6 May 2013

Society for Sustainable Engineering -Response to NCFE Issues paper Australia's Energy Options and Strategies

We commend the NCFE for initiating Energy policy to guide Engineers in the essential transition to a low emission economy through rapid change to technology, systems and investment. The policy must be driven by scientifically based on irrefutable global CO2e emissions peaking at 450ppm and rapidly declining to reduce the risk of exceeding global temperature of rise of 2C. This will require urgent action this decade, as well as commitment to the 80% 2050 reduction noted in the paper. Engineers can only be at the forefront of this transformation if Engineers Australia initiates policy, advocacy, innovation and training to equip the profession to deal with emissions abatement and the adaption in energy, water, infrastructure and our human environment.

- We now have irrefutable scientific evidence that Global CO2e emissions must peak at less than 450ppm and then rapidly decline to have a 75% chance of avoiding global temp over 2C. At present we are heading for 550 to 650ppm and 4 to 6C global temperature rise, which would be beyond any reasonable risk assessment and completely unmanageable in Australia and many other parts of the world.
- Although Australian emissions are only 1.5% of the global total, it would be a significant risk and possibly compromise item 4 of the Code of Ethics to advocate a Policy that does not reduce our emissions in accordance with the scientifically established minimum.
- Economic Risks include cost and trade penalties under potential international agreements, inability to develop and participate in emissions reduction technologies in other countries, costs and reliability of imported energy (oil) and loss of international reputation and standing. These risks need to be quantified by consultation with climate negotiating authorities and Government, peer organisations in other countries so that EA policy meets the highest standard of our global peers.
- Whilst energy exports (coal and LNG are around 4% of world emissions) are not directly part of this paper as emissions are measured in the country in which they occur, the Risk of rapid decline in prices and volumes, and penalties needs to be assessed as this will have a direct bearing on indigenous energy and economy.
- The issues paper assumes the Government target 80% reduction on emissions by 2050, however the rapid transition to very low emissions energy systems is required to achieve a 20% reduction in CO2e emissions by 2020 to be on track to limit CO2e to 450ppm (refer Appendix & climate commission– the critical decade)
- EA is a key organization to promote technology, training and innovation in engineering solutions and assist Governments and industry in the transition so that impacts on the community, environment and economy are mitigated.

- EA Council, Colleges and members have written many papers and developed policies with clear understanding of the issues since 1992, culminating in the 2008 climate policy. The rapid advance of research and knowledge on Climate science, global monitoring of changes and careful Risk based predictions means these policies are in need of urgent revision.

- EA have to deal with the dilemma. On the one hand advocating and promoting, energy efficiency and renewable energy, endorsing Government policies on emissions reduction and renewable energy commitments and emissions trading. On the other championing major FF projects in direct conflict with the overwhelming evidence that Australia will be a significant contributor to Global warming and vulnerable to international action on emissions restrictions and cost penalties.

- Engineers are concerned about their jobs and economic well being, generally trained to get the project done to meet their employer or client requirements – within the standards, regulations and systems applying at the time. Many work in water management, Councils, as environmental consultants and other organisations and are acutely aware of Climate change and Sustainability issues and that current regulations and standards fall well short of what is required.

- After 20 years of debate Consensus on policy and commitment to change is as difficult in EA as any other organization or the wider community, however as a learned society we now have to lead the Profession with evidence based long term policy and short term action.

- We call on NCFE and EA council to produce a “Climate change guidance for Engineers” as a matter of urgency. This would provide a framework for development of the Fuels and Energy and other policies.

Response to NCFE issues paper

David Hood, Fraser Gibson and others participated in the workshops, listening to the ideas and views and expressing our own. Generally it was felt that the Paper did not address the urgency and extent of emissions reduction required, and that participant’s focus was on low cost and secure energy, and the various technologies and systems rather than the transition to low emission outcomes that must be achieved. (Refer Appendix)

Much of the information in the paper is out of date or incomplete and further work is required to make decisions on technology, systems and forecast costs to support a policy. There is a large body well founded studies and reports, and it would be better to reference these than repeat the work. NCFE may have to organise technical groups to investigate and report on specific technologies and systems to guide EA in advocacy, training, innovation to equip the profession for the transformation required.

