Why engineers now need to engage in Australia's climate change policy debate[1]

by Tony Kevin

With Julia Gillard's recent accession to the Prime Ministership on 24 June 2010, Australian policy options for climate change mitigation through limitation of carbon dioxide emissions are again thrown open. In her first doorstop interview at Parliament House, she expressed her firm belief in the scientific truth of man-made climate change. She declared her support for putting a price on Australia's carbon emissions, but gave no specific support for her predecessor's Carbon Pollution Reduction Scheme or any form of emissions trading; indeed, she made no mention of emissions trading at all. She said it is now up to Australians to come to a broad public consensus on how we want to price carbon dioxide emissions. This paper is offered as a contribution to this necessary public policy debate.

Australia's engineers need to become part of this public dialogue. Engineers could be, but are not yet, public innovators in climate change policy. The public debate so far has been mostly among scientists, politicians and their economic advisers, and business leaders and lobbyists.

If engineers have been involved, they have been wearing another hat, as project managers or on corporate boards of Australia's resources and energy, transport, or land development companies, or working in government. When these engineers speak on climate change, it is normally to express the views and interests of their employers.

A series of debates is now taking place in Australia on the climate crisis.

First, there is still a residual public debate questioning the scientific evidence for a man-made climate crisis. On this, I accept the consensus science – science that both Julia Gillard and Kevin Rudd have endorsed without doubt or qualification.

In a recent *Australian Financial Review* article[2], Dr Lorraine Stephenson – who has a Ph.D in chemistry, and is a partner and Oceania Climate Change Leader at Ernst and Young - writes:

'There is wide consensus among leading scientists that human activities are linked to a changing climate'.

and

'The reality is the fundamentals are still evident, the science unequivocal. Our global greenhouse gas emissions trajectory is unsustainable and emissions need to peak as soon as possible'.

Two more examples: Australia's Chief Scientist, Professor Penny Sackett, said on ABC radio on 20 April 2009[3] that the world has just six years to begin reducing its carbon dioxide emissions. (And in June 2010, she repeated a similar public warning).

The Head of CSIRO and former vice-president for technology of BHP Billiton, Megan Clark, said at a high-level business leaders' climate change conference in Perth in March 2009[4] that a sea-level rise of one metre or more could be seen by the generation born today; coupled with an increase in severe cyclones and flooding, that generation could see major coastal erosion and serious damage to infrastructure, especially in delta regions.

Such warnings are reinforced by the recent CSIRO/Bureau of Meteorology report, '*State of the Climate'*.[5] With eight clear maps and charts based on sound Australian-collected climate data, going back thirty-five to fifty years, this short six-page report offers no forecasts. But it supports a clear conclusion that disruptive climate change is already well advanced in Australia, as part of a pattern of global climate disruption. This publication should be accessible in every Australian company boardroom, school and college library.

Noting Australia's vulnerability to climate change, Dr Stephenson[6] advocates energy sector decarbonisation - the progressive and finally complete replacement of carbon-burning energy systems by greenhouse gases-free energy systems.

What is the policy roadmap now for decarbonisation? As Dr Stephenson commented[7], Australian society is still very divided on this:

'Here in Australia at the end of March 2010, there is a lack of strategic clarity about the way forward. From a business perspective, there is no clear national climate change/ energy/ innovation strategy underpinned by legislation'.

In July 2010, this remains true. There are three major ongoing national debates about climate policy.

First, how quickly should Australia's energy economy be fully decarbonised? As proposed by Greenpeace Australia, the climate science now suggests, on prudent risk-management grounds, no later than by 2030, twenty years from now[8]. By then, Australia as a wealthy responsible nation in a world facing worsening climate change effects should already have up and running a fully electrified transport sector, and a reliable national electricity grid, drawing on a safely diversified combination of renewable energy power generation sources, and possibly including nuclear energy as well.

Can this be achieved? Yes it can, if our whole society agrees it is necessary. We can win this battle, as we won World War Two, but only by great efforts of national will. Our society's present failure to start down this road is a failure of vision, not of lack of technical or financial capacity.

This failure of vision stems from many things: climate change denialism, in its various explicit or unacknowledged manifestations; the dominance of short-term election-driven thinking; and, within the environmental movement itself, a lack of unity, policy focus, and effective public outreach.

I am not going to dwell on climate change denialism. The science is in. Climate crisis denialism should simply be condemned, as a socially destructive cognitive disorder[9]. It seduces people who are psychologically unwilling to admit limits to economic growth. Denialists cling to the arrogant 'mechanical philosophy' of mankind's infinite right and capacity to exploit and transcend his natural environment. Or, they suffer from a kind of morally indifferent, fatalistic nihilism.

