

# Engineering a change in climate

Why and how engineers should step up to the challenge



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## Why and how engineers should step up to the challenge

### The problem

Action has been taken to combat climate change and its impacts, but much more needs to be done to avoid dangerous global warming. This is increasingly apparent to all sectors of society, with action being taken independently by citizens, businesses and regulators in spite of the perceived inaction of Australian governments.

### The solution

Finance for climate change solutions is not in short supply. A shortage of practical solutions that are scalable, affordable and easy to embrace is the impediment. This is where engineers can play a transformative role. Engineers can lead practical actions in their organisations and communities, leveraging the profession's trusted status and the power of its collective capability.

### The benefits

Australia is at greater risk from inaction than many other countries. But it also has much to gain, with comparative advantages that support the development of scalable, sustainable solutions. The combined benefits of mitigating climate risk and developing transferable technologies are substantial if Australia and its engineers have the wit and wherewithal to pursue them.



Saskia Cook-Knowles of Port Kembla High School holds a placard as thousands of students rally demanding action on climate change, in Sydney, Friday, November 30 (Source: AAP at SBS News)

# Introduction

**Governments, businesses and individuals are taking action to combat climate change and its impacts. It's not enough, however, to avoid dangerous global warming. Much more needs to be done. This is increasingly apparent to all sectors of society, creating frustration at the perceived inaction of governments. The engineering profession could enter the breach in a very practical and impactful way. How that might be achieved is the subject of this paper.**

"Your apathy towards my future scares me." That was one of many damning messages on placards held by school children as they took the streets in November 2018. They were protesting the lack of government action on climate change. At the time, Australia's Prime Minister criticised the protests. He said "we want more learning and less activism in schools"<sup>1</sup>.

Certainly, Australia's school children have much to be thankful for. They live in one of the wealthiest countries on earth that's enjoyed an unprecedented period of economic growth. They have access to a good education, healthcare and job prospects. Many others around the world aren't so lucky. But perhaps their activism was *the product* of their education in science and history. Perhaps it was a response to politicians lamenting the disengagement of younger people in politics. And perhaps it was the action of responsible, globally-minded young citizens. Indeed, it's precisely because Australians are so fortunate that we have the capability and obligation to act on global issues like climate change – if only through enlightened self-interest.

We must also acknowledge that Australia's prosperity has come at a price. Sacrifices have been made to grow and sustain our standard of living. Building our economic and physical capital has involved erosion of natural capital. We can see first-hand evidence of this in the recent fish-kills in the Darling River and the death of corals along much of the Great Barrier Reef. Perversely, environmentally destructive activity that occurs with "development" makes a positive contribution to our gross domestic product – a key measure of our economic prosperity. So, while our economy continues to grow the once hidden and substantial costs of that growth are becoming apparent. There's a risk that our children will be the first generation to be left worse off by their parents<sup>2,3</sup>.

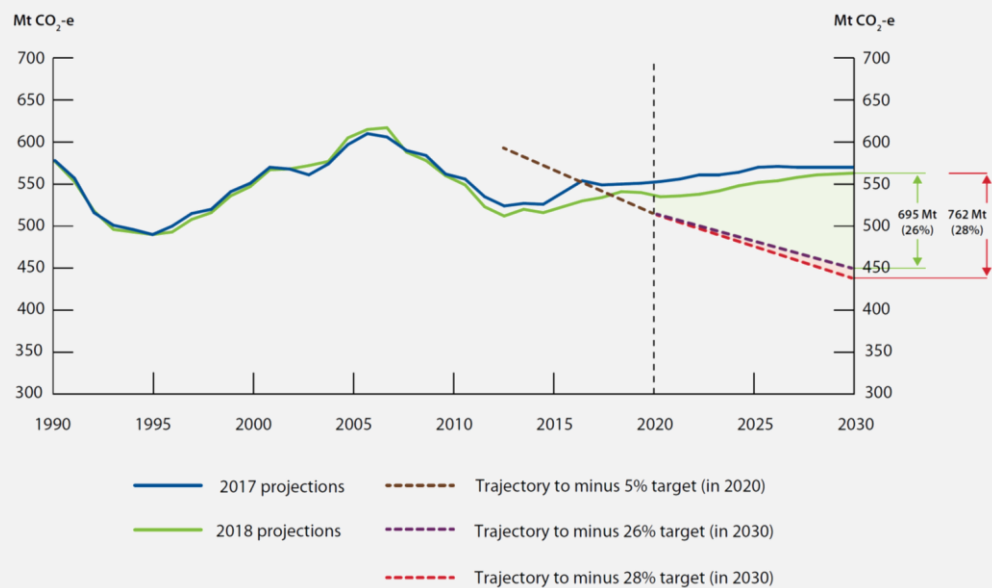
Indeed, Australia faces a number of mounting challenges, many of which are complex and persistent. Our biggest cities are congested, houses are unaffordable to many, farming communities suffer under more extreme droughts and floods, and dramatic rises in energy prices dampen the economy. The all-encompassing backdrop is climate change – a force according to Australia's Reserve Bank Governor, Guy Debelle, that is unparalleled in its scale, persistence and systemic risk<sup>4</sup>. Indeed, company directors have indicated climate change is the number one issue they want the federal government to address in the long term<sup>5</sup>.