The policy (including climate change for Engineers) must have evidence based clear directions and firm commitments to outcomes. The major system and technology changes must be clearly stated with implementation timelines so that the Emissions reductions and costs can be validated. Details of technology and cost studies and reports can be referenced.

Minor and insignificant technologies and systems, and those that cannot be demonstrated technically and financially or unlikely to get community, Government, industry and investor support can be noted, and the justification for excluding at this time noted. This may improve focus and decision making on the most relevant systems and solutiuons.

Response to Specific clauses and items in the paper

Executive summary

The Broad review & statement of current energy status notes the Policy driver assumed to be orientated towards reduction in CO2e from energy use. A considerable understatement– it is, we have to do it, and soon. (Appendix)

Australia depends on low cost secure reliable energy. Maintaining this whilst transitioning requires strategy for complete energy cycle, closely linked to industrial and commercial development strategy**.** Everybody has to cope with changes and rising costs. Industrial and commercial responses are quite clear and are reactionary, reflecting short term interests. Extensive consultation and debate already done and policies are there for EA to support and advocate, or reject as inadequate.

Paper concludes that initiatives complimentary to the clean energy policy position will be necessary to meet target for reduction of emissions by 2050. What initiatives are we advocating? Note it is not a target and it's not 2050. Risk analysis tells us not achieving that leaves us with is a situation well beyond our control and management. I.e. Engineers will not be able to deal with the adaptation required.

Scenarios show need to reduce demand for energy, and strategically target transition to lower emission sources (e.g. transport from fossil fuels to electricity from low emission sources). This requires extensive changes to efficiency and electrification of transport. None of the scenarios achieve required emission reductions.

Investment in long term assets requires international capital and we have to pay a return. Policy and market consistency critical to accessing investment capital. The evidence is that investment funds and financiers are very willing and investment is available. Changing Government policies, incentives and restrictions (mainly state level) perverse subsidies and the way we have privatised electricity distribution means major intervention and structural reform is required. Existing FF industry is manipulating markets and lobbying Governments. The stable and predictable long term strategy and policy to attract international investment finance noted in the paper is very unlikely. There is extensive analysis and recommendations and EA needs to align with peer professional and other credible organizations to push for the right reforms to deal with the issues.

Introduction and **Energy in Australia** a section note the economic importance of reliable low cost energy, and provides a breakdown of energy consumption by sector (Transport 38%, residential 12% manufacturing 28%etc and by energy type (Electricity 20%, gas 20%, renewable 4% oil 52%) and notes the dependence on imported oil. Electricity production 49% black,29% brown coal 15% gas and no solar (obviously out of date) The whole sector energy includes Coal 40% oil 37% gas 21% and 1% renewable. This is out of date; however it shows the high dependence on FF and imported oil and the huge challenge for EA NCFE to demonstrate a pathway out of this. Particularly difficult as many engineers work in the very industries we need to phase out.

A key driver of Energy strategy re iterates the need for secure, reliable, minimum cost – while addressing CO2e emissions. The remainder of this section is generalized and fairly convoluted narrative about energy cycle and conversion, final use, synergies, transitions of energy structure and strategically desired outcomes. This section includes evolution of control systems, negative economic impacts, and complementary industrial and commercial development with linkage to global activities to leverage strategic positioning. Most of this is not new and already addressed in a raft of Government, energy industry, and analyst organizations including NGO's in the renewable energy area.

KEY CONSIDERATIONS

Long term stability of strategy – As assets (e.g. buildings) last 25 years and changes to existing infrastructure is more difficult and costly than performance standards for new investments. Strategy has to be for decades and linked to long term industry and social strategies. This is restating the obvious and fails to recognize we are in an unstable political, economic and social environment. We have to deal with the current energy infrastructure and systems as well as what will be built– and we have to start now.

Energy efficiency notes importance of efficiency related to limit capital costs of renewable technologies and reiterates Prime Ministers task group on energy efficiency "an energy efficient culture in Australia through long term nationally integrated strategy" and strategy needs to recognize specific opportunities in various sectors. We have already identified the sectors and opportunities – NCFE policy paper can identify the clear sectors and actions.

Demand management Energy must meet demand so production and supply requires demand management restating the obvious, however the concept of as much as you want whenever you want is over for all forms of energy. In the case of electricity users can accept load shedding at various times with little or no adverse effects on activities. We have systems to manage this.

