2025 consultation

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21st Century Weather
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ARC Centre of Excellence for the Weather of the 21st Century
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Monash, Thursday 10 July 2025

Subject: 2025 Consultation - NSW Net Zero Commission

Dear members of the NSW Net Zero Commission,

The Australian Research Council Centre of Excellence for the Weather of the 21st Century welcomes the opportunity to contribute to the New South Wales Government's efforts to reach net zero and adapt to a changing climate.

The Centre's goal is to understand and predict the changes in our weather linked to climate change. Building on that understanding, we seek to prepare our communities and economy for these changes. This ambition connects us to virtually all sectors of government and business.

In this submission, we address eight of the 27 questions posed in the Consultation Paper. We use climate change research to highlight that *every tonne of CO_2 emissions adds to global warming*[1]. We also propose policies that can help reduce emissions and limit the impacts of climate change, and research, some of which 21st Century Weather is leading.

We would be happy to discuss the policy approaches outlined in this submission and contribute to future consultation stages with the NSW Net Zero Commission.

Please contact us for further clarification or information.

Professor Christian Jakob
Director, ARC Centre of Excellence for the Weather of the 21st Century

The **ARC Centre of Excellence for the Weather of the 21st Century** is a consortium of world-leading climate and weather researchers based across five Australian universities, together with major domestic and international partner organisations, including the Bureau of Meteorology and CSIRO.

21st Century Weather aims to address these challenges by answering a vital question:
How will Australia's weather transform as our climate changes?

We will advance our understanding of atmospheric circulation and weather systems, and develop ultra-high-resolution climate models to enhance our understanding of Australia's weather and climate.

The foundational knowledge we create will enable policymakers, industry and communities to make better decisions, harness weather resources and help us prepare for high-impact weather.

[1] IPCC. (2021). Climate Change in Data. Climate Change 2021: The Physical Science Basis. Available at: https://www.ipcc.ch/report/ar6/wg1/resources/climate-change-in-data/

Q1: What can you tell us about your experience of the impacts of climate change and how can the Commission seek to reflect and respond to this in its work?

Heatwaves are Australia's deadliest natural disaster. The combination of hot and humid weather conditions significantly increases health risks. Hours-long exposure without shelter can lead to heatstroke or death. Extreme heat can also be deadly in dry conditions, and it can worsen kidney and heart problems.

Strengthening healthcare services is vital to manage the rising number of heat-related casualties. This includes ensuring proper resources, well-trained staff, ample ambulances and medical equipment, as well as preventive measures like robust warning systems, public education and access to cooling spaces. Further, we need more research to understand how heat and humidity affect vulnerable groups like children and pregnant people.

Drought increases the likelihood of extreme heat, which in turn heightens fire risk. Southeast Australia faces longer fire seasons and more extreme fire weather as heatwaves intensify, as seen during the 2019-20 Black Summer. Bushfires cause air pollution, exacerbating respiratory problems.

Conversely, the heavy rainfall that ends droughts can lead to flooding and severe loss of biodiversity, not just the prospect of replenishing dams. To prepare for these intertwined risks and opportunities, our understanding of the interactions between climate, weather and catchment and the impacts of human activities on these systems must deepen.

Weather can impact transport, like fog on highways or floods on roads. Understanding these events requires small-scale localised data that is hard to measure with traditional meteorological methods. Fostering collaboration between climate scientists and transport network managers would help to better understand and respond to these weather-related issues.

Sea level rise and coastal inundation are likely to persist beyond a net zero emissions future. The impacts of rising sea levels will likely be exacerbated by more frequent storm surges. Further, low-lying coastal areas and estuaries along southeast Australia are at a risk of more frequent flooding, threatening the lives of coastal communities and valuable ecosystems.

To address these impacts we must combine mitigation, long-term adaptation and community engagement. Reducing greenhouse gas emissions is critical to stop further damage. Adaptation measures to sea level rise include the protection and restoration of natural coastal defences like

mangroves, salt marshes and sand dunes. Communities' involvement can help develop locally relevant solutions.

Q2: What actions can the Commission take to engage across the community to help drive the shifts needed for the net zero transition and for effective climate change mitigation and adaptation?

