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Economic modelling of potential Australian emissions reduction pathways

Consultation paper – August 2023

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The Authority recognises the First Peoples of this nation and their ongoing connection to culture and country. We acknowledge First Nations peoples as the Traditional Owners, Custodians and Lore Keepers of the world's oldest living and continuous cultures and pay our respects to their Elders – past and present.

Why is the Climate Change Authority undertaking economic modelling?

Australia is due to submit its next Nationally Determined Contribution under the Paris Agreement in 2025. Under the *Climate Change Act 2022*, the Climate Change Authority is to provide advice to the Australian Government on greenhouse gas emissions reduction targets to be included in Australia's Nationally Determined Contributions. The Minister for Climate Change and Energy has formally requested the authority provide advice on a 2035 target and expects to receive it in late 2024.

The authority proposed in its 2023 Issues Paper (Setting, Tracking and Achieving Australia's Emissions Reduction Targets) that its advice on future emissions targets be based on four pillars: international considerations, wellbeing, sectoral pathways and economic analysis. Economic modelling will be a key input to the 'economic analysis' pillar.

Modelling will help the authority understand the opportunities and costs for the Australian economy associated with different emissions reduction scenarios. This includes impacts on national headline figures (such as Gross Domestic Product, Gross National Income, Consumer Price Index, trade balance, and wages) and analysis of impacts at a sectoral level.

Importantly, the authority's economic analysis will not be limited to economic modelling. Modelling will be complemented by other analysis, data, consultation and qualitative research to establish a holistic understanding of the likely socioeconomic implications of possible emissions pathways.

This consultation paper outlines the authority's preliminary thinking on a modelling approach to support its advice, including potential scenarios and assumptions. Feedback on this consultation paper will inform the development of the modelling approach and related analysis. This consultation paper is intended for an expert audience, however we welcome all feedback.

What questions is the modelling aiming to answer?

The authority has identified two key questions to answer with this modelling exercise:

Modelling question 1: What are the likely economic effects on Australia of different emissions pathways to net zero relative to Australia's current level of ambition?

To answer this question, the authority will need to consider both positive and negative economic effects. This includes considering the opportunities and trade-offs in the Australian economy at each stage of the transition to net zero. Modelling of Australia's current level of ambition (its existing targets) is needed as a reference point, along with plausible scenarios for futures where Australia and the world pursue different emissions pathways.

Modelling question 2: What are the likely emissions pathways, outcomes, risks and opportunities for different parts of the economy under different national emissions pathways to net zero?

To answer this question, the authority needs to consider how to break down the whole-of-economy results to provide more granular insights. This includes developing an understanding of where and when decarbonisation could occur in the economy in order to achieve a given whole-of-economy emissions reduction pathway.

Consultation questions: What are your views on the two modelling questions? Are there other questions the authority should explore through economic modelling to inform its advice?

What models does the authority plan to use?

The authority has engaged Australia's national science agency, the CSIRO, to undertake the economic modelling exercise. CSIRO has three well-established models that can be used to answer the two questions above: **GTEM**[i], **AusTIMES**[ii] and **LUTO**[iii].

GTEM can be used to analyse Question 1 above. GTEM is a hybrid model that combines the top-down macroeconomic representation of a computable general equilibrium (CGE) model with the bottom-up engineering details of energy production, along with a representation of greenhouse gas emissions by economic sector. The model features detailed accounting for global energy flows that are embedded in traded energy goods and offers a unified framework to analyse the energy-carbon-environment nexus.

AusTIMES and **LUTO** can be used to answer Question 2, breaking down the results of GTEM to provide greater sectoral detail.

AusTIMES is a partial equilibrium model of the Australian energy system. The model satisfies energy services demand at the minimum total system cost, subject to physical, technological, and policy constraints. Accordingly, the model makes simultaneous decisions regarding technology investment, primary energy supply and energy trade to solve for given constraints.

LUTO is a spatially explicit partial equilibrium model of Australian rural land use that combines data on existing land use, production functions, input and output prices, and physical variables (including climate) to calculate the relative profitability of a wide range of potential land uses. LUTO reports on the implications of land use change for agricultural output, water use, carbon sequestration and habitat restoration.

Consultation questions: What are the strengths or limitations of these models the authority should keep in mind when interpreting their outputs? Are there other models that would provide valuable insights into the questions the authority is trying to answer?

What scenarios does the authority plan to run?