Identify and support technology pathways and manage transitions Achieving goals will require new technologies – some commercially mature others highly prospective. The technologies systems are developed and for most renewable proven at scale. Nevertheless adapting to our circumstances and implementation in a rapid time frame place a huge demand on our technical resources which are already dealing climate change effects. The policy will have to identify priorities.

Regulatory stability and capital predictability Investment requirements are noted above. Stability and predictability highly desirable but very unlikely. The policy must apply to whatever circumstances we find ourselves in. A hierarchy of risk based options to be identified in the policy to deal with variation and some failures.

Integration of smart grid and diversified electricity generation. This is well understood and systems solutions available. The potential for balancing energy supply, interconnecting grids and distributed energy systems in terms of renewable energy and efficiency is considerable and in fact a necessity for The electric economy **scenario 3**

TECHNOLOGY OPTIONS

States need to move beyond one for one substitution (renewable for FF) considers whole system from generation to end use. Notes limitations of LCOE – does not consider economic benefits, costs of energy transfer to users, demand profile and synergies of technology. This seems to be saying that LCOE is a raw comparator for electricity generation. For example it may be cost effective to introduce a local energy production (solar PV, tri generation, etc) with a higher LCOE as it reduces transmission losses and system costs. Another example is Melbourne CBD. Tri gen is cost effective in major buildings as the poles and wires in the city cannot cope with more peak demand. So it makes sense to cross subsidise these systems to avoid substantial upgrades to grid.

PRIMARY CONVERSION TECHNOLOGIES

Coal based electricity Efficiency 30% LCOE $40 to $60 /Mwh
Technology trends -Ultra critical coal with efficiency 45%, Gasification combined cycle 50% Carbon capture and storage. Cost trends are stable- decrease in capital costs and increase in coal costs with Risk of global cost convergence. This is obsolete, Coal power stations - even without CCS- have increased in cost for a range of reasons including carbon emissions, water and environmental compliance. The LCOE needs to be updated and comparative tables and charts provided as decision basis. CCS expensive and unlikely to be proven at scale before 2030 (Refer subsequent part of the document).

Gas based electricity efficiency 20% open cycle 45% combined cycle LCOE $60 to $100MwH (combined) $120 to $400 open cycle. Advantages are lower construction cost and can follow demand. Requirement to have significant gas power to enable solar and wind to work. Seen as adding cost and duplicating renewable capacity and likely world (export) gas price to apply in future. The necessity of duplicating wind and solar power with gas due to varying generation is not entirely correct. Further investigation of grid integration, storage, and load management is required. The higher LCOE delivered may be acceptable for a peak demand times if it allows renewable energy for the bulk of power delivered.

Hydro - limited sites for development- Can vary output to suit load, and cover peak times. Bass link enabled pumped storage and demand management.

Wind LCOE $120-$220 Need for supplementary generation to meet peak demand. Constraints on available sites.

Wind has been very successful, and grid instability issues resolved. Capacity for far greater installation with interconnected Grid. Ultra low frequency sound health issues are a furphy, and in any case a fraction of the ULFS recorded from rumbling coal trains and dump trucks in the Hunter valley.

Solar Thermal- for residential water heating. There is much greater scope for substitution. More investigation and analysis needed.

Solar voltaic LCOE $200 to $350 Mwh. Advantages - scalability from residential to grid scale) many sites (roofs) low operating costs. Disadvantages - small proportion available at peak demand requiring additional investment to supplement capacity. Group noted we have a million solar PV about 3Gw and growing even with declining subsidies. Discussion about the Grid management requirements and costs for diversified generation. This needs more investigation and analysis. With grid interconnections and management we can substantially increase this highly efficient energy source (Sunlight straight to electrons at the point of use)

Concentrating Solar Thermal LCOE $250 -$400 Mwh constrained by higher cost. Advantages - can reduce variability through storage, many sites available near Grid. Disadvantages - only part capacity at peak times needs storage or supplementary generation. There are large scale systems in place and CSIRO at front of developing more efficient units with competitive costs at scale. Investment and industry support with Government and regulatory intervention to overcome generating industry resistance.

Nuclear - Commercially mature construction and operating costs, reliability well established. LCOE $100-$140/MwH. High capacity factors and low cost base load. Social and political perceptions in Australia reflect higher costs and longer construction, and decommissioning issues. Working Group enthusiasm was deflated by explanation that a 2000Mw station close to sea and city on East coast required. Finance, approval, project risk (new to Australia) as well as no government or community support at any level is the reality. Definitely a non starter!

