negative emissions solutions to help address any overshoot in global temperatures - though such action should be more akin to an insurance policy than a first preference.

That CCS is likely to play a distinct but secondary role in reaching net zero emissions is borne out by leading global authorities. In promoting CCS, LETs 2021 posits, “Analysis by the Intergovernmental Panel on Climate Change [IPCC] and the International Energy Agency [IEA] concluded that the Paris goals won’t be met without geological carbon dioxide storage.” In our submission, this oversimplifies the conclusions reached by both bodies.

The IPCC’s ‘Mitigation pathways compatible with 1.5°C in the context of sustainable development’³² provides that while CCS will likely play a role in deep mitigation efforts, the scale of deployment varies widely across potential pathways consistent with average warming not exceeding 1.5°C.³³ The report continues: “A few 1.5°C pathways with very low energy demand do not include CCS at all...There is uncertainty in the future deployment of CCS given the limited pace of current deployment, the evolution of CCS technology that would be associated with deployment, and the current lack of incentives for large-scale implementation.”³⁴

Similarly, the IEA’s ‘Net Zero by 2050: A roadmap for the global energy sector’ envisages a distinct though subsidiary role for carbon capture. Its own 1.5°C warming scenario provides that only 10% of global industrial energy use, and well under 10% of power generation, will be realised with carbon capture by 2050.³⁵ The IEA notes further that the contribution of carbon capture will vary across countries according to their circumstances.³⁶

The disconnect between the frontline role for CCS envisaged by the Technology Investment Roadmap and the evidence that it is likely to play only a secondary role in Australia must be addressed. LETs 2022 must shift its approach from CCS technologies – deprioritising support relative to solutions of greater importance to Australia’s mitigation challenge.

Recommendation 7: LETs 2022 should deprioritise support for carbon capture and storage, relative to solutions of greater importance to realising Australia’s net zero emissions target.

Hydrogen

Zero emissions hydrogen is likely to play an important, multidimensional role in Australia’s zero emissions economy, and its production represents a significant economic opportunity for the nation. Nonetheless, we note that LETs 2021 supports hydrogen produced via renewable energy and electrolysis, as well as hydrogen produced by steam methane reforming and coal gasification with CCS. Despite ostensibly equal support for all three production methods, their

emissions outcomes are not equivalent. At present, only hydrogen produced with renewables and electrolysis is legitimately 'zero emissions'. Hydrogen manufactured through steam methane reforming and coal gasification is presently associated with methane leakage from gas fields and coal mines. Likewise, carbon capture rates in the steam methane reforming and coal gasification processes are currently imperfect, sitting at around 91% to 94%.³⁷

In addition, Australia enjoys unique comparative advantages in the production of hydrogen from renewable energy and electrolysis: its low population density, favourable geography, and hot dry climate make it well-positioned to deploy solar and wind power at low cost and very large scale.³⁸

For these reasons, LETS 2022 should recalibrate its support for hydrogen technologies, prioritising zero emissions hydrogen produced through renewable energy and electrolysis.

Recommendation 8: LETS 2022 should prioritise support for hydrogen produced using renewable energy and electrolysis.

Soil carbon

Though Engineers Australia recommends that the Commonwealth plays a greater role in supporting uptake of all priority technologies, the case for an expanded, multifaceted approach is particularly clear in the case of soil carbon.

While LETS 2021 focuses on the need for accurate and timely testing of emissions fluxes in the soil sub-surface, measurement represents just one of many obstacles to sequestration as an effective emissions reduction tool.³⁹ Among other challenges are that increased soil productivity, often associated with sequestration, incentivises livestock cultivation – a high emissions activity.⁴⁰ Also due to the related productivity benefits, additionality of incentives to support sequestration is often difficult to establish.⁴¹ Thirdly, while the potential use of biochar as soil amendment to increase sequestration is established, doubts around cost-effective production of that substance remain.

Even if the Australian Government elects not to adjust and expand supports for all priority technologies as we advocate, it must amend its approach to soil carbon to address issues unrelated to measurement technologies.

Recommendation 9: LETS 2022 should address barriers to increasing soil carbon sequestration unrelated to measurement technologies.

