ATTACHMENT A

KEY STATISTICS AND MESSAGES FROM EXPERT PRESENTERS AT AUSTRALIAN CLIMATE ROUNDTABLE WORKSHOPS

<table>
<tr><th>Workshop 1</th><th>Exploring the Risks and Impacts of Climate Change on Australia: Physical Climate Changes</th></tr>
<tr><td>Dr Karl Braganza, Bureau of Meteorology</td><td>Exploring the Risks and Impacts of Climate Change on Australia: Physical Climate Changes</td></tr>
<tr><td></td><td>Changes already happening and requiring adaptation:
• Increased frequency of large-scale heatwaves and record-high temperatures
• Prolonged high ocean temperatures
• Longer fire season with more extreme fire danger days
• Reduced average rainfall and more time spent in drought
• An increase in heavy rainfall
• Increased frequency of coastal storm surge inundation</td></tr>
<tr><td></td><td>Future Sea Level:
• Inundation from storm tide under a business-as-usual median-estimate sea level rise by 2050 (1-in-100 year storm tide ~2.32 metres)
• Inundation from storm tide under a business-as-usual high-estimate sea level rise by 2100 (1-in-100 year storm tide ~3.08 metres)</td></tr>
<tr><td></td><td>Australian average temperature trends from different emissions pathways:
• Australia’s warmest year on record, 2013, will be considered a cool year after around 2050 under medium and high emissions scenarios.</td></tr>
<tr><td></td><td>Scenarios: Record Breaking extreme heat:
• A heatwave like 1939, 2009 and 2017 combined, but hotter.
    ○ Adelaide to 47C
    ○ Melbourne 50C
    ○ Western Sydney towards 50C
• Top of the scale are surface temperatures above 50 degrees Celsius for 12-15 December 2090. (CSIRO CCAM model downscaling UK Met Office HadGCM2- CC for RCP8.5 to 5km resolution)</td></tr>
<tr><td>Prof. Andy Pitman, Director, ARC Centre of Excellence for</td><td>Future projections for Australia</td></tr>
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Climate Extremes, University of NSW	
	Future temperatures: • Future averaged warming: RCP 8.5 (scenario where global greenhouse gas concentrations grow strongly) at 2100: +4oC over 2000 • Future averaged warming: RCP 2.6 (scenario where global greenhouse gas concentrations decline strongly) at 2100: +1oC over 2000 • It is important to understand that a change in these global average hides very much larger changes in some regions over land
	The future: inertia • Stop emissions, takes ~20 years for temperature to stop rising. Takes a millennium for sea levels to stop rising • Mitigation (cutting CO_2 emissions) is 20 years late. We argued for deep cuts in 2000 to 7 billion tonnes of emissions – 20 years later we emit 10 billion tonnes • Adaptation is necessary, but adaptation to 4oC is unlikely to be feasible

	Summary
	• Higher temperatures are locked in.
	  ○ Hotter days, hotter nights, heatwaves
	  ○ But smaller increases if emissions are rapidly reduced
	• More intense rainfall is locked in where rainfall occurs in storms.
	  ○ Evidence that the most intense storms are intensifying most
	  ○ Some places will see less rain due to how the largescale climate changes
	  ○ Increase in the variability of rainfall
	• Everything is worse at RCP8.5 cf. RCP4.5 cf. RCP2.6 but at local to regional scales the benefits of low emissions must be assessed case-by-case
	• In a risk framework, deeply cutting emissions – so net zero fast – is required.
	• To get an accurate picture of changes at the scale of a city is very challenging. Climate models are not designed for this.

Workshop 2	**Climate change impact: Australia's water resources and dependent systems**
Dr Chantal Donnelly, Leader, Water Investigations team, Bureau of Meteorology	**Climate change impact: Australia's water resources and dependent systems**
	Australia is the driest inhabited continent with highest per capita water use.