Unfortunately, most Australians have lost trust in their governments to tackle these big challenges effectively<sup>6</sup>. People recognise, for example, that the lack of a national climate and energy policy has impeded investment in the electricity network and in building resilience to extreme events. It's incurred real, substantial and immediate costs<sup>7</sup>. It's no wonder citizens are taking to the streets and asking "What do we have to do to make real progress, and who can we look to for meaningful help?"

## Australia's GHG emissions trajectory and its implications

The energy sector accounts for more than 80 percent of Australia's greenhouse gas (GHG) emissions. This includes electricity generation and fuel consumption in buildings, industry and the transportation, as well as fugitive emissions released during coal mining and oil and gas production<sup>8,9</sup>. The remaining emissions are generated in agriculture, waste management and via forestry and land use change.

Australia's GHG emissions are rising (see below); they are projected to grow by 4 percent by 2030<sup>9</sup>. This compares poorly with Australia's commitment to reduce emissions under the Paris Agreement by 26 to 28 percent from 2005 levels. Whether Australia is 'on track' to meet its Paris commitment is debated. It may be met "on paper" if two things occur: a) Australia claims credits for over-delivering on Australia's 2010 and 2020 commitments, and b) if low economic demand contributes to further substantial emissions reductions (as might occur if energy-intensive industries are driven off-shore by high gas and electricity prices)<sup>10</sup>.



Ultimately, whether Australia can meet its Paris Agreement or not is not the real issue. Rather, the cumulative contribution of countries under the Paris Agreement is presently insufficient to curb dangerous global warming. The aim of preventing the average global temperature rising by 1.5°C will not be met. Without intervention, it will rise by 3°C by 2100<sup>11</sup>. Quite simply, the pace and scale of efforts to reduce GHG emissions is insufficient.

While there can and should be debate about the economic cost of alternative climate policies, Australians must not lose sight of the far more significant, pervasive and persistent costs of inaction. Early action is easier and cheaper than deferred action, something that has been recognised for years<sup>12</sup>.

Australia is particularly vulnerable to a changing climate. We have much to lose and are already suffering the economic, social and environmental consequences of extreme drought, floods and wildfires. We also have much to gain, with many sources of comparative advantage for low emissions and other technologies to build on<sup>8</sup>. A very strong argument therefore exists for Australia to meet and exceed its Paris commitment and to encourage and lead other countries to do likewise.

# Australia needs engineers

Most of the big challenges we face as a nation require a substantial level of engineering input to solve. For example, transitioning to an affordable, low-carbon energy supply; developing cost-effective infrastructure in high-amenity, mixed-use cities; and developing advanced manufacturing products and inputs to global value chains are all ventures that demand intensive engineering input. Similarly, reducing greenhouse gas (GHG) emissions requires engineering solutions, particularly in emissions-intensive industries like oil and gas, coal and cement production<sup>13</sup>.