Like other cognitive disorders that have in the past caused great suffering to humanity, climate denialism is impervious to observed facts. As the climate crisis worsens, denialism perversely flourishes even more, confusing the community and eroding public support for sound risk-averse policies.

The only solution is better public education on the science of climate change, and more robust involvement in policy discussion by those with real knowledge of the nature of the climate crisis[10].

Here, engineers have a major role to play, which they are not yet playing.

A second policy debate: should decarbonisation be pursued by market trading in carbon emissions (like the former Rudd Government's proposed Carbon Pollution Reduction Scheme), by increasing taxes on carbon combustion, or by direct national regulation and infrastructure investment?

After the diplomatic failure of Copenhagen, we cannot assume that any international carbon emissions trading scheme will be achievable any time soon. The new Executive Secretary of the UN Framework Convention on Climate Change, Christiana Figueres, recently warned at the UNFCC Senior Officials' Meeting in Bonn, in June 2010 that it will be many years before the world can hope to agree on such a system.

James Hansen, a foremost world climate scientist and policy advocate, rejects trading in carbon emissions as the wrong way to go altogether [11]. He argues for simple national carbon emission taxes on carbon fuel producers, levied once only at the mine or wellhead or point of importation, and with all the proceeds to be fully and equitably refunded to taxpayers. Such a tax, working through price effects on the economy, would encourage national changes in production and consumption patterns that would sharply reduce carbon emissions. A number of prominent economists – Ross Garnaut, Geoff Carmody, John Quiggin, Richard Denniss – have come out recently in support of some form of national carbon tax, without waiting for international agreements.

Finally, China relies increasingly on emissions reductions through direct regulation and state investment.

My last policy question: should nuclear energy be part of the decarbonisation mix, given the problems some experts predict if Australia were to try to rely on renewables-based energy to achieve safe 24/7 baseload power in all seasons and weather conditions? [12] This raises issues of engineering feasibility and public policy. No country has yet achieved transition to a national fully renewable energy-based power grid. Maybe, as James Hansen believes, nuclear energy will have to be part of the non-greenhouse gas emitting energy mix to replace coal? Or maybe Australia, with its rich geothermal, solar, and wind power potentials, won't need nuclear power? At this stage of engineering appraisal of non-coal energy technologies in Australia, a lot of people are pushing barrows, but I believe no one really knows.

Nuclear energy will certainly have to be part of the solution in countries less well-endowed than Australia with renewable energy resources.

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It is the worst kind of climate crisis denialism to recognise the truth of the climate crisis in one's words, but then to do nothing effective about it as political leaders. Generally, the Australian political response to the climate crisis has so far been a major disappointment (and a major reason why Kevin Rudd lost the prime ministership).

When political leaders pursue policies that the public can see are trivial or phoney, the integrity of the cause itself is discredited. In the normal way of Australian politics, government and opposition parties have since 2007 treated the climate change crisis as just another interest group to be placated with feel-good rhetoric and half-hearted token policies that have little if any real impact on the arithmetic of decarbonisation. As we have seen in the news, both major parties have since 2007 espoused 'greenwash' policies which have hidden a core reality of continued reliance on, and political support for, Australia's dominant carbon-based energy system. Maybe (as I write this in July 2010) this might begin to change now.

The Greens have throughout these years had an expert understanding of the science of the climate crisis. But it has been but one item on their crowded political agenda. They, too, have traded off climate policy against other priorities and ideologies – in particular, their fervent opposition to nuclear energy.

The result has been policy paralysis. Climate crisis policy in Australia – after the initial trust in Kevin Rudd, who in his 2007 election campaign promised real climate policy leadership[13] – now isn't going anywhere.

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How can Australia's engineers help the Australian public to become better informed, more effective participants in the formation of sound national policy on the climate crisis?

The perspectives of scientists and engineers are different. Scientists explore knowledge about the natural world. Engineers design and build complex systems for human sustainability, like large buildings, road

systems, aircraft, rail networks, electricity grids, hydraulic systems, chemical plants etc.

The core engineering syllabus still rests on a solid base of mathematics, physics and chemistry, engineering design and theory of machines. All engineers are familiar with the two laws of thermodynamics. The first law is that energy can neither be created nor destroyed: it can only be transformed. All energy transformations to mechanical work involve losses of energy efficiency – usually, as heat. The second law is that all closed systems will over time increase in entropy or disorder, with the progressive loss of thermal or other kinetic energy gradients that can be converted into useful mechanical work.