	Rainfall: projected changes • Drying trend projected to continue in southwest WA, southeastern Australia • Winter rainfall declines also to continue in Southern Australia Key Messages: • Soil moisture is currently decreasing in southwest and southeast of Australia. • Mean rainfall and runoff is currently decreasing and somewhat likely to continue decreasing in southwest and southeast of Australia. • But, annual variability is large (can mask or enhance climate change impacts in the short-term). Variability may increase. • Winter rainfall and runoff is projected to decrease in major agricultural regions (high confidence, SE Australia). • As a result Winter runoff and streamflow likely to decrease. • For nearly all regions, flash flood risks will increase. • Groundwater in the MDB is decreasing and might be expected to decrease going forward.
	• Increased investments into resilient drinking water sources will be needed. • Cost of adaptation could be relatively high – conflicting needs of drought and flood adaptation. • Some environmental assets may not survive.
Professor Lesley Hughes, Department of Biological Sciences, Macquarie University	**Climate change impact: Australia's natural systems**
	Fires penetrating into new ecosystems • World Heritage Area, Tasmania: substantial portion burnt (2016) • 80% Blue Mountains World Heritage Area burnt (2019/20) • 50% Gondwana rainforests burnt (2019/20)
	Coral reefs are bleaching • Bleaching in 2016/17 & 2017/18 →up to 50% loss hard coral cover on GBR • GBR worth ~$6 billion p.a. Provides 60,000-70,000 jobs
	More impacts on natural systems and ecosystem services • Mangroves dying in Gulf of Carpentaria • River red gums in Murray Darling system affected by drought & salinity • Fish mortality in Menindee Lakes

	• Saltwater intruding into freshwater ecosystems • Most of Kakadu floodplain <.5m asl, thus very vulnerable to sea level rise • Snow cover & duration declining in Snowy Mountains • Kelp forests declining from multiple causes, including ocean warming • Jarrah forest dieback in WA due to heat and drought • Turtles feminizing • Australia has first documented mammalian extinction due to climate change (Bramble Cay melomys due to storm surge and sea level rise in Torres Strait)
Workshop 3	**Exploring the Risks and Impacts of Climate Change on Australia: Sectoral impacts Infrastructure and Insurance**
Kate Bromley, QIC	**Overview of the impacts of climate change on infrastructure**
	Key Issues for Infrastructure in Building Physical Resilience: Standards and Guidelines • No set guidance or standards for assessing the physical resilience of infrastructure • Standards currently applied to infrastructure assets and portfolios include ISCA's Infrastructure Sustainability rating, the Green Building Council of Australia's Green Star rating, and the Global Real Estate Sustainability Benchmark (GRESB) Infrastructure Fund Assessment. Climate change impacts at regional/local level • Climate change impact at larger geographical scales and over the long-term are well understood, however there are nuances and difficulties at understanding the impacts at a regional and local level. Different infrastructure projects, and classes of infrastructure assets, face unique challenges. • Planning for these risks may mean building infrastructure to different standards, or considering different options for the nature, operations or location of an asset. Beyond the physical impacts • Some infrastructure assets face many impacts beyond just the physical: economic losses, businesses disruption, supply chain shocks, ripple effects, city construction and design (urbanisation with increase of non-permeable surfaces/lack of drainage creates additional flood risk) Infrastructure in a net zero carbon future • 70% of GHG in Australia directly attributable or influenced by infrastructure • Infrastructure assets built and managed today will still be operating in 2050 when countries are expected to reach net zero emissions under the Paris Climate Agreement. All Australian states and territories have set commitments or aspirations to reach net zero emissions by 2050. • Infra that is unprepared for net zero emissions risk becoming 'stranded' assets and face unanticipated losses of value Associated costs