The authority proposes to model scenarios that show the impacts of a range of global and domestic climate action ambition. This will highlight the economic effects in Australia of being ahead, in-step or behind other international efforts to transition to net zero.

For each scenario, the model will solve for a least-cost pathway, given the scenario assumptions including the emissions constraints applied.

Global action

The authority is proposing to model two global action pathways to 2050. These pathways will be broadly aligned with the goals outlined under the Paris Agreement to limit global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. We propose that a **1.5°C pathway** be aligned with action to limit warming to 1.5°C with no or limited overshoot, and a **2°C pathway** be aligned with action to 2050 consistent with limiting warming to less than 2°C.

Key assumptions the authority proposes using for these pathways are outlined in the table below:

Assumption	1.5°C pathway	2°C pathway
Global emissions	Aligned with the Intergovernmental Panel on Climate Change's (IPCC) renewables-focused illustrative mitigation pathway (IMP-Ren)	Aligned with the IPCC's gradual strengthening illustrative mitigation pathway (IMP-GS)
Global energy use and production	Aligned with the International Energy Agency's (IEA) 1.5°C-aligned 2021 Net Zero Emissions scenario	Aligned with the IEA's 2.1°C-aligned 2021 Announced Pledges scenario
Global land-use and forestry emissions	Aligned with a Global Biosphere Management Model (GLOBIOM) scenario consistent with limiting warming to 1.5°C.[iv]	Aligned with a GLOBIOM scenario consistent with limiting warming to 2°C.

The calibration of these pathways will be informed by the climate literature on global emissions pathways consistent with Paris Agreement goals and the distribution of effort across nations.

Consultation questions: Do you think the proposed global action pathways provide an appropriate context for assessing potential Australian emissions pathways? Are there alternatives you think are higher priority pathways to consider? Are the IPCC, IEA and GLOBIOM assumptions appropriate for the proposed scenarios?

Australian action

The authority is proposing to model a '**current ambition**' Australian pathway for each global action pathway outlined above. These pathways would be consistent with Australia's existing emissions reduction commitments of a 43 per cent reduction in greenhouse gas emissions by 2030 from 2005 levels, and net zero greenhouse gas emissions by 2050.

The current ambition pathways would form reference cases against which to compare **more ambitious Australian pathways**. Together, modelling results for these pathways would provide information on the potential economic effects of the range of targets the authority may consider in forming its advice.

Australia's plausible level of ambition is not independent of global ambition. The authority plans to consider more ambitious pathways for Australia alongside more ambitious global action pathways.

The authority does not plan to model Australian emissions pathways that are less ambitious than Australia's current targets.

Consultation question: What potential Australian emissions pathways or scenarios do you think would provide the most valuable modelling insights and inputs to support the authority's advice?

