Senate Inquiry

into

Recent Trends in and Preparedness for Extreme Weather Events

SUBMISSION

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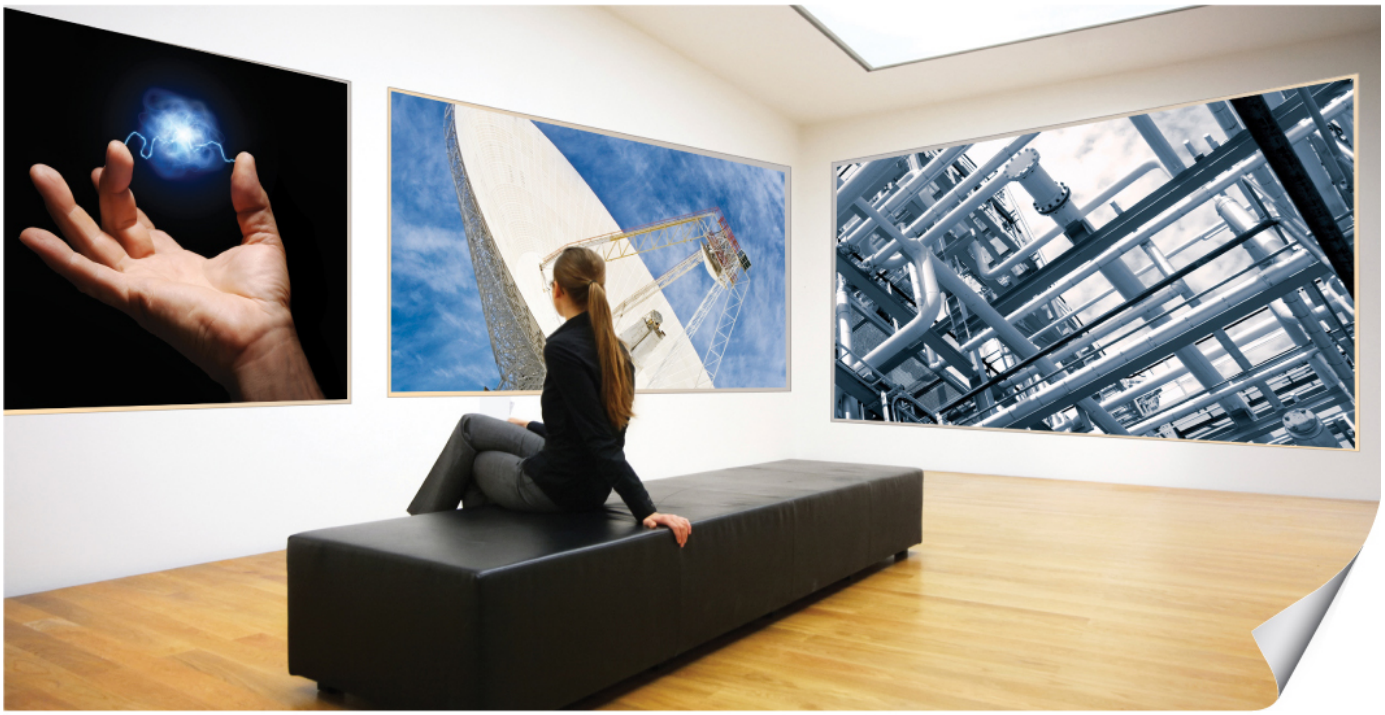

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EXECUTIVE SUMMARY

Engineers Australia welcomes the opportunity to make this submission to the *Inquiry into recent trends in and preparedness for extreme weather events*. Engineers Australia recognises that robust, resilient and cost effective infrastructure underpins Australia's economic security and wellbeing. For the purposes of this submission, infrastructure consists of transport, water, energy and telecommunications assets engineered to facilitate the flow of goods, energy and services between producers and consumers.

Given infrastructure's importance, it is critical that transport, water, energy and telecommunications systems are able to resist the effects of extreme weather events, or where damage occurs, to be rapidly brought back into service. For this to occur, infrastructure owners, designers, constructors and operators need to ensure that their projects do not further contribute to the causes of severe weather events (climate change), and that they design and build both emergency operational and strategic preparedness into their projects. Such capabilities must span the prevention, preparation, response and recovery spectrum.

Establishing the quality of the emergency operational preparedness within each infrastructure owner/operator is mostly within the control of that organisation. For example, each organisation within its resource constraints can determine the size and efficiency of emergency response crews, the level of stockpiling replacement assets, and the development of memoranda of understanding with interstate utilities so that their staff can be brought in to assist in the response and recovery. For the majority of Australia's infrastructure owners/operators, the quality of the emergency operational preparedness is high given resource constraints. This is reflected in the general high quality of response following disastrous extreme events.