Additional technologies

While an amended focus on priority technologies as suggested would enhance the efficacy of the roadmap, a strategy of adequate scale to deliver emissions reductions as required will ultimately need to support the uptake of low emissions solutions in most or all sectors. A whole of emissions lifecycle approach would bring greater rigour to the assessment of additional priority technologies. This would require the Australian Government to consider the emissions impact of technologies holistically - that is, with regard not only to their emissions profile in isolation, but to the implications of uptake for emissions across the economy.

For example, as electric vehicles have zero operational emissions, they are typically classed as a zero-emissions transport technology. Yet most are charged using the electricity grid – increasing demand on a system which continues to rely heavily on fossil fuels in most regions of Australia.⁴² Further upstream, the electric vehicle manufacturing process is more emissions intensive than for internal combustion engine vehicles. Viewed through a wider lens, road infrastructure also includes large quantities of embodied emissions relative to infrastructure utilised by alternative transport modes. A lifecycle approach would require policymakers to consider all such impacts in

directing support to the development and rollout of electric vehicles, and/or prospective solutions in other sectors affected by their uptake.

Recommendation 10: LETS 2022 should adopt a whole of emissions lifecycle approach to assessing and allocating supports to priority technologies.

Coordination of initiatives

Engineers Australia notes that investments and other activities under the Technology Investment Roadmap are managed in large part by five key agencies.⁴³ Given all five have long been engaged in activities to advance the development and uptake of low emissions technologies,⁴⁴ it is appropriate that the Commonwealth seeks to coordinate such actions under an overarching strategy.

However, whether the roadmap has succeeded in coordinating as intended appears open to question. Most notable is its approach to investment in hydrogen technologies. One of the largest investments announced in LETS 2021 is AUD\$410m to support the establishment of ‘hydrogen hubs’ in regional Australia. The statement provides that this investment is intended to geographically consolidate users and producers.⁴⁵ Separately, LETS 2021 also affords priority to hydrogen refuelling stations, in order to “*support consumer choice*” in the vehicle market.⁴⁶ This would require a very widespread rollout of refuelling infrastructure, most importantly in major cities. In every respect, this approach contradicts that advanced in the regional hubs program.

It is also not clear that there is a meaningful nexus between some activities highlighted in the roadmap and the realisation of its vision. For instance, LETS 2021 neglects to explain the connection between its objectives and the work of either the Australian Research Council or CSIRO.

LETS 2022 must amend its approach to coordination. The next statement must ensure that all investments and other activities within its purview are consistent in their focus and intended outcomes, and clearly support the roadmap’s overarching goals.

The inclusion of a program logic model⁴⁷ in future technology statements would assist in achieving the necessary cohesion. This would connect the roadmap’s vision statement with objectives that need to be met to realise that vision, actions from various stakeholders intended to satisfy those objectives, and resourcing required to take those actions. In addition to aiding coordination, a program logic model would assist stakeholders to understand and evaluate the roadmap.

Recommendation 11: LETS 2022 should ensure that all supported actions are consistent in their approach and objectives, and clearly support the Technology Investment Roadmap’s vision and key objectives.

Recommendation 12: LETS 2022 should include a program logic model for the Technology Investment Roadmap.

Evaluation framework

Engineers Australia welcomes the proposed inclusion of an investment evaluation framework future technology statements. It is critical that an initiative at the centre of Australia's emissions reduction program is subjected to ongoing assessment. The Commonwealth must ensure that the first evaluation under the framework is published in LETS 2022.

However, the evaluation framework proposed in LETS 2021 should undergo extensive amendment prior to this analysis. Evaluation of the roadmap must centre on the scale of emissions abatement outcomes achieved, progress towards Australia's net zero emissions target, and related costs. According to the framework proposed, "*Actual and projected progress of Australia's annual emissions*" will represent only the last of twenty metrics against which the roadmap will be assessed.⁴⁸ This is plainly inadequate.

Evaluation should also rely on outcomes attributable to action under the roadmap. According to the proposed framework, the roadmap will be evaluated in large part against the price of priority technologies.⁴⁹ As this submission has established, the potential for the roadmap to meaningfully impact prices in what are dynamic global markets appears highly uncertain.