Geothermal Deep hot rock is pre commercial, critical technology developing. LCOE $120 to $220MwH**.**
Discussion on technology failures, retreat of investment and unlikely to make significant energy contribution any time soon**. Low Grade heat for heating and cooling buildings.** Using heat pump systems for highly efficient (Co efficient of performance 4 to 6 and increasing) is attractive at user end. Installation costs are high at present but significant cost reductions through standardisation and multi site installations.
Bio fuels & Fuel cells. Development stage and unlikely to make a major energy contribution.

ENABLING TECHNOLOGIES
Storage No useful information provided. This key area needs investigation and analysis. Molten salt, Batteries, any other technologies are available and can be deployed to address varying demand and generation. Some group discussion re electric cars and batteries providing storage.
Carbon Capture & storage (CCS) Large scale not achieved, environmental & safety issues– which technology can manage! Capital cost of station +50% and reduced efficiency 30% . Not suitable for retrofit. Discussion about public safety & storage risks, no success even after world wide $B research (including several hundred million from Aust) Noted that coal industry is clinging to this as a solution. Investigation required on cost and decide if it can be implemented at scale and by when or eliminated as an option.

SYSTEM TECHNOLOGIES
Smart Grids The paper notes distributed energy generation is impacting system stability voltage and frequency control. Electricity utilisation uncertainty (we don't know where the solar PV is, when it will generate of the wind might blow!) Customers are changing their consumption patterns. The feasibility of distributed energy network is enhanced by information and communications – called smart Grids
This assessment is inadequate and out of date. We know how to design and operate a "Smart Grid" and "smart meters" already widely installed (some of the group questioned this). Earlier claims the system would be unstable and wind etc cannot be more than 20% are unfounded. The potential for efficiency, renewable energy and reduction of transmission losses is considerable. Moving to "The Electricity Economy" will require major grid interconnection and capacity upgrade. As noted above (ref Integration **of smart grid and diversified electricity generation**) roadblocks include structural reform of the diverse grid ownership, retail providers, and impediments from major generators and retailers.

HYBRID TECHNOLOGIES
Tri generation Generation, heating cooling from one source with up to 80% efficiency.
This is a well developed proven technology often used in commercial buildings. (See **TECHNOLOGY OPTIONS above)**
The potential for energy (and emissions) savings from integration of Gas engines, Solar PV and heat pumps retrofitted to buildings is significant. A third or more of energy consumption can eliminated. A reference is the Melb.City Council 1200 buildings program. Building ratings (NABERS, Bldg Council Star etc) and some regulatory requirements are now in BCA. Impediments remain the cost of fitting, building management systems and the way the industry has disconnected owners from tenants. The former has no incentive to spend capital to reduce tenant costs, and leasing does not provide tenant with benefit of long term investment.

This is an area where we can act quickly and get real results.

Solar- Thermal – Transport Combine solar with FF to improve efficiency, reduce emissions. i.e. Gas supplementation of solar thermal power stations, preheating water in FF power stations and hybrid vehicles.

The first is only necessary where there is insufficient storage or grid integration, the second has marginal benefit and we already know about Toyota Prius. Nothing new here.

END USE TECHNOLOGIES

Electric Cars Transfer transport fleet to electricity with charging from renewable sources, and batteries providing storage and grid balancing. This is an important transition and technically well advanced with electric vehicles in production. Impediments are the vested interests from car manufacturers, distributors, service sector etc and FF suppliers, and perceptions about car range, capital cost etc. Potential is very significant, and no reason why Australia cannot take a lead here (along with Smart Grid etc.) An electric train with 1500 people on it or a tram with 80 will remain more efficient, and we know that cars need roads and other supporting infrastructure.

Energy efficiency Control and management technologies, new materials are supporting trends to greater efficiency. Major opportunity for prompt action, with known systems and materials. The much maligned home insulation program has been successful from energy savings point of view. We urgently need to implement a properly managed comprehensive residential and small business efficiency scheme. If we can do 1million solar PV, connect NBN to homes, install smart meters, surely Engineers can get behind efficiency and insulation retro fit.