However, for much of the nation's infrastructure systems, strategic preparedness is inadequate. Strategic preparedness capabilities are those geared to preventing damage from occurring or minimising its impact. Examples are designing structures that exceed current wind loads, building in areas not prone to natural disasters, maintaining redundant systems, and providing excess supply capacity. The reasons for this low level of strategic preparedness are complex and outside the control of infrastructure owners/operators. They include institutional frameworks (e.g. national policy, legislation, economic regulation and standards and codes), changes in population vulnerabilities, and significantly, changes in the location of, and the increasing severity and frequency of, severe weather events due to climate change. All of these factors place impediments on how infrastructure owners/operators can build strategic preparedness to extreme weather events.

This submission examines the strategic preparation of infrastructure owners/operators for extreme weather events in terms of their ability to adapt to the effects of climate change. This incorporates not only adapting to extreme weather events themselves but also adapting to climate change, which in turn is to contribute to changes in extreme weather events.

Engineers Australia makes the following recommendation to improve infrastructure owners/operators preparation for extreme weather events

1. Infrastructure sector stakeholders should develop and report on metrics which identify their level of operational and strategic preparedness for extreme weather events.

2. Infrastructure sector stakeholders should work together to develop a detailed understanding of the existing institutional framework for each infrastructure sector in relation to climate change adaptation, including reporting on the constraints and barriers to adaptation, and this document should be used to form the basis for a structured approach to reforming institution frameworks so as to embed adaptation in the sector.
3. Infrastructure sector stakeholders should work together to prioritise the key cross-sector engineering adaptation initiatives identified in this submission and work to advance them.
4. Infrastructure sector stakeholders should adopt sustainability principles in the design, construction and operation of all infrastructure projects, and particularly adopt targets related to the ongoing reduction of emissions that are contributing to climate change.
5. Governments should encourage the uptake of sustainability assessment and rating schemes (e.g. AGIC's IS rating scheme) in pursuing the realisation of Recommendation 4.

INTRODUCTION

Engineers Australia welcomes the opportunity to make this submission to the *Inquiry into recent trends in and preparedness for extreme weather events*. Its comments relate to the following three terms of reference:

(c) an assessment of the preparedness of key sectors for extreme weather events, including major infrastructure (electricity, water, transport, telecommunications), health, construction and property, and agriculture and forestry;

(e) the current roles and effectiveness of the division of responsibilities between different levels of government (federal, state and local) to manage extreme weather events;

(f) progress in developing effective national coordination of climate change response and risk management, including legislative and regulatory reform, standards and codes, taxation arrangements and economic instruments.

About Engineers Australia

Engineers Australia is the professional body for engineering practitioners in Australia, representing all disciplines and branches of engineering. With membership of over 100,000 Australia wide, Engineers Australia is the largest and most diverse professional engineering association in Australia.

All Engineers Australia members are bound by a common commitment to promote engineering and to facilitate its practice for the common good. Engineers Australia maintains representation in every state and territory.

Engineers Australia accredits university courses in engineering using internationally accepted standards and protocols and audits practitioner competencies against world best practice. Engineers Australia facilitates the transition of its graduate members to fully competent practicing engineers capable of independent engineering decision making and professional judgement; it facilitates an environment of continuous professional development for its members, and provides the frameworks and facilities required for the development and exchange of engineering knowledge through its learned society activities.

The Engineering Profession

The collective membership of Engineers Australia is referred to in terms of the 'engineering team'. The engineering team in Australia is comprised of three groups:

- Professional engineers.
- Engineering technologists.
- Engineering associates.

To qualify for the engineering team, individuals must have formal educational qualifications in engineering. The educational qualifications required are:

- Professional engineers, at least the equivalent of a four year full time bachelor degree in engineering.
- Engineering technologist, at least the equivalent of a three year full time bachelor degree in engineering technology.
- Engineering associate, at least the equivalent of a two year full time associate degree or a diploma or advanced diploma in engineering technology.

Engineering applies science-based theory and practice to analyse, design and manage technology-based physical systems and to provide the supporting infrastructure. Engineering is a diverse profession, and engineers are involved in various aspects of infrastructure-related organisations,

projects, programs to create assets and infrastructure and the attendant processes for their safe, effective and long-life operation and maintenance. This includes everything from design and maintenance of information technology and communications networks to the design of critical infrastructure and physical assets and the integration of complex systems and structures. Engineering expertise plays a central role in government's ability to design, develop and to provide quality technical assessments and processes in the critical national security and defence domain.