Recommendation 13: LETS 2022 should include the first annual assessment of the efficacy of the Technology Investment Roadmap.

Recommendation 14: The evaluation framework utilised in LETS 2022 should centre on emissions abatement outcomes attributable to actions under the roadmap, related costs, and progress towards Australia's net zero emissions target.

Conclusion

As this submission has explored, the Technology Investment Roadmap is, in nearly every respect, unsuitable to its ostensible role as the cornerstone of the Australian Government's emissions abatement program. LETS 2022 must therefore represent a fundamental departure from its predecessors: refreshing the roadmap's strategic vision, providing greatly expanded supports, adjusting and expanding technology priorities, and delivering more effective coordination and evaluation. Short of abandoning the roadmap process for an alternative strategy - designed from the outset with a clear and unchallenged view to realising emissions reductions of the target scale - only change of the scale we advocate will suffice.

More information

Engineers Australia welcomes the opportunity to engage further with the Department on the Technology Investment Roadmap and other matters raised in this submission. Please contact Thomas Mortimer, Senior Policy Adviser - Climate Change, via tmortimer@engineersaustralia.org.au or 0422 361 462.

Sincerely,

Jane MacMaster
Chief Engineer

- ¹ That is, discount emissions reductions on 2005 levels achieved to date: Australian Government, *Australia's Long-Term Emissions Reduction Plan*, p. 15, available at <https://www.industry.gov.au/sites/default/files/October%202021/document/australias-long-term-emissions-reduction-plan.pdf>
- ² *Low Emissions Technology Statement 2021*, pp. 8, 11, 17, 48; Australian Government, *Australia's Long-Term Emissions Reduction Plan* (2021), pp. 14, 46, available at <https://www.industry.gov.au/sites/default/files/October%202021/document/australias-long-term-emissions-reduction-plan.pdf>; Minister for Industry, Energy and Emissions Reduction, *Emissions Fall in 2019* (2020), available at <https://www.minister.industry.gov.au/ministers/taylor/media-releases/emissions-fall-2019>; Minister for Industry, Energy and Emissions Reduction, *Harnessing new technology to grow jobs and the economy and lower emissions* (2020), available at <https://www.minister.industry.gov.au/ministers/taylor/media-releases/harnessing-new-technology-grow-jobs-and-economy-and-lower-emissions>
- ³ *Low Emissions Technology Statement 2021*, p. 7; *Low emissions Technology Statement 2020*, p. 4
- ⁴ *Low Emissions Technology Statement 2021*, p. 7; *Low Emissions Technology Statement 2020*, p. 5
- ⁵ Department of Industry, Science, Energy and Resources, *National Greenhouse Gas Inventory: Quarterly updates* (2021), available at <https://www.industry.gov.au/data-and-publications/national-greenhouse-gas-inventory-quarterly-updates>
- ⁶ See Intergovernmental Panel on Climate Change, *2006 IPCC Guidelines for National Greenhouse Gas Inventories: Overview* (2006), available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/0_Overview/V0_1_Overview.pdf; United Nations Framework Convention on Climate Change, *Reporting requirements*, available at <https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/reporting-requirements>
- ⁷ See for example, ABC Radio National Breakfast, *Keith Pitt: Australia will keep selling coal for as long as the world keeps buying it* (2021), available at <https://www.abc.net.au/radionational/programs/breakfast/keith-pitt-australia-cop26-coal-emissions-methane/13620966>; Minister for Industry, Energy and Emissions Reduction, *Interview with Fran Kelly: ABC Radio National Breakfast* (2021), available at <https://www.minister.industry.gov.au/ministers/taylor/transcripts/interview-fran-kelly-abc-radio-national-breakfast-8>
- ⁸ Engineers Australia, *Our position on climate change* (2021), available at <https://www.engineersaustralia.org.au/sites/default/files/resource-files/2021-11/climate-change-position-statement-2021.pdf>
- ⁹ *Low Emissions Technology Statement 2021*, pp. 6, 8
- ¹⁰ *Low Emissions Technology Statement 2021*, p. 20
- ¹¹ The World Bank, *GDP (current US\$)* (2020), available at <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD>
- ¹² See for example, World Steel Association, *World Steel in Figures 2019* (2019), p. 2, available at <https://www.worldsteel.org/en/dam/jcr:96d7a585-e6b2-4d63-b943-4cd9ab621a91/World%2520Steel%2520in%2520Figures%25202019.pdf>
- ¹³ *Low Emissions Technology Statement 2021*, p. 15
- ¹⁴ *Low Emissions Technology Statement 2021*, p. 11
- ¹⁵ *Low Emissions Technology Statement 2021*, p. 34
- ¹⁶ *Low Emissions Technology Statement 2021*, p. 68
- ¹⁷ *Low Emissions Technology Statement 2021*, p. 15
- ¹⁸ Wood, T Reeve, A. & Ha, J. *Towards Net Zero; Practical Policies to Reduce Transport Emissions* (2021), The Grattan Institute, p. 11, available at <https://grattan.edu.au/wp-content/uploads/2021/04/Towards-net-zero-Practical-policies-to-reduce-transport-emissions-Grattan-Report.pdf>
- ¹⁹ *Low Emissions Technology Statement 2021*, p. 24
- ²⁰ See Intergovernmental Panel on Climate Change, *Special Report: Global Warming of 1.5 °C* (2018), available at <https://www.ipcc.ch/sr15/chapter/spm/>; Intergovernmental Panel on Climate Change, *Climate Change 2021: The Physical Science Basis: Summary for Policymakers* (2021), available at https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf
- ²¹ Organisation for Economic Cooperation and Development, *Public procurement – size of public procurement* (2017), p. 12, available at https://www.oecd-ilibrary.org/docserver/gov_glance-2017-59-en.pdf?expires=1642466651&id=id&accname=guest&checksum=3B099D14FFD6A8E14A5B6B9E9F4FDA8E
- ²² Department of Industry, Science, Energy and Resources, *Low Emissions Technology Statement 2022: Webinar* (2021), available at <https://www.industry.gov.au/data-and-publications/low-emissions-technology-statement-2022-webinar>
- ²³ Grant, T.F. *Greenhouse gas and Sustainability Footprints of Emerging Biofuels for Queensland* (2018), Department of Environment and Science
- ²⁴ Crawford, D.F. et al *A spatial assessment of potential biomass for bioenergy in Australia in 2010, and possible expansion by 2030 and 2050* (2015), *GCB Bioenergy*, vol 8 no. 4, available at <https://onlinelibrary.wiley.com/doi/full/10.1111/gcbb.12295>
- ²⁵ See Department of Water, Agriculture and the Environment, *National Waste Policy Action Plan* (2019), available at <https://www.awe.gov.au/sites/default/files/documents/national-waste-policy-action-plan-2019.pdf>