	- Responding to climate change risks is becoming critical for accessing capital markets – flow on impact to insurance premiums, credit risks and portfolio value at-risk - Infrastructure that is incompatible with net zero emissions in 2050 will face a restricted pool of financing and insurance. - Infrastructure that aligns with sustainability outcomes, such as net zero emissions, can sometimes involve higher upfront capital costs than traditional infrastructure – often more than compensated for by savings in operational costs (energy use and maintenance).
Nicola Falcon, AEMO	**Case study – Impacts of climate change on electricity sector**
	Electricity sector vulnerabilities - Individual electricity sector assets have climate vulnerabilities that may damage equipment or reduce cashflows. - The electricity system as a whole is particularly vulnerable to coincident and compound climate impacts, potentially impacting system reliability during extreme weather conditions when customers are most vulnerable. Quantifying customer outcomes: - AEMO makes investment recommendations on behalf of society, we therefore need to make prudent decisions to minimise these risks considering substantial uncertainty, including climate uncertainty. - But low probability high impact 'tail risks' are likely to become more probable and possibly higher impact as coincident climate impacts arise. - The availability of strategic system redundancy and operational flexibility means that the relationship between climate impacts and customer outcomes is highly non-linear. - There are significant implications on the electricity system from temperature, bushfire, wind, precipitation/dam inflows, coastal inundation.
Mark Leplastrier, IAG	**Severe Weather in a Changing Climate**
	There are regional trends in tropical cyclones, severe thunderstorms hail. Sea levels will continue to rise. - Under RCP 8.5 scenario sea level rise projected at 2.5 metres in 2100, increases toward 10 metres by 2200. - Worldwide more than 100 million people live within 1 metre of high tide. Regional variations in climate sensitivity and average annual loss per property have hyper local sensitivity.

	• Annual average losses vs current climate: 23% increase in losses at 2°C and 52% increase in losses at 3°C, with significant regional variations. • Worse case is the Tweed/Byron region with an 80% increase at 2°C and 170% increase in losses at over 3°C. Property-level peril risk assessment includes scientific review, changes in weather extremes, catastrophe models, and impact on peril risk.
Workshop 4	**Exploring the Risks and Impacts of Climate Change on Australia: Human Health, Disasters and Communities**
Dr Robert Glasser, Visiting Fellow, Australian Strategic Policy Institute	**Climate Change, Natural Disasters and Communities**
	Climate science findings: • Even "small" changes in temperature have big impacts on hazards, which in turn have big impacts on communities. • We will be surprised: Changes are happening non-linearly. • Warming of at least 1.5 degrees is already locked-in. "Small" changes = big impact • Extreme heat events increased 20- fold over last 10 years, relative to previous 30 years (IAG/Hansen) • From less than 1 degree C of warming • Over 3 degrees of warming is likely Extreme flooding: Sea-level rise • 10cm rise= 1-in-100-year event, becomes 1-in-33-year event • 20cm rise= 1-in-11-year event • Soon annual event in many places • Over 30 cm rise by 2050 (IPCC). IPCC Report: difference between 1.5 and 2.0 degrees warming: • 50% increase in water stress • 420 million more people exposed to extreme heatwaves • Up to 270 million more to water scarcity

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10X increase in vulnerable people exposed to decrease in crop yields (8-81 million), jumping 30X at 3 degrees of warming
100 million people fall into poverty

Climate change is increasing risk of compound events and cascading impacts:

Increasing the severity (cyclones) and frequency (floods, bushfires) of sudden-onset hazards.
Changing the patterns (lengthening bushfire season, cyclone tracking further south, flood zones—e.g. Hurricane Harvey)
Interactions with slow-onset hazards (sea-level rise + cyclone= extreme storm surge)

Building community resilience

Increasingly urgent: Over half of QLGAs have had 3 or more disasters in past three years.

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<tr><td>John Richardson, National Resilience Adviser, Australian Red Cross</td><td>Climate Change, Health and Communities
The Human Impacts of Disaster</td></tr>
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The human impacts of disaster are long, protracted and complex, and disrupt people’s lives for years, if not into decades.
Social costs tend to persist over a person’s lifetime while most tangible costs are a one-off. The social costs are equal to, if not greater than the physical costs.
Recovery is a multifaceted complex process, with people at the Centre. Defining recovery: The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and ‘build back better’, to avoid or reduce future disaster risk.
People have capacity to deal with disasters. Repeated or extended disasters may exhaust this capacity
What does a changing climate mean?