THE CHANGING CLIMATE ENVIRONMENT

Engineers Australia accepts the overwhelming scientific evidence that anthropogenic global warming is causing change to the earth's climate. These changes are shifting the average mean temperature of the oceans and the atmosphere of the planet upwards. The extent of the shift and time frame for the changes are extremely difficult to predict. Suffice to say that we have already experienced a global average surface temperature rise of close to 1.0 degree Celsius since the beginning of the industrial revolution. While attempts to contain global average rises to within a deemed safe level of 2 degrees were proposed and largely accepted internationally, serious mitigation efforts are yet to be internationally agreed. It is now widely predicted by climatologists that the current world wide emissions trajectory will see a rise closer to 4 degrees Celsius, or higher, unless drastic measures to curb emissions are taken.

Two impacts of a warming planet are contributing to the increasing severity of weather events. A hotter atmosphere can hold and transport more moisture resulting in increasing intensity of rain and snow falls. Secondly, a warming ocean increases sea levels, and causes cyclonic events to increase in intensity as they gather energy travelling across water. The net effect is a significant increase in both intensity and variability of severe weather events compounded by higher sea levels.

Much of Australia's infrastructure is located adjacent to the Australian coastline where weather events are at their most severe, and where sea level rise will exacerbate severe weather impacts.

MEASURING THE LEVEL OF PREPAREDNESS

Infrastructure has always been prone to extreme weather events. To address this risk, owners/operators of infrastructure have built both emergency operational and strategic preparedness capabilities across the prevention, preparation, response and recovery spectrum.

Operational preparedness capabilities are those geared to preparing, responding and recovering so that when damage occurs to infrastructure, continuity is rapidly restored. Examples of such capabilities are emergency response crews, stockpiling replacement assets, and developing memoranda of understanding with interstate utilities so that their staff can be brought in to assist in the response and recovery.

The scale of emergency operational activities following extreme weather events can be enormous. For example, the Forcett/Peninsula bushfires in south-east Tasmania in January 2013 destroyed over 600 power poles, more than 100 transformers, and more than 20 kilometres of power lines.[1] The response by the electricity distribution company, Aurora Energy, was the State's single biggest mobilisation of resources for an electricity emergency in history. Up to 250 Aurora employees and both state and interstate contractors worked for up to 16 hours per day over a period of 14 days to complete all reconnections in the damaged area.[2] Given the huge amount of infrastructure destroyed and the initial need to ensure that downed power lines and power poles were safe, the response reflects highly on

[1] http://www.auroraenergy.com.au/bushfire/electrical-restoration
[2] http://www.aurora.com.au/media_centre/Download.aspx?view=238

the operational preparedness of Aurora Energy. Another sign of its preparedness was the fact that Aurora Energy did not experience any asset shortages for its reconstruction activities.[3]

Strategic preparedness capabilities are those geared to preventing damage from occurring or minimising its impact. Examples are designing structures that exceed current wind loads, building in areas not prone to natural disasters, maintaining redundant systems, and providing excess supply capacity.

Assessing the quality of preparedness across Australia is challenging as there are no standard metrics to measure it.

Some indication of operational preparedness can be obtained by examining published metrics that reflect continuity of infrastructure services (such as examining outage duration and restoration time for electricity systems, or the dependability of an access slot for airports). However, these do not actually identify the loss of continuity specifically caused by extreme weather events. The lack of metrics on operational preparedness means that an assessment needs to be made based on synthesising the results of actual incidents, and evaluating the preparations made to respond and recover. Evaluating the preparations made to respond and recover can be done through comparing the owner/operator's emergency management and business continuity activities with best practice. This would include assessing their risk management arrangements, emergency and business continuity plans, and communication with the public and information sharing ability. These activities are commonly reported by the companies, however, rarely in a form that allows comparisons over time or across organisations.

Determining objectively the level of strategic preparedness for each infrastructure sector or geographic region is currently impossible as there are no accepted measures for this.

The lack of metrics on infrastructure owners/operators' levels of operational and strategic preparedness for extreme weather events means that it is difficult to determine how the levels change over time and across geographic areas. This means that it is not possible for owners/operators and stakeholders to determine if this is an appropriate level given existing constraints, and if not, what constraint changes are required to address the shortfall.

Recommendation 1

Infrastructure sector stakeholders should develop and report on metrics which identify their level of operational and strategic preparedness for extreme weather events.

PREPAREDNESS LEVELS AND CONSTRAINTS ON IMPROVING THEM

As identified above, making a rigorous assessment is currently not possible. However, an indication of the level can be obtained by examining the response to recent disastrous events and through the information gathered during preparation of the Engineers Australia 2010 Australian Infrastructure Report Cards[4].

Examining a number of recent disastrous events, including the 2009 Victorian Black Saturday bushfires, the 2009 and 2011 fires that affected Western Australia, and the 2010–11 floods that inundated Queensland, Western Australia, New South Wales and regional Victoria, reveals that the effort shown by the infrastructure owners/operators was generally at a similar high standard to that of Aurora Energy described above.