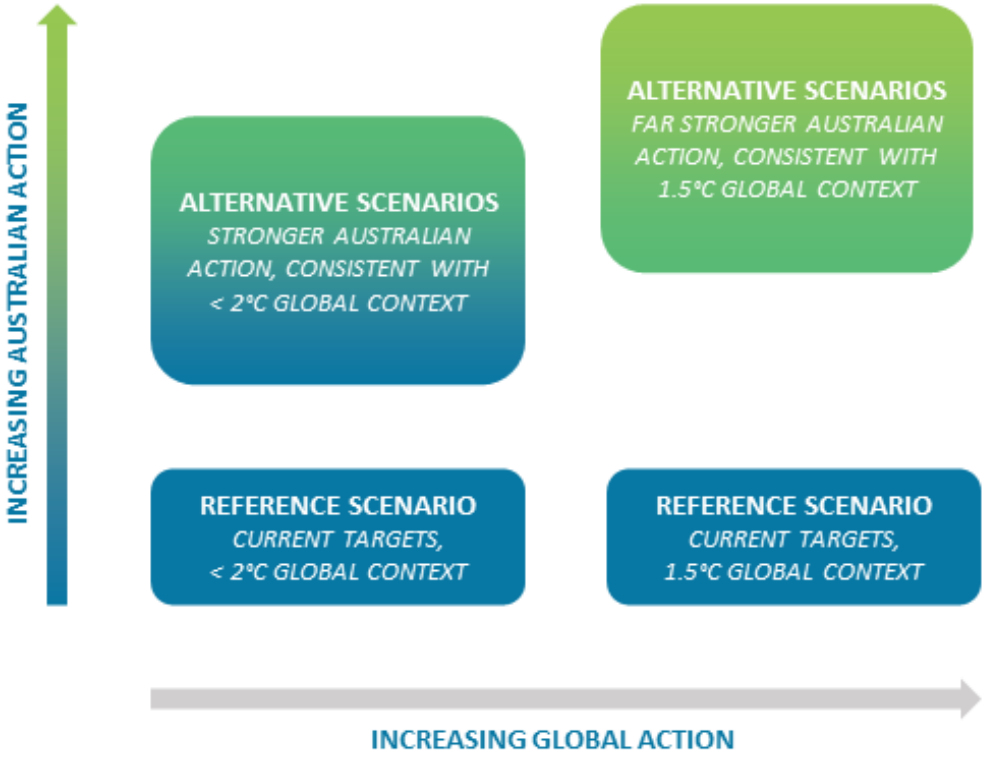

Figure 1: *Proposed scenarios, sorted by levels of global and Australian emissions reduction action.*

Modelling the potential benefits of the net zero transition

The authority is keen to ensure the modelling captures the **potential benefits of greater action for** Australia, particularly in scenarios with faster or deeper emissions reductions in domestic and global emissions. Potential benefits the authority could explore or assess include:

- accelerated technology cost reductions for low-emissions technology, due to stronger global action or targeted research and development investment.
- the emergence of new industries in Australia as a result of the global net zero transition (e.g., green iron and steel, green hydrogen, critical minerals)
- reducing investment risk to or lower costs of capital in Australia, compared to a scenario where Australia takes significantly less action to reduce its emissions than other advanced nations.

Modelling is one of many ways to analyse the economic benefits of the net zero transition. The authority will be complementing its modelling with other quantitative and qualitative analysis that will explore these benefits.

Consultation questions: How do you think the authority should capture the potential benefits of stronger action to reduce national and global emissions in its modelling? Are some approaches better than others?

What questions is the modelling not intended to assess?

The authority does not propose to use this modelling exercise to assess the economic effects of physical climate change impacts, or the benefits (avoided economic costs) of greater reductions in global emissions. Other analytical tools will be used to investigate the likely physical effects of climate change and the impacts they will have on the economy, including drawing on other existing economic modelling.

The authority does not propose to model the economic impacts of specific emissions reduction policies. For example, the modelling could explore the economic effects of an increased take up of electric vehicles but would not assess the relative benefits of different policy mechanisms used to encourage that take up.

The authority's economic modelling of regional impacts will be limited to an extrapolation from the analysis of sectoral impacts. For example, outputs from the modelling on the coal power generation sector can inform analysis of regions with coal power stations. The authority will explore regional economic impacts in greater depth through other means, including case studies, consultation, analysis of demographic data and existing economic modelling.

Consultation question: Are there any other issues the authority should consider as part of its modelling exercise?

How to make a submission

Submissions to this consultation paper can made via our Consultation Hub until 5pm, 15 September 2023. Submissions are published on our Consultation Hub unless made in confidence. Please indicate in your submission whether your submission is made in confidence.

Your submission does not need to be constrained by the issues or questions in this consultation paper. Answer as many or as few questions as you are interested in, and feel free to provide broader commentary, information and evidence than specifically requested in this paper. This can include your previous submissions to other consultation papers, research and data we may not be aware of, or your personal perspective and experiences in modelling emissions reduction and economic impacts.

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[i] GTEM stands for Global Trade and Environment Model. The data and theory behind GTEM are outlined in detail in Cai, Y., Newth, D., Finnigan, J., Gunasekera, D. (2015), 'A Hybrid Energy-Economy Model for Global Integrated Assessment of Climate Change, Carbon Mitigation and Energy Transformation', Applied Energy, 148, pp. 381-395.

[ii] AusTIMES is an Australian version of The Integrated MARKAL-EFOM System (TIMES) model. The TIMES model has been jointly developed under the IEA's Energy Technology Systems Analysis Project (ETSAP). Documentation of the TIMES model generator is available from the ETSAP website. The Australian version of the TIMES model (AusTIMES) has been developed by CSIRO in collaboration with ClimateWorks Australia.

[iii] LUTO stands for the Land Use Trade Offs model. LUTO was developed as a core model of the Australian National Outlook 2015 initiative. More detail on LUTO can be found on the CSIRO website.

[iv] GLOBIOM was developed by the International Institute for Applied Systems Analysis (IIASA). More detail can be found on the IIASA website.