Greater number of deaths from smoke inhalation
Greater number of deaths from extreme heat and cold
Higher levels of PTSD and depression with longer fire seasons, more extreme fire weather days
Disruption of cities from flash flooding

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	• More intense droughts • Pressures on housing and rebuilding from cyclone impacts in areas not built to code Multiple and extended disasters reduce people's coping capacity. People may be forced to make decisions about where and how they live.
Workshop 5	**Exploring the Risks and Impacts of Climate Change on Australia: Macroeconomic risks**
Alex Heath, Head of Economic Analysis Department, Reserve Bank of Australia	**Economic and financial stability impacts of climate change: a central bank's perspective**
	Climate weather events have always affected Australian macroeconomic variables. Systemic climate change is more challenging. • Trends vs cycles • The nature and persistence of shocks • Changes in behaviour and expectations ↔ changes in prices • Policy responses • History is not very helpful
Prof Tom Kompas, School of Biosciences, School of Ecosystem and Forest Sciences Melbourne Sustainability Society Institute University of Melbourne	**Country Inequality, Australia and the Economic Damages from Global Warming**
	Climate change is happening faster than we thought. • More destructive hurricanes are developing; devastating fires burn on every continent except Antarctica; the ice is melting and sea-level rise is accelerating – threatening island nations, major cities, and coastal areas.

	• Water supplies are shrinking in many parts of the world and droughts are threatening farms, livelihoods and food security. • The ocean is warming and becoming more acidic, destroying coral reefs and harming fish populations. • Record-high temperatures are making many parts of the planet unlivable, and the number of climate refugees is growing rapidly.
	Estimation of long term GDP loss per year in 2100 and forward under global warming scenarios ($US billion/year) • Global long term economic damages in 2100 (albeit with limited damage functions) at 3°C are $US 9.5+ trillion per year and at 4°C losses are $US 23+ trillion per year. Cumulative damages from now unitil 2100 are more than $600 trillion. • Long-run annual losses in GDP (on average) range from 2-6% depending on SSP and/or assumptions on economic growth. • The real point: Some country losses are especially severe. GDP losses, for example, at 4°C, for Cambodia, Sri Lanka, and Nicaragua are over 17%, for Indonesia 19%, for India 14%, Thailand 17%, Singapore 16%, the Philippines 20%, and for much of Africa the losses range from 18 to over 26% of GDP. Global losses in GDP during the Great Depression (1930s) were 15%. (China 4.6%, USA 0.9%) Damages or avoided costs (BAU) for Australia • (2020-2050 BAU/RCP 8.5) Infrastructure damages $611 billion; productivity losses (agric and labour) $151 billion; biodiversity losses (WTP): $116 billion. • Total: $878 billion USD ($1.34 trillion AUD). • Added? Bushfires: $48 Billion AUD 2 or 3 times a decade (48x2.5x3), or $360 billion AUD. (Total: $1.89 trillion AUD)
	Costs of emissions reduction The cost of transition from fossil fuels to renewables (energy, transport, etc.), changes in net exports, deadweight losses from a price on carbon (or equivalent renewable target), cost of land-use changes, cost of negative emissions technology (NET). • Key drivers: Rapidly falling price of renewables, changes in resource efficiency. • Example Target: 70% share of renewables in end-use energy consumption in 2050. (ROW on Paris target.) • (2020-2050 target): Deadweight loss/change in GDP ($31.65 billion) and cost of energy transition ($40.76 billion): $72.41 billion USD ($106.81 billion AUD). • Or: $106/$80977 = .0013 or 0.13% of cumulative GDP.
	The severe falls in GDP in the long term will put many governments in fiscal stress. Tax revenues will fall dramatically and increases in the frequency and severity of weather events and other natural disasters, which invoke

	significant emergency management responses and expenditures, indicate that pressure on government budgets will be especially severe.
Dr Alan Rai, Director, Baringa Partners LLP	**The application of macroeconomic and systemic financial climate risks** *Embedding a climate risk framework within financial institutions*
	Baringa's climate scenario modelling framework integrates transition and physical risk scenarios into aggregate and instrument level impacts on financial statements. A key output from the model is an organisation's temperature alignment i.e. the warming scenario that their portfolio would be aligned with if there is no additional climate change action by the organisation. Temperature alignment is a key plank of the evidence base on which to discuss mitigation and adaption measures with clients. Baringa's model is part of a broader analytical toolkit that seeks to provide climate-risk related insights to inform and influence a financial institution's strategic decision making and strategic priorities.