Further work is required to remove impediments to commercial and large residential building management systems and retro fit. (See **Tri generation** above)

Demand Management Energy storage, electric car batteries, smart grids, demand management. All required and noted in **KEY TECHNOLOGIES** and **SYSTEM TECHNOLOGIES**

TRANSITIONS and SCENARIOS

Three scenarios are considered. Each has base energy (emissions) profile 2010, and estimates of 2050 outcomes to identify policy for each strategy (Scenario). Scenarios draw on data used in other modelling publically available, and are selected to compare various interventions in the market that will contribute to meeting emission reduction targets.

None of the Scenarios achieve the current Government commitment of 80% by 2050 emissions reduction (based on 2000 emissions).The Scenario 3 The Electric Economy has projected 75% reduction over 2010 for electricity sector and 60% for energy sector.

SCENARIO 1 Current policy

- 20% renewable energy target by 2020.
- Carbon tax & trading in accord with **Clean Energy Future** legislation.
- Buy out 2000MW coal fired power stations

Scenario Parameters

- Renewable target not extended from 2020
- Demand grows at current rates
- Energy sources not markedly changed
- Global stabilisation target emissions 550ppm

- CO_2e \$29 /tonne in 2016
- Best available lowest cost technology (after allowing for emissions costs) for new electricity generation.
- Coal fired power stations retired when market prices make them uncompetitive.

Scenario issues

Constrained by capacity to change infrastructure in electricity production (long life coal fired power stations)

Wind power will drive lower efficiency higher CO_2 open cycle gas as backup.

Need for Base load will drive advanced coal, geothermal or nuclear as lowest cost bankable sources

Scenario outcomes

Fossil fuels remain dominant source of energy. Electricity FF declines from 90% to 70% in 2050

CO_2e emissions approximately the same as 2010 for electricity, and increase for whole energy sector.

SCENARIO 2 Energy Efficiency

SCENARIO 1 Plus efficiency policy from 2015 (Mandatory efficiency standards)

Scenario outcomes

Fossil fuels remain dominant source of energy. Renewables increase in electricity generation.

CO_2e emissions approximately 40% below 2010 for electricity, and 30% lower for whole energy sector

SCENARIO 3 the Electric Economy

SCENARIO 2 Plus

Transition of light vehicle fleet to electric (25% by 2030, 80% by 2050)

Storage batteries in vehicles charged during high electricity production periods from renewable (and other) generation.

Grid management and use of vehicle batteries to reduce peak demand.

Integrate solar in commercial building sector.

Scenario outcomes

Increased use of electricity less reliance on imported oil.

Rapid growth of advanced coal fired generation, geo thermal or nuclear.

Gas increases to 2020 to support renewable, with higher marginal cost reducing growth.

Solar grows rapidly for specific applications (buildings transport)

CO_2e emissions approximately 75% below 2010 for electricity, and 60% lower for whole energy sector

Key factors arising from SCENARIOS

- None of the scenarios achieve 80% reduction by 2050.
- Initiatives complimentary to current policy will be necessary, including emission reductions across all sectors, particularly transport and other sectors beyond the “Big polluters” focus.
- Need to reduce demand for energy and transition to lower emission sources. (e.g. electric transport).
- Changes will be regulatory and support based, rather than market driven.
- High cost of (electricity) production means investment long term– in excess of 30 years. Thus the **electricity production facilities in 2050 will be determined by investment**

this decade.

- Driven by Renewable energy target and policy of retirement of older power stations (similar to China and USA)
- The high capital cost requires access to international capital. Lenders will balance Australian risk /return with other global investments. Policy and market consistency will determine capacity to access these funds, and the cost.
- Australia needs the skills to develop and deploy appropriate technologies.

The CHALLENGE for ENGINEERING

Major transformation of energy production, transportation and utilisation.
To maximise benefits of this transformation it will be necessary to develop skills to develop, integrate and implement the new technologies and processes

Engineering skills to address disciplines such as:

- Complex networks, modelling, monitoring, control and design for massive distributed energy system.
- Unique chemical, mechanical and environmental problems in Geothermal and Coal seam gas.
- New structures for buildings incorporating active and passive energy gathering and management components.
- Design & build new energy production facilities and new storage technologies.

SENG SUMMARY

- **SCENARIO 3 The Electric Economy** provides a basis for transformation to lower emissions economy, although the urgency of interim emissions reductions is not made clear, and the emissions reductions achieved are insufficient to meet Australia's international obligations to cap our total emissions and do our part in limit Global emissions to 450ppm and warming to 2C +/- 0.8C.