Engineers understand that these two laws set physical limits for man's exploitation of the planet's large natural energy potential. They also underpin the earth's energy and climate equilibrium, and equip scientists to understand how finely balanced this equilibrium actually is.

Incoming energy from the sun, our basic energy source, powers through various energy transformations all the world's usable energy gradients: i.e., the thermal energy stored in the earth's interior and in fossil fuel deposits; the nuclear energy stored in radioactive mineral isotopes; and the natural physical and temperature kinetic gradients in the world that drive our weather and climates, and furnish our planet's solar, wind, and hydraulic energy potential.

The laws of thermodynamics shatter the naïve techno-dream that scientists could one day discover unlimited pollution-free energy. There are no magic crystals or perpetual motion machines. Everything has to be paid for in work; and everything sooner or later runs out of steam.

Engineers also understand the non-fungibility of nature, the remarkable and unique properties of particular materials. We know how naïve is the economic theory that all materials and energy resources are infinitely substitutable, if only the price system is allowed to equalise supply and demand: we cannot build bridges out of sand, or transmit electricity through cables of non-conducting materials. Scarce materials with special properties must be cherished.

Engineers are thus well placed to help educate society away from the impossible dream of infinite economic growth and growth in living standards, knowing as we do that we inhabit a finite world of limited and use-specific resources, energy supplies and waste absorption capacities.

The climate crisis signals a broader societal question – how can *homo sapiens* learn, before it is too late, how to live within sustainable limits as a species?

Systems engineering has useful intellectual tools to offer. Engineers build complex, mission-critical systems which are not supposed to fail; so they design these complex systems according to conservative risk-management principles. The challenge is to apply this professional way of thinking about managing risk in safety-critical systems to thinking about how climate change is now stressing, to the point of increasing risk of failure, human society as a whole.

Engineers are taught the difference between stable and unstable equilibrium states. Engineers know that the causes of failures in complex systems begin with small faults in overstressed parts. These failures then spread and compound in a series of positive feedbacks, tipping the system into other larger failures as it tries to move to a new equilibrium. Engineers are thus well placed to understand how easy it is to upset the delicate energy balances governing the global climate system, complex as this system is.

James Hansen's *'Storms of my Grandchildren'* is the best book for general readers on the science of the climate crisis that I have read. [14] Hansen demystifies climate science, giving clear explanations of the complex fast and slow feedbacks, inertias and accelerations involved in the climate changes the world now faces. He offers convincing projections of catastrophic global climate change if business-as-usual carbon dioxide emissions continue. Hansen relies mostly on the planet's observed paleoclimatic history and on contemporary observational data. He does not base his analysis on climate models.

Hansen's book would be readily understood by engineers. It addresses in illuminating detail the key scientific concepts relevant to climate change. I summarily list these concepts hereunder.

Engineers can capably get their heads around the greenhouse effect, first discovered by Fourier in 1824: how infrared radiation passing through certain gas molecules in the atmosphere generates heat, and how the heat thus generated in the atmosphere by very small concentrations of carbon dioxide has for the past 30 million years kept the earth within a range of life-sustaining temperatures, suited to the evolution of large mammals like us.

Engineers can understand the carbon cycle in nature, how carbon is present in many forms in nature: in solid or liquid or gaseous forms stored underground, also in living plant matter and soils, also dissolved in water or ice or as gases locked in permafrost, and finally diffused as gas in the atmosphere. Engineers can grasp how an initially carbon-dioxide rich atmosphere, highly unfriendly to life, was gradually oxygenated by photosynthesis and the geological fixing of carbon in water, plant and animal matter, soils, and eventually in solid or liquid carboniferous deposits.

Engineers can comprehend the vital role of the polar icecaps and sea ice as global thermostats. They can understand the dramatic dynamics of how polar continental icecaps are now starting to melt, as ambient air and seawater temperatures rise: not as an iceblock melts in the sun, but as an accelerating dynamic cracking and sliding process, generated by compounded direct and shearing stresses in three dimensions, as giant ice masses begin to melt and fracture from above, within and below. And how, if polar region average summer temperatures go on rising by just a few more degrees, much of the ice-mass in our polar icecaps will melt within decades, leading to metres of sea level rise by 2100, with much more to follow.

Engineers can understand the physics and chemistry behind the apparent puzzle of how the planet has moved repeatedly in its millennia of paleo-climatic history between sharply contrasting climate states – ranging from a hot world without any ice at all, to an almost frozen-over ‘slushball’ world, and back again. Such huge climate changes have been triggered by magnifying feedbacks from quite small perturbations in the earth’s energy equilibrium, of no greater order of magnitude than the sharp increase in atmospheric carbon dioxide that humanity is causing now, since the Industrial Revolution began.