Formulating public policies, writing reports, making speeches and directing funding doesn't solve these problems. It doesn't solve the climate problem. This was clearly recognised by Australia's former Prime Minister, Malcolm Turnbull, when he rather bluntly stated "we need engineering and economics rather than ideology and innumerate idiocy"<sup>14</sup>.

Policies and regulations may provide the "enabling environment", but governments, corporations and financiers need things to invest in. These things are often the technologies and infrastructure developed and deployed by engineers. New technologies and solution ideas can also be the prime enabler and catalyst to create the institutional enabling environment.

Engineering isn't just required to translate policies into practice on the ground. What Australia also needs today is the practical problem-solving and project delivery capabilities of engineers. Engineers get things done.

Getting things done is pivotal to restoring trust and productivity in our public institutions and private corporations. Restoring trust is central to restoring confidence in our economy, which in turn fuels spending and generates jobs. Jobs create the wealth and government tax receipts that fund social welfare and environmental restoration. Growth – and its associated tax revenues – also provides the wealth to support structural reform and transitioning of communities most vulnerable to climate change risks and responses (e.g. those dependent on thermal coal mining). So, when governments and businesses are struggling to find sustainable solutions, enhance productivity and make progress, they could do far worse than seek the practical help of engineers.

Of course, it would be wrong and naïve to suggest that the engineering profession can achieve change alone. There are many dynamic people and powers at play – some seeking to benefit by preserving the status quo. The profession can, however, act as a catalyst and facilitator of collaborative action by individuals and organisations with shared values to achieve practical progress in the public interest.

# Practical ambition

What can the engineering profession do to tackle climate change in a meaningful way? What are the practical actions that engineers should take to make a positive impact within their organisations and communities, consistent with their ethical responsibilities?<sup>15</sup>

## Be informed.

Like the general public, the engineering community will have a range of views on climate change. But engineers understand and respect science and statistics and look for evidence to back judgements. So, with **access to credible, concise, peer-reviewed information**, engineers are likely to respect the hypothesis, observations and evidence for human-induced climate change that has the overwhelming backing of scientists<sup>16</sup>.

Engineers are also very pragmatic. With an understanding and acceptance of the science, engineers will then ask “OK, so what does this mean in practice? What do we need to do? What needs to change?”

*The number of scientific papers rejecting anthropogenic (or human-caused) global warming is a miniscule proportion of the published research, with the percentage slightly decreasing over time. Among papers expressing a position on anthropogenic global warming, more than 97% endorse the scientific consensus that humans are dangerously accelerating and accentuating the natural processes of climate change. Often, this overwhelming consensus isn't appreciated. When people are informed it can shift their attention to what needs to be done<sup>17</sup>.*

## Inform others.

While most Australians are concerned about climate change and want action to be taken<sup>18</sup>, many people couldn't reliably explain the mechanics of climate change, the risks and how they need to be tackled. This includes many business leaders and public sector executives. For example, what does “keeping temperature rises within 2°C” mean in practice? Misinformation and misunderstanding allows procrastination, whereas information enables action and even a responsibility in law to act. So, engineers should **translate the science into practical terms, examples and implications**.

*Historical rainfall records are used to design infrastructure such as stormwater drainage systems. These systems are designed to meet certain standards, such as a 1-in-100 year storm event. The intensity of a 1-in-100 year storm is calculated using historical data. As more data becomes available, updated calculations can be made. Over the past 20 years, the additional data includes more extreme weather events. Consequently, the statistics have changed. What was once a 1-in-100 year storm might now statistically be considered only a 1-in-30 year storm. Now, a 1-in-100 year storm is a much larger event. In practical statistical and engineering terms, the climate has changed<sup>19</sup>. The consequence is that stormwater drainage infrastructure may no longer meet our design standards. It doesn't provide the protection against flooding that's expected.*



## Manage risks overtly.

Identifying and managing risks is integral to the work of engineers. Climate change is just another risk to be addressed. Of course, the threats from climate change are pervasive and intertwined. They include physical, supply chain, regulatory, technological and reputational risks, all of which have financial consequences.