The 2010 Australian Infrastructure Report Card project assessed infrastructure in each State and Territory in terms of its fitness for purpose. The report takes a strategic view, and was not an audit of

[3] http://www.auroraenergy.com.au/bushfire/electrical-restoration
[4] http://www.engineersaustralia.org.au/infrastructure-report-card

each piece of infrastructure in every State and Territory. The report is based on publicly available information. The Report Cards were developed in consultation with stakeholders and infrastructure owners/operators and each chapter was reviewed by sector experts. The ratings and recommendations are developed by the Division Infrastructure Report Card Committee in conjunction with the sector experts.

The Report Card process obtained information on owners/operators' emergency management and business continuity preparedness. Based on this information, the consultant that drafted the Report Cards considers that the vast majority of infrastructure owners/operators have a moderate and growing level of emergency management and business continuity preparedness for extreme events. This assessment coupled with the observed outcomes from recent disastrous events leads to the conclusion that, given resource constraints, the disaster operational capability is appropriate.

However, based on the information gathered during the Report Card process, there is a low level of strategic preparedness. The reasons for this low level are complex and mostly outside the control of infrastructure owners/operators. They include institutional frameworks (e.g. national policy, legislation, economic regulation and standards and codes), changes in the frequency, scale and location of extreme events, and changes in population vulnerabilities. All of these factors place impediments on how infrastructure owners/operators can build strategic preparedness to extreme weather events.

This submission does not discuss changes in the frequency, scale and location of extreme events as this is well discussed in climate change literature. Nor does it discuss changes in population vulnerabilities as this has also been noted in other publications.[5] Changes in vulnerabilities can be caused by increased development in hazardous areas such as coastal and treed locations, urbanisation, and dependence on infrastructure services for climate control.
This submission focuses on institutional frameworks, as the constraints that they impose on the activities of infrastructure owners/operators are consistently underappreciated. While this Inquiry is focusing on preparation for extreme weather events, it is more useful to examine the issue as part of climate change adaptation. Adaptation is the process by which strategies to moderate, cope with, and take advantage of the consequences of climate events are enhanced, developed and implemented. Adaptation's goal in relation to infrastructure systems is to make them more resilient to changing extreme weather events (notably increasing frequency and severity) as well as mean levels. Thus building climate change adaptation in infrastructure means increasing its ability to withstand extreme weather events, and more rapidly recover from them.

To date, adaptation issues have not become deeply embedded in Australia's infrastructure-related institutional frameworks, which significantly explains why infrastructure owners/operators' strategic preparedness is low. Below is a summary of the degree to which selected institutional frameworks consider adaptation issues.

Where there is recognition that climate change will affect infrastructure in the vast majority of high-level Australian Government and State/Territory infrastructure-related strategies, the focus in these documents is on mitigating greenhouse gas production rather than adapting to climate variability and long-term climate change. Only about half of the national-level strategies identify the need to adapt and almost none of those that identified the need treated the issue in depth. For example, the National Land Freight Strategy and the National Ports Strategy do not explicitly refer to adaptation, although both recognise that climate change should be considered as an input in identifying the future needs of infrastructure. The National Aviation Policy White Paper does not consider climate change effects at all.

Two national-level strategies explicitly recognise the need for adaptation. The *Critical Infrastructure Resilience Strategy* (2010 supplement) identifies that research is required to improve the understanding of climate change adaptation, and that 'international engagement and research should

[5] For example, Department of Climate Change, 2009, *Climate Change Risks to Australia's Coast: A First Pass National Assessment*.

continue to keep abreast of emerging issues and trends relevant to resilience, such as climate change adaptation and the trusted insider threat'. The *National Urban Policy* (2010) seeks to increase resilience to climate change, emergency events and natural hazards through adaptation, and identifies that capital city strategic planning systems 'should address the nationally-significant policy issue of climate change adaptation'.

At the State and Territory level, most of the high-level infrastructure and capital city strategies explicitly identify the need for adaptation. This adaptation is frequently identified as a tool to improve resilience and/or sustainability. For example, the *Plan for Greater Adelaide* (2010) states that it is "*critical to intervene now in the urban form and the built environment ... to prepare the region to adapt to the likely impacts of a changing climate*". This Plan is underpinned by 14 principles – one of which is climate change resilience through adaptation. Like national level plans, these plans contain very limited details on implementing adaptation.