Engineers can understand how, in most of the world’s previous paleo-climatic states, the world’s climate was unfriendly to human life. As a species, *homo sapiens* has only been here for 200,000 years. By comparison, the dinosaurs were here for 185 million years. The human species has a narrow climate-range tolerance in nature. How lucky humanity has been in its 200, 000 years of existence - a mere blink in geological time - to have enjoyed a benign range of temperatures, in which humanity could populate the planet and develop food-gathering, food-growing and civilisational skills.

How vital it is to try to sustain this precious gift of a stable human-friendly climate. I would like humanity to give itself more time to explore its wonderful potential as a species: not to destroy our grandchildren's future by irresponsibly wrecking our climate.

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The climate security of our children and grandchildren is thus a proper business for engineers. But why are engineers seemingly reluctant to apply their intellectual tools, their professional insights and habits of mind, to thinking in a systematic and synthesised way about the climate security of human society as a whole? It seems many engineers have come to think that this is somebody else's responsibility – that the climate crisis is above engineers' pay grade.

But there is no 'somebody else'. Neither scientists nor economists nor politicians have higher skills than engineers in providing useful answers to how society can mitigate or, to the extent possible, adapt to disruptive climate change.

The climate crisis is at its core a problem caused by human technology - how can the human species safely transform and use the earth's enormous energy potential?

Engineers could and should be at the forefront in designing and proposing safe and sustainable energy solutions. They should certainly not be lagging in the rear, defending the continued use of high-risk and obsolete carbon-burning systems.

When scientists discovered in the 19th century how dirty water and untreated sewage carried cholera and typhus, engineers created the remedies. They built great urban systems for clean water supplies, and safe sewerage and stormwater removal and treatment. Now it should be engineers who advise society on how to make the transition to a safe non-carbon-burning energy economy.

The silence of professional engineers as to the 'how' of decarbonisation is being masked by a cacophony of voices on the Internet, mostly uninformed and ideologically driven. Within all the contested ideas on Internet sites about alternative energy technologies, there is already much useful technical information[15]. But it is impossible to distinguish the good from the bad or irrelevant. There is no quality control, and no way of sifting sense from nonsense.

Part of the reason for engineers' professional reticence on the climate crisis is that market economics has claimed this policy ground for its own. Western society is intimidated by the large claims of market rationalist economics: that the price mechanism can solve all problems, even climate change. So Western society has looked to market economics to give all the answers.

As we now know, Copenhagen's emissions trading approach failed to win international support. What looked good in New York or London or Canberra, and satisfyingly profitable for bankers and traders, did not look so good in Beijing or Delhi or African capitals. Developing country governments distrust international trade in carbon credits – they know such trading will be at best a brake on their industrial development, at worst an encouragement to corruption of their frail governance institutions.

Both Adam Smith and John Maynard Keynes understood that market economics only exists to serve human society. The market forces model of society is simply a mental construct, generalising from simple marketplace behaviour. In the end, what things cost is far less important than their physical and social impacts on the real world.

We still get such wisdom from a few contemporary economists, like Paul Krugman[16] in the US, or John Quiggin in Australia[17]. But for most economics professionals , especially those working in corporations or in government, the bottom lines of market economics - prices and interest rates – usually trump the laws of science and social necessity.

The servant has become the master, and we are all the losers from this loss of wisdom.

Every tonne of coal burnt produces nearly three tonnes of carbon dioxide, which is dangerously overheating our planet. Yet the effects of not costing carbon-burning's external diseconomies, and of applying commercial discount rates to cost-benefit investment analysis, is that the renewable energy infrastructure which urgently needs to be built *now*, if we are to protect our grandchildren's climate security, is still sometimes claimed to be 'uneconomic'. In effect, economics is here advising society that our grandchildren's lives in 50 years time are worth far less than our own lives today – a morally repugnant proposition[18].

Governments do not apply market economics-dominated decision rules to questions of large public expenditures on defence, or policing, or public health. Governments happily order astronomically costly submarine or joint strike fighter defence systems, for which taxpayers will be paying over many decades. Once society has decided the levels of protection it wants in national security areas, money is found.

So it should be with national decarbonisation. Society needs to understand decarbonisation as a national security emergency, so that Australia can begin to put in place sustainable energy solutions, as a responsible action and inspiration to the rest of the world.