Furthermore, the risks are not just in the future. The Australian Prudential Regulation Authority (the statutory authority that oversees the banking, insurance and superannuation sector) has stressed that climate risks are “material, foreseeable and actionable now”<sup>20</sup>. So, it’s simply good governance to act to mitigate climate risks. Indeed, inaction is irresponsible and unethical, exposes development projects to judicial review, and exposes leaders in private and public enterprise to legal liability<sup>5,21,22</sup>.

Engineers should therefore inform people of the risks associated with climate change, **explicitly factoring these risks into their advice, option evaluations and solutions**. This is particularly important for development of physical assets (like water, transport and power infrastructure) that should operate effectively over decades.

*Leaders surveyed for the 2019 edition of the World Economic Forum's Global Risks Report indicated that environmental threats dominate their concerns – both in terms of impact and likelihood. “Of all risks, it is in relation to the environment that the world is most clearly sleepwalking into catastrophe,” the report warns. After 2018 saw unprecedented heatwaves, storms and floods across the globe, extreme weather events top the list of most likely risks and come third for impact. Leaders are clearly reflecting their increasing concerns about environmental policy failure<sup>23</sup>.*

## Leverage the profession’s trusted brand.

Throwing more science, facts and data at people often doesn’t help to trigger a shift in attitudes and behaviours, particularly if they are ill-equipped to assimilate the information presented. Indeed, it can reinforce competing and more simplistic views. Cut-through occurs when people receive relevant climate insights from people whom they trust and share similar values.

Engineers may not be front-of-mind for the general public like doctors or lawyers, but they are highly trusted<sup>24</sup>. Indeed, they hold substantial and growing levels of trust within the community, placing them in the top 5 most trusted professions alongside nurses, pharmacists, doctors and school teachers. This trust is a valuable commodity and one to be used carefully and thoughtfully, particularly at a time when people distrust government and big business<sup>25</sup>.

Engineers can inject evidence-based, risk-weighted advice into public discourse, providing a much-needed, apolitical perspective on the scale of the climate challenge and pragmatic approaches to achieve meaningful progress. The objective is to **help people understand how science and engineering can be used to address their needs in practical ways**, protecting them from potential conflicts between beliefs in science and the beliefs of their influencing community or “tribe”<sup>26</sup>.

*Most Australians are concerned about their escalating electricity and gas bills. While they might also want more renewable power generation, the additional cost of 'green' power from their energy retailer can be a deterrent for many. Those who can afford the additional cost or choose to invest in household solar panels might still ask "Is it better for renewable energy to be generated at a community or national scale or on my rooftop?" and "Should I buy now or wait for newer and better technologies to come onto the market?" While more and cleaner energy generation is a good thing, energy efficiency measures can have big financial benefits for individuals, organisations and society while delivering simultaneous climate benefits.*

### **Update design principles.**

Climate risks and GHG emission objectives need to be factored into engineering solutions. Whether developing new solutions or enhancing existing assets and operations, some of the core principles that could apply to the design process and objectives are:

- Solutions must enhance energy efficiency
- Solutions must achieve net zero-GHG emissions
- Solutions must be adaptable to a changing climate and resilient to extreme events
- Solutions should be as simple as possible (reducing resource use and enhancing affordability).

Of course, the fields of engineering are very broad from civil and environmental engineering to biomedical and aerospace engineering. So, the **design principles need to be thoughtfully tailored** to ensure maximum relevance. If, however, principles are not specified or required, the question should be asked "If not, why not?" with the decision and its consequences made clear for investors and customers to see and judge on its merits.

### **Make the engineering task easier.**

While engineers can undertake sophisticated analysis and bespoke solution design, they are often required to work under tight time and cost constraints. Furthermore, most practising engineers won't be familiar with climate-risk analysis. In these circumstances, tools that simplify the engineering task are welcomed. Hence the profession should work alongside scientists to **develop simple, transferable tools to assess climate risk and determine design priorities**. Similarly, a library of up-to-date case studies and technologies that achieve energy efficiency, reduce GHG emissions and enhance resilience in different industry contexts would assist.