- Australia's dependence on FF for more than 90% of our energy, and a large proportion of our export income makes use vulnerable to FF constraints, price collapse, international penalties.

- Australia is particularly vulnerable to oil price and supply to our transport, agriculture, mining industries and regional communities. A transformational change is required, which will be the most difficult to achieve due to the extensive investment at many levels in the system.

- We will have a huge engineering challenge with Sustainability and Climate change adaption. When added to the Engineering energy transformation we will be overwhelmed unless we completely rethink the profession and how we can train the Engineers to meet the task.

- Most Engineers put their employment first, and are working in the wrong direction. There is a huge task to rethink and redirect our efforts.

- The Paper calls for stable investment and policy environment, however we have a hiatus in both as States overturn various initiatives, support and regulations and Commonwealth Clean energy legislative package (including emissions pricing, Investment in renewable energy, innovation and technology) may be eliminated or substantially reduced by a change of Government. Critically there is no analysis or justification for many of the changes and dismantling of emission reduction programs.

- We do have investment capital available within our own finance system, including some willing to take technology risk, however we have failed to provide stable and consistent investment and regulatory environment. EA must advocate for effective long term policy by establishing our own clear policy and strategy.

- There are further efficiency and demand management initiatives which can be implemented quickly and at relatively low cost with significant emissions reduction. Residential and commercial building insulation and retrofit, appliances and heating cooling systems, vehicle emissions standards and transport management, removal of FF subsidies are examples. This could lead to behaviour change and prepare for further changes.