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- ²⁶ Sokolowski, P. *Australia's Poor Energy Systems Resilience* (2021), Institute for Integrated Economic Research – Australia, available at https://globalaccesspartners.org/wp-content/uploads/2021/10/GAP_IIERA_EnergySystemsResilience_Report_Oct2021.pdf
- ²⁷ Australian Renewable Energy Agency, *Australia's Bioenergy Roadmap* (2021), p. 16
- ²⁸ Australian Renewable Energy Agency, *Australia's Bioenergy Roadmap* (2021), p. 5
- ²⁹ *Low Emissions Technology Statement 2021*, pp. 62, 65-66, 72
- ³⁰ Most notably, whether retention of the thermal generation fleet in the long-term is economically efficient given the lower and falling cost of zero emissions alternatives. And, in light of lower-cost alternatives, whether retention could only be achieved via market interference.
- ³¹ See for example, International Energy Agency, *Special report on carbon capture utilisation and storage: CCUS in clean energy transitions* (2020), available at https://iea.blob.core.windows.net/assets/181b48b4-323f-454d-96fb-0bb1889d96a9/CCUS_in_clean_energy_transitions.pdf
- ³² The principal source referenced by LETS 2021 in making the abovementioned claim; *Low Emissions Technology Statement 2021*, p. 80
- ³³ Intergovernmental Panel on Climate Change, *Mitigation pathways compatible with 1.5°C in the context of sustainable development*, pp. 6, 56, available at https://www.ipcc.ch/site/assets/uploads/2018/11/sr15_chapter2.pdf
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