Adaptation is not often mentioned in owner/operator strategic plans. For example, there are limited references to adaptation in the Master Plans and Airport Environment Strategies of the main leased federal airports of Adelaide, Brisbane, Melbourne, Sydney and Perth. There is also a lack of explicit discussion of adaptation in most of the publically available port plans. As it is not common for roads to have strategic plans,[6] determination of the link between adaptation and road infrastructure need to be sought in other documents, such as network plans, corporate plans and codes of practice. In general, many such documents mention adaptation but do not examine it in depth. For example, the Department of Transport and Main Roads (TMR) Corporate Plan 2011-2015 identifies as a strategic challenge the need to "*manage the impacts of climate change on the transport system*". TMR has identified as priority to 'increase the preparedness and resilience of the transport system to significant events'. Formal recognition by rail infrastructure owners of the need to consider adaptation is also seen in many strategic rail documents, but like the other sectors is generally limited to identifying it as a challenging and expressing a need to manage the risk in the context of maintaining asset performance, reliability and sustainability.

There are very few pieces of infrastructure-specific legislation that reference adaptation. One such Act is the *Victorian Transport Integration Act 2010. This Act was modified following the passing of the* Victorian *Climate Change Act 2010 to require that Victoria's* transport system should be "*preparing for and adapting to the challenges presented by climate change*".

A number of infrastructure Acts specify the need for relevant environmental issues to be considered in the planning and operation of infrastructure, and if adaptation is deemed to be a relevant issue or is specified in regulations or guidelines under the Act, then the need to mention adaptation may be an implied requirement. For example, the *Airports Act 1996* requires the preparation of a Master Plan which must identify the environmental issues that might reasonably be expected to be associated with the implementation of the Master Plan, and how it will deal with them, including plans for ameliorating or preventing environmental effects. The plan covers a 20-year period, and thus it would be reasonable to expect that the consequences of climate change would be felt over this period.[7]

To date there has been limited consideration of adaptation in the Australian Government project prioritisation, facilitation and funding arrangements that affect infrastructure. In the area of project prioritisation, adaptation is not explicitly considered in Infrastructure Australia's *Better Infrastructure Decision-Making Guidelines*. However, it could be argued that they may be addressed in the economic viability stage which 'seeks to establish whether a proposal's economic, social and environmental benefits outweigh its costs to society, in a triple bottom line assessment'. Adaptation is not identified in

[6] Some jurisdictions do provide regulatory frameworks for road infrastructure, such as Victoria and Queensland, which provide for the development of road management plans.
[7] The guidelines (*Master Plan Guidelines* (draft), 2010), which are produced by the Australian Government to provide operators of the leased federal airports with guidance on meeting the requirements of the Airports Act for master plans, do not mention adaptation issues.

the *National Guidelines for Transport System Management in Australia* (2nd edition, December 2006). These guidelines provide a basis for project selection, appraisal and stakeholder engagement.

However, several states including Queensland and Tasmania have introduced a requirement for a Climate Change Impact Statement (CCIS) to be produced for policies and projects submissions to Cabinet and Budget processes. One of the purposes of the CCISs is adaptation related. Specifically, the CCISs are to provide information on the relevant risks associated with a proposal or policy from predicted changes in climate, and to facilitate agencies taking climate change into consideration during their development.

There is a growing volume of policies and action plans on climate change and these often identify the need for infrastructure to consider the impacts of climate change. Examples of such are *ClimateSmart Adaptation: 2007–2012 Action Plan* (Qld), and *Weathering the Change, ACT Climate Change Strategy 2007–2025* (ACT).

Historically, environmental impact assessment (EIA) regimes focused on the likely effects of a project on the environment, rather than the effects of a changing environment on a project. In recent years there have been a number of examples in Australia of climate change adaptation being elements of an EIA.[8] Currently, several State-based planning authorities, notably ACT and NSW, require a climate change risk assessment be undertaken for certain projects where a potential hazard may increase over time due to climate change.[9] This will have an effect on infrastructure projects.

Statutory land-use planning systems are increasingly considering adaptation issues by requiring climate change impacts to be considered. This is reflected in the number of structure, master plan or development plans addressing climate change risks. This trend is most obvious in coastal areas where sea level rise is required to be considered by a number of jurisdictions. However, there is no nationally consistent requirement to accommodation adaptation issues in land-use planning systems, and even within States and Territories there is often a lack of consistencies in how adaption issues are integrated.

Across infrastructure sectors there are common constraints and barriers to implementing adaptation actions, including:

- Decentralisation and lack of integration within the infrastructure sector prevent coordination across modes, within modes, along supply chains and between jurisdictions. This makes it difficult to coordinate system-level adaptation activities.
- Economic regulation mostly does not currently require consideration of climate change.
- Most engineering standards and codes do not reflect future climate meaning that designs produced today do not reflect the performance requirements needed to withstand extreme weather events in future decades. To date, the incorporation of climate change effects and adaptation into engineering standards and guidelines has been limited. This mainly reflects the fact that engineering codes and standards require significant evidence and many years for this information to be reflected in change.[10]

[8] See Agrawala S., A. M. Kramer, G. Prudent-Richard and M. Sainsbury (2010), *Incorporating climate change impacts and adaptation in Environmental Impact Assessments: Opportunities and Challenges*. OECD.