'Every tonne of CO_2 emissions adds to global warming.' This key finding from the latest Intergovernmental Panel on Climate Change (IPCC) assessment report means that even the smallest levels of CO_2 emissions matter in reducing climate change impacts. This IPCC statement could be the basis for a tangible, science-based approach to engaging with the community.

Improve climate risk reporting requirements in new fossil fuel-intensive project proposals. Currently, proponents of new fossil fuel projects are required to detail their anticipated greenhouse gas emissions using government guidelines. The Commission could expand those guidelines to include risk and impact assessments of those emissions. This would help dispel the misconception that emissions from fossil fuel projects are negligible.

Work by 21st Century Weather researchers[2] demonstrates how project proposals could robustly assess the impact of future CO_2 emissions, by:

- Quantifying the additional global warming resulting from each proposal.
- Quantifying and assessing the consequences of this additional warming in a risk assessment framework.
- Putting those emissions in the context of Australia's shrinking carbon budget and goal to achieve a 43% reduction by 2030, and to zero by 2050.

Incentivise everyday accessibility to low-emission technologies and long-term and permanent shifts in industry. Policies to support the shift to low-emission and no-emission options include:

- Ongoing and larger incentives to promote the uptake of electric vehicles, home batteries and rooftop solar, as well as the phase out of internal combustion engine vehicles.
- Building more public infrastructure to charge electric vehicles.
- Pushing a year-on-year increase in the use of renewable energy by industry, whether self-generated or drawn from the grid.
- Setting a cut-off date for coal-fired power stations to cease operations.

[2] Currently under peer review.

Decision-making for and by communities. Effective climate change mitigation and adaptation require decision-making by and on behalf of communities. Two key areas of decision-making are:

1. Living and lifestyle choices, including the choice between electric and gas appliances and vehicles, where to live, and which building materials to use.
2. Risk communication, reduction, preparedness and response to weather and climate hazards.

Weather and climate literacy is crucial across all levels of government, industry and society. Weather and climate literacy can empower people to make these critical decisions, leading to positive behavioural change and appropriate mitigation and adaptation actions. We recommend ongoing literacy campaigns from trusted voices and institutions such as 21st Century Weather, the Bureau of Meteorology, CSIRO, the National Environment Science Program and Australian Climate Service.

Q5: What additional information and evidence should the Commission consider when assessing progress towards NSW's targets for reducing net greenhouse gas emissions?

Consider emissions reductions in all decisions within all sectors, even at the local level. Since every tonne of emissions contributes to global warming, careful accounting and tracking of emissions is critical.

Consider the durability of offsets and carbon uptake to estimate net emissions. Net emissions are the combination of emissions and carbon uptake projects, both of which vary with the weather. The volatility of Australia's, and NSW's, land-carbon flux from year to year highlights how carbon uptake due to afforestation can rise and drop with climate variability. Climate extremes, like droughts and heatwaves, can also cause carbon reversals. For example, as the world warms, an increase in fire risk will most likely limit the land's capacity to act as a carbon sink. These climatic factors must be considered to assess the contribution of carbon uptake projects.

While not in scope, **any fossil fuel extraction and export from NSW should be tracked.** Burning fossil fuels in NSW and anywhere in the world has virtually the same impact on our climate.

Q6: The speed of deployment of electricity generation and infrastructure is a key risk to emissions reduction targets. What more could be done to fast-track deployment?

NSW could tailor the installation of renewable energy to match the times of year and day of peak energy use. A key challenge in achieving net zero is ensuring that renewable energy meets demand precisely when and where it is needed because Australia is strongly influenced by rapidly changing weather systems and variations in weather and climate. While battery storage can help balance supply and demand, matching regions of systematic supply and demand could be a better long-term solution. NSW could design its energy network based on weather systems and their future changes.

Q22: What should be included in a monitoring framework for NSW in the context of the transition to net zero, including any specific metrics and indicators?

Include greenhouse gas emissions by sector and by gas, esp. carbon dioxide and methane. While emissions of all greenhouse gases need to fall, there is value in tracking carbon dioxide (CO_2) and methane (CH_4) separately, given their distinct effects and lifetimes in the atmosphere. Methane's role—a short-lived but potent gas that can reduce short-term warming—and efforts to cut its concentration are growing internationally, so this information is essential.