*C40 – a network of the world's megacities committed to addressing climate change – has established a case study library<sup>27</sup>. The online library makes it easy for city officials, researchers and urban stakeholders to find relevant, real-world solutions from a growing collection of unique examples. A map interface and topical search functionality make the case studies readily accessible, along with details of quantifiable economic, social, health and environmental benefits.*

### **Build transferable solutions.**

Just as engineers want their task to be as easy as possible, so do citizens and business owners. Engineers should develop **simple, affordable products that can tackle the climate challenge at scale**, while recognising and responding to the short-term cost-consciousness of business and

consumers. It's clear from the take-up of domestic solar panels in Australia that there is a sizeable and willing market for such products. Products should also be designed to tap into the substantial international market, providing export opportunities while scaling up the climate mitigation and adaptation benefits.

A range of transferable solutions also makes the task for governments and politicians easier, which can only be a good thing. The larger the range of solutions the greater the policy flexibility and market choices, which in turn reduces the cost of adjusting to a changing climate and the associated 'transition risk' for all involved.

*As the global population expands, incomes grow, the world becomes more urbanised and temperatures rise, the demand for air conditioning is forecast to accelerate rapidly, increasing fourfold to 4.5 billion by 2050<sup>28</sup>. This will place a huge burden on electricity supply, while also contributing 0.5°C to global warming by 2100<sup>29</sup>. Developing highly energy efficient air conditioners could provide a very material economic and climate benefit. Rocky Mountain Institute, Mission Innovation and the Government of India recently launched the Global Cooling Prize precisely to catalyse smarter solutions for residential cooling.*

### Catalyse missions.

Australia's collective multi-disciplinary engineering capability is very powerful. Indeed, we probably have no real idea what it could achieve if even a small fraction of that capability was effectively focused. Yet while much is written about the need for collaboration across business and government, we seem to lack the mechanisms to achieve goals that require coordination and collaboration at scale. The business community seems to enjoy the ease and comfort of competition, while governments struggle to achieve alignment and collaboration across departments<sup>30</sup>. Indeed, policy positions can even conflict and ultimately work against public value creation. Perhaps more worryingly, it seems that too many people in positions of authority and power are afflicted by a "can't do" mentality, being "stunted creatively and imaginatively" as Donald Horne (author of *The Lucky Country*) once lamented<sup>31</sup>.

So, it would be useful to focus the problem-solving and project management capabilities of engineers on **a few outcome-focused, time-bound missions**. Missions should be linked to things that people are trying to create or achieve, that speak to their way of life and aspirations. The possibility that the missions can't be achieved wouldn't be entertained. Input could be crowd-sourced, as could funding. The benefits of diversity<sup>32</sup> should also be harnessed with input welcomed from complementary disciplines. Many alternative approaches to the missions could be entertained, even running several teams in parallel and with cross-pollination of ideas at key milestones.

*Australia is endowed with abundant sources of renewable energy, offering the potential in time for energy supply at very low cost. The sources are geographically distributed, across multiple time zones. We have a stable political environment and minimal corruption by global standards. Financial capital is equally abundant; what is lacking are attractive, risk-managed projects in which to invest. How then could a sustainable, affordable energy network literally be delivered within a decade?*

### Combine resources, share rewards.

Many organisations are taking action on climate change but the change and impact is falling short of what's required. Well-intentioned but piecemeal initiatives are not enough. They're also sub-economic and wasteful of public and private resources. The engineering profession could foster collaboration to **harness and focus the collective resources, networks and communication vehicles** of like-minded "can do" organisations with a focus on practical change with genuine impact. Many business leaders would welcome the prospect of leveraging their investment with an enhanced prospect of a return with an agreeable reward-sharing arrangement in place.

#### What do others say about action on climate change?

The **Business Council of Australia** "supports Australia ratifying the Paris Agreement and setting a target to reduce Australia's emissions by 26 to 28 per cent below 2005 levels by 2030. This is a sensible and achievable starting point."

The **Australian Industry Group** advocates for the federal government to "cement durable frameworks for energy and climate, the lack of which is a serious barrier to needed investment."

The institutional **Investor Group on Climate Change** recognises that "climate change will impact our investments, that there is an economic transition underway and it is accelerating. We support a response ... to avoid dangerous climate change."

The **Water Services Association of Australia** argues that "it is essential that the water industry build climate resilience into their long-term planning and decision-making processes."