[9] The national *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) currently has no relevance to consider climate change adaptation. While it can consider matters of national environmental significance, including in the context of strategic environment assessments, climate change is not explicitly listed among such matters.

[10] It should be noted that revisions of some standards are underway such as Australian Rainfall and Runoff. In addition a new principles-based climate change adaptation standard is underway. The 'principle-based' Climate Change Adaptation Standard, currently under development with Standards Australia, specifies a requirement to consider climate change risks across a variety of key decision-making and operational activities. By proposing a 'principle based' approach, an overarching standard can be prepared and implemented in the face of uncertainty while scientific data is evolving. The establishment of this principle-based standard will be important, in future work, to the development of a suite of standards and guides that align with national climate change priorities and provide strategic principles to adapt to climate change effects.

- Difficulty in refurbishing existing infrastructure to become more resilient to climate change. Adapting infrastructure while it is in service often results in the partial removal of capacity, or full closures. This interruption is unpopular with infrastructure users locally, and business, community and political groups more broadly.
- Difficulty in upgrading damaged infrastructure to become more resilient to climate change. Policy and procedures impede betterment[11] of infrastructure following natural disasters. After damage, it is assumed that agencies responsible for managing infrastructure will act strategically to design replacement infrastructure that is better tuned to changed environmental conditions. However, this is not necessarily true. Reasons for this include the insurance requirements of replacing like with like, difficulty of rebuilding in less vulnerable locations and challenges in modifying existing rebuilding schemes, such as Natural Disaster Resilience Grants Scheme funds.
- Investment frameworks do not generally factor in adaptation because:
  - Procurement and investment guidelines do not require climate change to be considered.
  - Most benefit cost methodologies do not adequately deal with dynamic change and changing risk.
  - The use of high discount rates in financial analyses results in future costs and benefits being undervalued in calculation, leading to an under valuing of climate change effects and adaptation benefits.
- Adaptation is not seen to provide a competitive advantage for infrastructure owners/operators and as such is not included in statements of works or output requirements.
- Lack of information about future climate, in particular extreme weather events.
- Lack of decision support tools to guide risk assessment, risk prioritisation and strategic response.
- Lack of methodology for incorporating climate change consideration into strategic and ongoing operational planning and activities.
- Lack of information about adaptation options and their costs over time.
- Limited understanding of the need for adaptation by infrastructure owners/operators.
- Difficulty in dealing with climate change due to its uncertainty and its complex effect on infrastructure. The uncertainty relates to not only the identification of future climate changes but also to the identification of direct, indirect and flow-on impacts on infrastructure. These effects are not only affected by climate but also by changes to other drivers (e.g. demographics, lifestyles, urban development and industrial development). The barrier that arises from the climate change uncertainties is that it is difficult to reconcile probabilistic climate forecasts with existing infrastructure planning process which is typically focused on ‘knowns’. Not only will the decision process need to be changed to accommodate this input, but infrastructure planning professionals will need to feel comfortable with this type of input. The barrier that arises from the multiple effects arising from climate change, coupled with other drivers, is that this requires an understanding of the complex interaction between the drivers as well as identifying how each may change. Another uncertainty is the effectiveness of different adaptation options. The uncertainties increase the lack of confidence of the level of the return on investment.
- High competition for financial resources resulting in adaptation funding getting less priority. Many parts of the infrastructure sector are already under stress because of under-investment and insufficient maintenance, due in large part to funding constraints. This makes it difficult to find additional funds to develop and implement adaptation actions. In addition, the demand facing most infrastructure owners/operators to build extra capacity as rapidly and economically as possible reduces the availability of adaptation-related funds. In most cases, the cost of building new or upgrading existing infrastructure that is more resilient to climate change will increase upfront costs. This increase in cost, while possibly reducing whole of life costs, may be sufficient to make the project unviable.

[11] Betterment is the restoration or replacement of the asset to a more disaster-resilient standard than its pre-disaster standard.

- Inadequate numbers of adaptation-related professionals for planning, design, assessment, construction and procurement of infrastructure. The shortage of skills can push up the cost of adaptation projects and delay the assessment and approval of projects.

Recommendation 2

Infrastructure sector stakeholders should work together to develop a detailed understanding of the existing institutional framework for each infrastructure sector in relation to climate change adaptation, including reporting on the constraints and barriers to adaptation, and this document should be used to form the basis for a structured approach to reforming institution frameworks so as to embed adaptation in the sector.