Yet there is no sign of this. In fighting the global recession, our federal government was ready in its 2009 budget to run up a $300 billion national debt to maintain public confidence and employment. Yet for what the former Prime Minister accurately labelled as the great moral and economic challenge of our times, the 2009 budget offered $2 billion for the false dream of carbon capture and storage, and a mere $1.5 billion – which a year later was still only a promise on paper - for a solar energy flagships program.

If engineers as a profession will not research and discuss publicly the urgency and physical feasibility of a national energy decarbonisation project in Australia, who will?

Questions of prudent career reticence are no doubt involved here. What can engineers safely say if they work for a coal company or coal-based electricity generator? But surely there should be professional safety in numbers. Corporate bodies like Engineers Australia could help break the silence, by mounting well-structured major national conferences where engineers could meet top-line international experts in the latest state-of-the-art renewable energy and nuclear energy technologies, and could discuss in working groups the feasibility of applying and combining these technologies in Australian conditions. Such conferences, well planned and broadly attended, would catalyse useful discussions among Australian energy engineers – knowledge which they wcould take back to their employer organisations. Engineering professional bodies like Engineers Australia could sponsor and plan such conferences for maximum public policy benefit. A major charitable foundation could provide funding, once a good planning vision was in place.

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[1] This paper originated as a talk given by Tony Kevin at the Engineering Deans of Australia annual conference dinner in Canberra on 8 April 2010, later published in the Australian Journal of Electrical and Electronic Engineering, Vol 7 No 2, under the title *'The role of engineers in framing national policy responses to Australia's climate crisis'* . This text is adapted and updated from that article, and thus does not infringe AJEEE copyright of that article.

[2] '*It's not all hot air'*, by Dr Lorraine Stephenson, *Australian Financial Review*, 26 March 2010.

[3] *'Interview with Sabra Lane, ABC PM: Six Years to fix climate change - Australia's Chief Scientist speaks about climate change with ABC PM's Sabra Lane'*, 20 April 2009 http://www.chiefscientist.gov.au/2009/04/interview-with-sabra-lane-abc-pm-six-years-to-fix-climate-change

[4] At the Greenhouse 2009 climate change conference in Perth in March 2009; as reported by Marian Wilkinson in '*Climate action rises above hot air', Sydney Morning Herald,* 28-29 March 2009.

[5] '*State of the Climate'* ,CSIRO/Bureau of Meteorology public information report, March 2010 http://www.csiro.au/resources/State-of-the-Climate.html

[6] Stephenson, op.cit

[7] Stephenson, op.cit

[8] 'Energy (R)evolution: a sustainable Australian energy outlook', by Sven Teske and Julien Vincent, Greenpeace Australia , June 2008 http://www.greenpeace.org/raw/content/australia/resources/reports/climate-change/energy-revolution-scenario-full.pdf

[9] '*Requiem for a species: why we resist the truth about climate change',* Clive Hamilton, (Allan and Unwin, 2010), addresses psychological origins of climate change denialism and the human disconnection from nature. See especially pages 38 and 118-158.

[10] '*The Garnaut Climate Change Review'*, October 2008 http://www.garnautreview.org.au/
is an authoritative survey of Australia's climate policy environment and market-based options. The history of the Rudd Government's failure to support Garnaut's climate change policy recommendations is reviewed in Chapter 1, 'Falling at the first hurdle: the Garnaut review' of my book *'Crunch Time: using and abusing Keynes to fight the twin crises of our era'* (Scribe 2009).

[11] *'Storms of my Grandchildren'*, James Hansen, Bloomsbury, 2010.

[12] 'Should Australia go nuclear?', debate at National Press Club, Canberra, on 7 April 2010 between Senator Bob Brown and Dr Ziggy Switkowski. For an ABC 'PM' report on this debate, see http://www.abc.net.au/pm/content/2010/s2866666.htm

[13] Quotations by former Prime Minister Kevin Rudd as cited in *'Crunch Time'*, pages 11, 13, 160-161.

[14] James Hansen, op.cit.

[15] *'Brave New Climate',* a pro-nuclear energy public access website hosted by Professor Barry Brook of Adelaide University, offers useful technical debates on renewable and nuclear energy technologies. http://bravenewclimate.com/

[16] See Paul Krugman's blog, 'The Conscience of a Liberal', http://krugman.blogs.nytimes.com/

[17] See John Quiggin's weblog Home Page, http://www.uq.edu.au/economics/johnquiggin/

[18] The limited value of a market rationalist economics perspective on inter-generational climate change policy is reviewed in Chapter 9, 'Discounting our Kids' Futures', of my book *'Crunch Time'*, which draws on work in this area by Professor (Lord) Nicholas Stern for his climate change report for the British Government . See '*Crunch Time'*, pages 200-208.