The **Australian Medical Association** believes that "because climate change involves potentially serious or irreversible harm to the environment and to human health, urgent international cooperation is essential to mitigate climate change."

**Origin Energy's** position on climate change "is absolutely clear. We unequivocally support measures to progressively reduce global emissions and acknowledge the role the energy sector needs to play in transitioning to a lower carbon future."

**Qantas** recognises "human-induced climate change as a significant issue for the aviation industry. We support the world-wide priority of limiting global temperature rise to below two degrees above pre-industrial levels."

**BHP** accepts "the climate change science which has found that warming of the climate is unequivocal, the human influence is clear and physical impacts are unavoidable."

The **Australian Council of Trade Unions** will "fight for decisive action to reduce emissions, improve energy efficiency, expand renewable energy capacity, and rapidly develop low carbon technologies while creating secure jobs."

# Stepping up and out

Clearly there are valuable steps that engineers can take that play to their strengths and use their practical know-how. Along with the benefits to society of effective, affordable and exportable climate solutions, engineers would enhance their skills, brand and professional recognition. Engineers might again be recognised for the substantial, positive contribution they make each day to society. Perhaps it would even build confidence to initiate similar action on other “grand challenges” that impede our aspirations for an inclusive, sustainable Australia.

For this vision to be realised, however, engineers will need to face into a potential Achilles heel. Generally speaking, engineers are rational, literal and very matter of fact. Many are introverted. They are typically expected to have the “right” solution by their managers or clients, and equally impose that high expectation on themselves<sup>34</sup>.

Engineers can be uncomfortable with emotion, preferring to prosecute and win debates on the basis of logic. But this denies the central role of emotion in human decision making – and people’s desire to be emotionally engaged. We might even observe that had logic played a role in the climate change challenge we would not find ourselves in the position we are today. Action would have been taken at scale years ago.

The fact that key dimensions of the climate change challenge are emotional and social doesn’t diminish the role of the engineering profession. Indeed, for reasons outlined earlier, making practical progress is critical to relieving anxiety, diminishing partisanship and achieving inclusive growth.

Some of the greatest engineers throughout history - like Brunel, Edison and Australia’s Bradfield and Monash – have dreamed and imagined how engineering solutions could benefit society. If the profession wants to reassert itself and realise its potential to contribute to society, then it needs to step up and out of the shadows, move beyond ‘instruction taker’ to become a ‘progress maker’.

The first step will involve letting go of having to know all the details, of knowing the solution and being right. Instead, the engineers need to accept ambiguity and gain satisfaction in making progress toward a goal that really matters, accepting that how to get there isn’t entirely clear, just yet.

*“We need to get better at finding solutions because it’s certain that the questions won’t be getting any simpler.”*

Marcia McNutt, President of the US National Academy of Sciences<sup>35</sup>



"We have a lot of infrastructure, not just homes, cable lines, gas lines, sewers, very exposed along the coastline and we need to come up with solutions." Professor Ian Turner, University of NSW  
(Source: ABC News online, 6 June 2016)

# In conclusion

While action has been taken to combat climate change and its impacts, much more needs to be done.

Despite the bickering and obfuscation of politicians, it's clear that banks, investors, insurers and regulators are now shifting their money and policies in favour of sustainable, profitable, climate-resilient industries.

Australia is not immune to this global trend and is at greater risk than other countries from inaction. Consequently, Australia has much to gain – economically, socially and environmentally – from pursuing scalable, sustainable solutions. This includes encouraging and supporting other countries to do the same, ideally employing technologies developed in Australia.

A shortage of capital is not the problem. A shortage of solutions that are scalable, affordable and easy to embrace is the impediment. This is where engineers can and should play a transformative role.

Engineers can help to make action on climate change seem inherently sensible, desirable and normal. Engineers can foster the belief that ambitious change is possible through tangible examples and practical solutions that bypass hollow rhetoric. That is, through action engineers can also shift Australia's attitudinal climate – in favour of a "can do" mindset.

Engineers might just engender an exciting climate of change.

*“Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. Pathways limiting global warming ... require rapid and far-reaching transitions in energy, land, urban, infrastructure and industrial systems.”*

Intergovernmental Panel on Climate Change<sup>36</sup>



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