SPECIFIC INITIATIVES TO IMPROVE STRATEGIC PREPAREDNESS

There are a host of initiatives that can be pursued immediately to improve strategic preparedness by advancing adaptation activities, in addition to advancing adaptation in a comprehensive manner as per Recommendation 2. Below are key initiatives of direct relevance to the engineering profession.

1. Integrate climate risks and adaptation options into the land-use and infrastructure planning process through:
   - Incorporating longer-term climate change effects into planning scenarios.
   - Increasing the planning timeframes to at least 40 years.
   - Encouraging or mandating the consideration of the accommodate/protect/retreat/develop redundancy approach in land-use and infrastructure planning including identifying trigger points at which responses are required.
2. Until engineering and infrastructure codes and standards are updated to reflect a changing climate, promulgate guidelines on appropriate variation of existing codes and standards.
3. Add to the objective of the Australian Building Code the aim of building durability in addition to the current one of life safety.
4. Develop infrastructure sector information sharing efforts so as to more rapidly identify leading practice and build consensus for adaptation. This can be done by:
   - Building on existing infrastructure-related information sharing groups such as the TISN Sector Groups, AGIC, IPWEA, NSW Government Climate Change Infrastructure Adaptation Network Forum, and Ports Australia's Environment and Sustainability Working Group.
   - Fostering special interest groups within existing infrastructure-related professional and industry groups (e.g. a group interested in identifying the impact of climate change on wind strength and direction at airports, or on geotechnical concerns of bridge scour, drainage and embankment/cutting stability monitoring).
5. Foster education and training activities within infrastructure-related professionals (notably project management, risk management, infrastructure planning, and coastal, drainage and geotechnical engineering).
6. Foster professional accreditation of adaptation related specialisations including those involved in planning assessment, environmental impact assessment, structural engineering and geotechnical engineering.[12]
7. Lead and support international adaptation activities by ensuring that adaptation is a core consideration in international standards/codes development.

[12] A model for an accreditation system is the National Professional Engineers Register.

8. Ensure adaptation issues are included in statement of works or output requirements in government contracts, both within Australia (e.g. ARTC projects) and internationally (e.g. AusAID projects).
9. Ensure adaptation is reported upon in Airport master plans through modifying the *Airports Act 1996* and guidelines.
10. Ensure Infrastructure Australia has and uses an adaptation element as a selection criterion for project assessments.
11. Endorse and utilise the AGIC Green Infrastructure Rating Tool for government infrastructure.
12. Provide accurate, comprehensive and scalable natural hazard information. As climate change is likely to exacerbate existing risks, it is becoming increasingly important that infrastructure stakeholders have access to accurate natural hazard information. Currently there is a lack of accurate and comprehensive natural hazard information that is available in a useable form at a reasonable cost to infrastructure stakeholders. Initiatives to provide this information are:
    - Produce national hazard mapping data sets that are publically available and reflect a changing climate. The data set priorities are overland flood, coastal flooding including storm surges, wind and bushfires.
    - Include infrastructure-users of scientific information in the science research decision-making process (particularly those involved in writing codes and standards).
    - Develop a central point for requesting climate science information.
    - Produce post-disaster infrastructure analyses that feed into standards and codes revisions.
13. Provide evidence of the economic benefits and costs of adaptation. While the benefits of adaptation are recognised conceptually, there is very little hard evidence of its economic benefits. Given that financial decisions by infrastructure owners/operators are based on cost-benefit analysis, this lack of evidence makes it difficult for it to be factored in. Initiatives to quantify the benefits of adaptation are:
    - Develop case studies for actual and hypothetical projects that identify the costs and benefits of adaptation that accrue to the infrastructure owner and operator, and those that accrue to other parties.[13]
    - Develop information on the cost-effectiveness of adaptation options.
    - Identify the cost of inaction.
14. Develop information on different adaptation decision or investment pathways including activities that would:
    - Demonstrate how decision-making can incorporate flexibility to manage risks of future climate.
    - Describe how to identify and respond to climate-related thresholds and trigger points in decision-making.
    - Identify alternative decision pathways for ongoing investment in or the relocation of an asset or settlement, including over decadal timeframes (see Box 11: Real option approach).
    - Identify the costs, benefits and trade-offs of investment to build resilience at different time points in the life of an asset.
15. Develop performance metrics for evaluating the effectiveness of adaptation actions. Initiatives to develop metrics are:
    - Identify the parameters required to evaluate the effectiveness of adaptation actions.
    - Evaluate the quality of the adaptation component of AGIC's Green Infrastructure Rating Tool.
16. Develop tools for infrastructure professionals to allow them to appropriately incorporate adaptation into to their areas of responsibility. These include:

[13] DCCEE has commissioned the following case studies: *Coastal Inundation at Narrabeen Lagoon – Optimising Adaptation Investment* and *Adaptation of Melbourne's Metropolitan Rail Network in Response to Climate Change*.