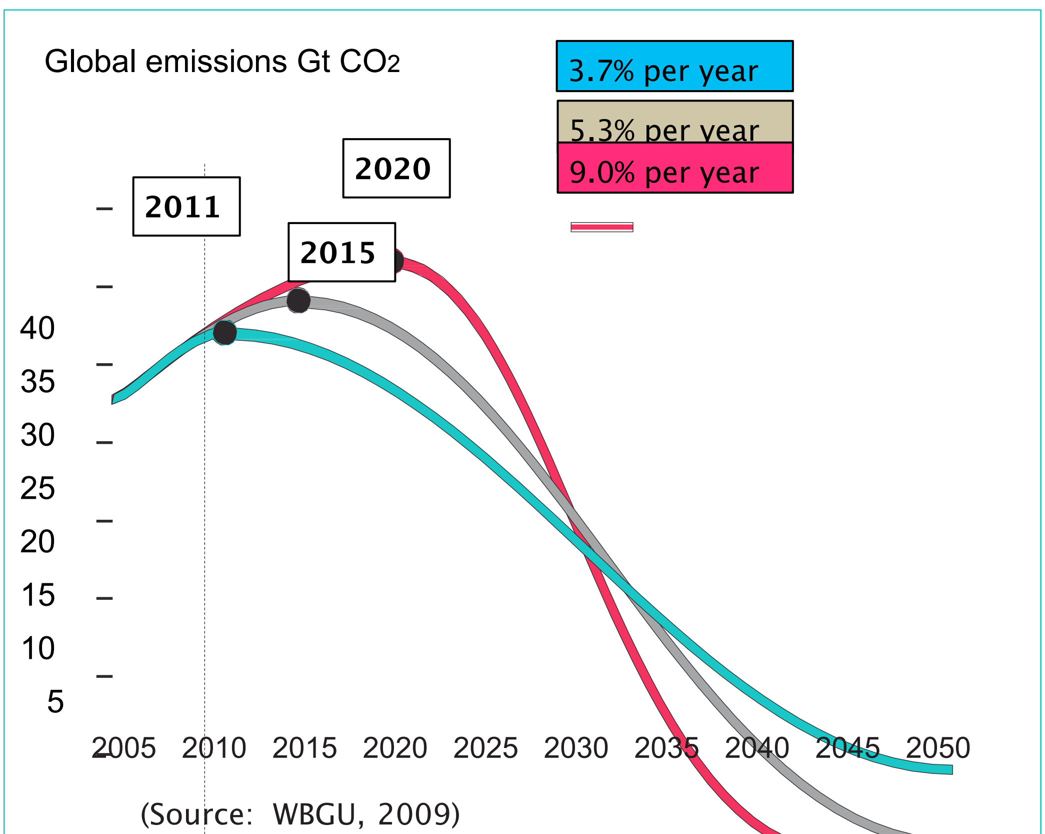
APPENDIX- The Global emissions Budget

From The Critical Decade –Climate commission August 2012

The peaking year for emissions is very important for the rate of reduction thereafter. The decade between now and 2020 is critical. Humanity can emit no more than 1 trillion tonnes (1 Gt) of CO2e between 2000 and 2050 to have a 75% chance of limiting temperature rise to 2C In the first nine years of the period (2000 through 2008), humanity emitted 305Gt of CO2 over 30% of the total budget in less than 20% of the time period. Australia emitted around 550Mt in 2012, and currently exports around 2.5 times that, mainly coal and Gas.

To limit temperature rise to the agreed goal of 2$_o$C or less, there is an upper limit on the amount of additional greenhouse gases we can put into the atmosphere. That is our greenhouse gas 'budget': the amount we can 'spend' before we are in the danger zone

Figure 1.4 – Three emissions trajectories based on the budget approach and giving a 67 per cent probability of meeting the 2°C goal.

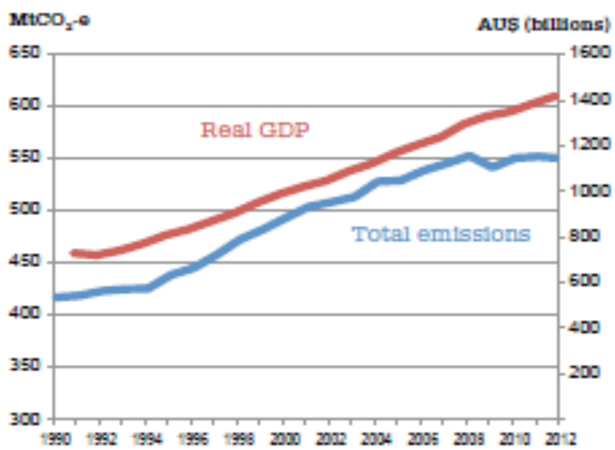


(Source: WBGU, 2009)

Figure 1.4 (WBGU, 2009) shows different emissions paths for the world with a carbon budget that gives us a 67 per cent chance of keeping temperatures below 2°C. Two things are clear: one, global emissions will need to be reduced to very close to zero by 2050 to meet this challenge; and two, global emissions must decline rapidly. But, the later we leave it the more sharply we will have to reduce emissions and the more disruptive it will be for the economy. The year emissions peak, that is, the maximum global emissions level, is especially important. For example, delaying the peaking year by only nine years, from 2011 to 2020, changes the maximum rate of emission reduction from 3.7 per cent each year, which is very challenging, to 9.0 per cent each year, which is much more difficult and costly.

Australian emissions level off under current policy and legislation. Rapid reduction is required

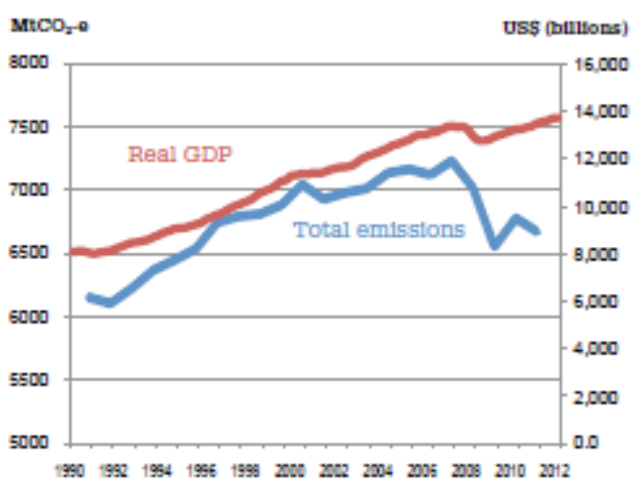
Figure 5: Australia total greenhouse gas emissions (excluding land use, land use change and forestry), and real gross domestic product, 1990 to 2012.



Sources: DIICCSRTE, 2013a, ABS, 2013

US emissions in decline under EPA Regs and state initiatives

Figure 2: US total greenhouse gas emissions (excluding land use, land use change and forestry), and real gross domestic product, 1990 to 2011.



Source: EPA, 2013; BEA, 2013