Track carbon uptake projects and assess their durability. Overemphasis on land-based carbon uptake through forestry is risky given the large-scale emissions from fire, as seen during the 2019-20 Black Summer. Indicators of climate risks to carbon sinks, like drought or fires, can ensure that carbon removal is not just claimed but maintained over time.

Focus on large project-level sources of emissions, such as at fossil fuel extraction sites or ports. The evolution of their emissions would highlight the value of policies aimed at reducing emissions at the company level.

Track public and private investment in clean energy and adaptation. Measuring progress can help maintain momentum in climate action. Indicators such as job creation in low-emission industries, household energy use or electricity grid emissions could demonstrate how the economy as a whole is moving towards net zero, and whether the shift is being shared fairly.

Q23: The adaptation objective is for NSW to be more resilient to a changing climate. The Act allows for regulations to further define the adaptation objective. What does a more resilient NSW look like to you?

A more resilient NSW is one where both human and natural systems maintain their core functions despite the increasing frequency, intensity and duration of hazards driven by climate change. This entails the proactive

and preventative adaptation to a broad spectrum of climate-related threats, such as heatwaves, droughts and extreme precipitation events.

Early action enhances systemic resilience, maximises the efficacy of adaptation measures, minimises impacts and expedites recovery processes. Climate projections show many hazards will intensify under ongoing climate change. To effectively manage these risks, climate vulnerability assessments and adaptation strategies must be implemented across all sectors of society.

In a net zero emissions future, the resilience of the electricity, transport and agriculture sectors will depend on a comprehensive understanding of the spatial and temporal characteristics of weather events.

- As the electricity generation sector transitions to renewable energy sources, less conspicuous events such as prolonged periods of low wind can significantly constrain wind energy output. Understanding the weather systems behind those events can help inform infrastructure planning, including the geographic distribution of generation assets, the diversification of energy sources (e.g., solar, wind, hydro), and the design of energy storage solutions (e.g., batteries and pumped hydro).
- The spatial distribution of electric vehicle charging infrastructure must withstand and remain accessible during increasingly severe weather events. Ensuring the robustness of these systems is essential to maintain functionality and public confidence in a decarbonised transport network.
- To achieve enhanced resilience in the water and agricultural sectors, likely changes to the nature of drought must be assessed together with other changes to climate, such as a rise in heatwaves and fire conditions.

Q24: What additional information and evidence should the Commission consider when assessing progress towards the adaptation objective?

The representation of most hazards is gradually improving with advances in higher-resolution modelling. Our understanding of future climate change is primarily derived from simulations produced by global and regional climate models. While global models provide valuable insights at broad spatial scales, they struggle to represent the small-scale processes that generate high-impact weather hazards. Regional models have higher spatial resolution and can better represent many of these processes. However, phenomena such as hail and extreme wind gusts can only be assessed indirectly due to insufficient model resolution. Nonetheless, as models approach kilometre-scale resolution or better, these hazards will become resolvable, enabling direct assessment of their behaviour under climate change and quantification of associated risks.

The iterative progress of models must be accompanied by ongoing climate risk assessments and evaluation of adaptation strategies to ensure they remain relevant and effective.

Q26: What other information or tools are needed to support decision-makers in NSW?

Climatic hazards manifest within the context of weather systems. Research into climate change risks frequently focuses on statistical analyses of individual hazards, their historical trends and future trajectories. While this line of inquiry is crucial to assess climate risk and adaptation planning, every occurrence of a climate hazard is caused by a weather system or a sequence of them. Therefore, changes in the temporal and spatial sequencing of weather systems play a critical role in shaping the occurrence and interaction of climatic hazards.

Weather systems' dynamics produce and control compound hazards. Compound climate hazards are the co-occurrence of two or more hazards in close temporal or spatial proximity. They can result in disproportionately severe impacts compared to isolated events. Thus, a deeper understanding of weather systems, and how they are changing with climate change, can offer valuable insights into the mechanisms behind compound climate hazards.

Compounding and cascading risks must be a focus to enhance resilience. An increased overlap in the fire seasons of North America and Australia, with whom we share aerial firefighting resources, heightens our vulnerability to fires.