- Planning tools that take into account the key drivers affecting infrastructure in the future, so that the comparative impact of climate change and other drivers (e.g. demographics, lifestyles, urban development and industrial development) are identified.
- Tools to aid vulnerability assessments and the integration of climate change risks with other corporate risks.
- Tools to allow cost-benefit analysis and multi-criteria assessment that incorporate adaptation.
- Tools to determine the cost/benefit trade-offs between infrastructure services that offer uninterrupted services and those which have an acceptable level of disruption.
- Life-cycle costing methodologies that incorporate adaptation.

Recommendation 3

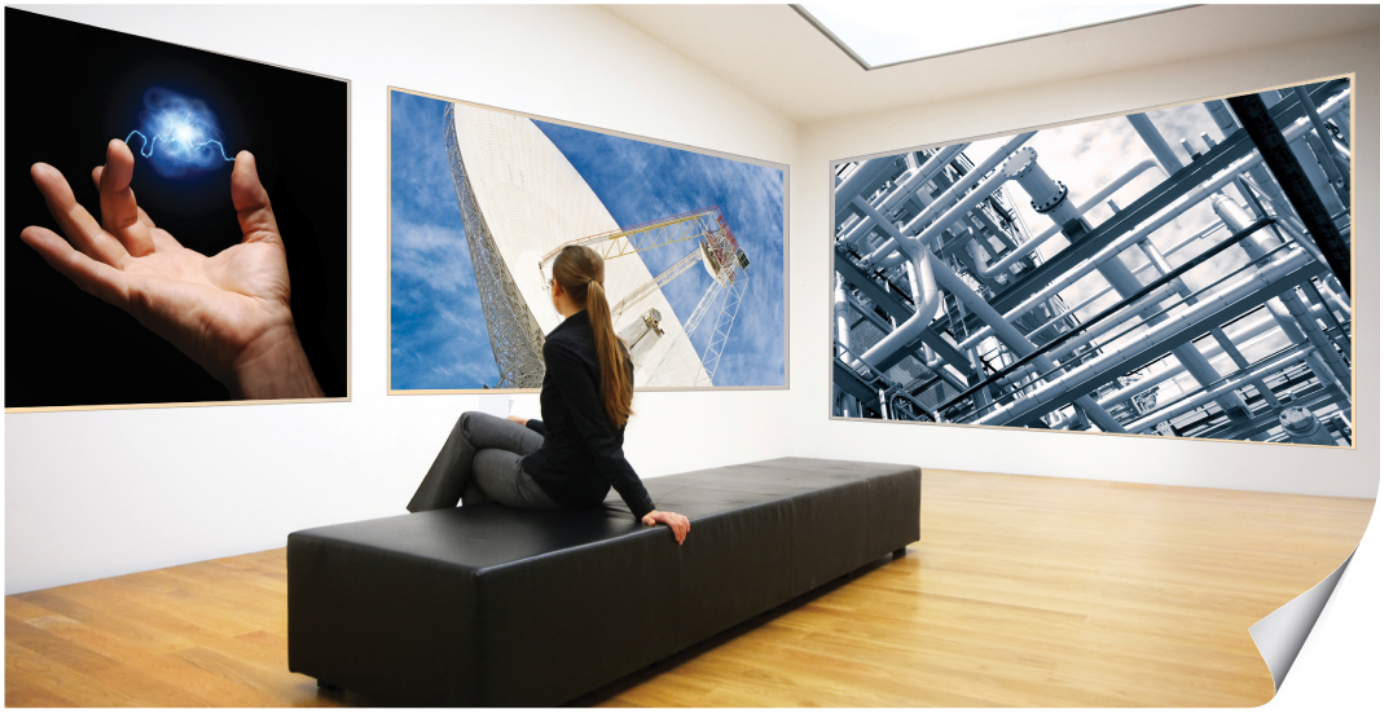
Infrastructure sector stakeholders should work together to prioritise the key cross-sector engineering adaptation initiatives identified in this submission and work to advance them.

Recommendation 4

Infrastructure sector stakeholders should adopt sustainability principles in the design, construction and operation of all infrastructure projects, and particularly adopt targets related to the ongoing reduction of emissions that are contributing to climate change.

Recommendation 5

Governments should encourage the uptake of sustainability assessment and rating schemes (e.g. AGIC's IS rating scheme) in pursuing the realisation of Recommendation 4.



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