SAFE CLIMATE AUSTRALIA

Developing the Safe Climate Transition Plan

Strategic Framework

Instalment 1: Strategic Imperatives

DRAFT FOR COMMENT

12 November, 2009

We welcome your feedback

This document is a draft. A revised version will be published after consideration of comments and feedback.

This is the first instalment of the Strategic Framework, with the focus on 'Strategic Imperatives' covering global and Australian perspectives. The second instalment will focus on 'The Solutions Platform' and the third instalment will focus on 'Managing the Transition'.

Whether your feedback is additional information to strengthen the framework, improvements in data accuracy, challenges to the interpretation of the science , questioning of the strategic analysis, an offer to engage in the ongoing project work, a willingness to provide funding, or interest in setting up a Safe Climate Leadership Workshop in your organisation or sector, please contact: feedback@safeclimateaustralia.org

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The team

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Acknowledgements

Many people, especially foundation members of Safe Climate Australia provided valued contributions, corrections and suggestions in getting the document to this stage.

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1. Introduction

The starting proposition

Safe Climate Australia was launched in Melbourne in July 2009 at a breakfast attended by over 1,000 people from research, business , community and government circles, with Nobel Laureate Al Gore as keynote speaker.

The proposition underpinning Safe Climate Australia's foundation was:

1. *Responses to date to climate change globally and in Australia are inadequate.*
2. *The scale, speed, complexity, pervasiveness and dangerous consequences of climate change represent an emergency.*
3. *Transformational change in the way society functions within the eco-sphere is necessary, possible and desirable.*
4. *A coherent Transition Plan for moving to a safe climate needs to be developed, communicated and implemented, with a focus on what can be done in Australia and by Australians globally.*

This document provides a strategic framework for developing the Transition Plan.

The approach, methodology, guiding principles, key assumptions and high-level analysis of the Strategic Framework presented here will give context to, and drive, the preparation of the Transition Plan.

This Strategic Framework has been designed to provide 'intelligent constraints' and a converging force on the transition planning process, as it moves to greater detail and engages an ever-wider range of people.




Methodology

structuring the planning process

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As we progress through the planning process, the emphasis will shift:

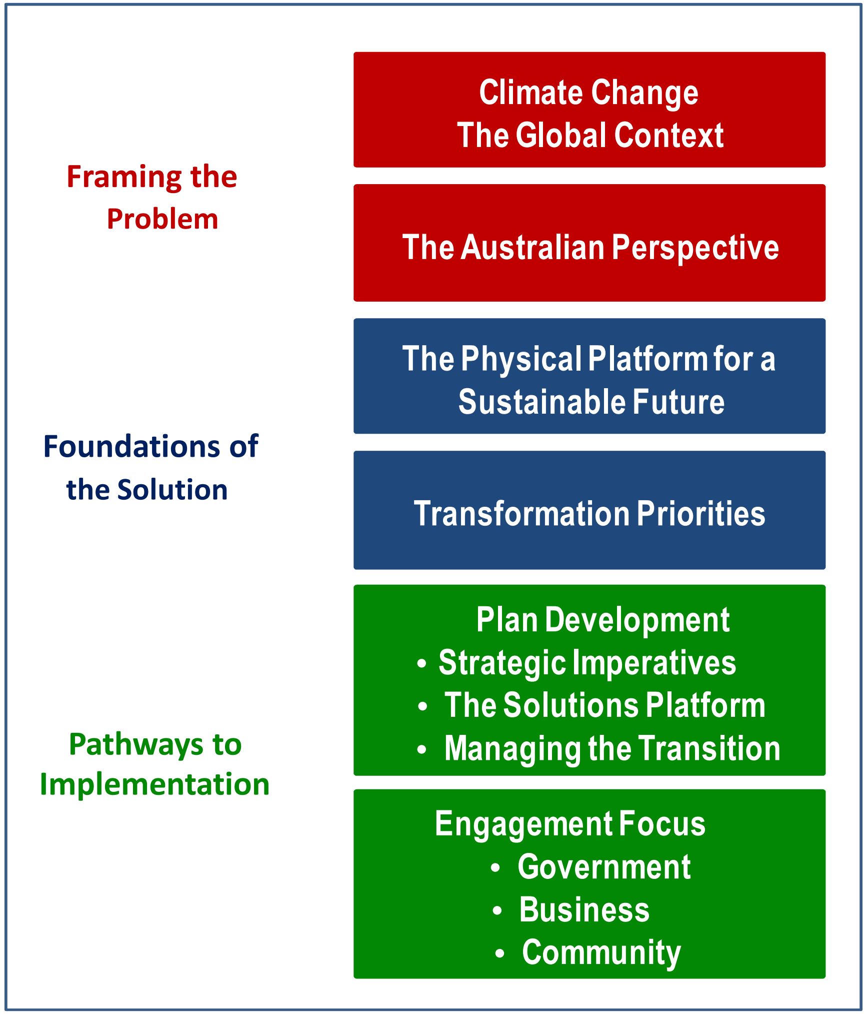
- from the Strategic Framework to the Transition Plan
- from systems analysis and principles to solutions
- from what is necessary to how it will become possible; ie. from the why to the how to the who

Philosophy

This Strategic Framework has been prepared in the belief that the climate system has been severely over- stressed at a planetary scale, with systematic degradation of ecosystems across the globe.

But it has also been prepared in the belief that it is **not too late to return to a safe climate,** given the will, creativity and sense of urgency commensurate with the task.

We therefore offer this as a positive, science- based, solutions-oriented contribution to the climate change debate.



Methodology
ingredients of effective planning

1. **Planning for success from the outset (backcasting from success):** starting from a vision of the desired future state (in principle) rather than some assumption of what is currently possible or expedient
2. **Taking a systems approach:** systems have meaningful boundaries, complex inter-relationships and hierarchy
3. **Values**:
   a) A deep respect for nature and humanity
   b) Grounding the analysis in the science of climate and solution technologies
   c) Outcome orientation
   d) Non-party political positioning
4. **Improving robustness:**
   Scenario planning and quality management processes, including the capacity for strategy adjustment in response to the latest science and emerging solutions

The Backcasting Sequence

Step A	**Desired Future**	Where do want to get to?
Step B	**Current Reality**	Measured against A
Step C	**Possible Solutions**	Driven by A - B
Step D	**Implementation**	Viable, flexible pathways

The System Hierarchy: Hierarchical thinking is essential for an effective approach: each level shapes the levels below and serves the levels above

Level 1	**The System**	What is the system and how it (mal)functions; social and ecological principles; system fundamentals and science
Level 2	**Success Principles**	Principles for a favourable and sustainable outcome; the desired end point
Level 3	**Strategies**	Strategic guidelines for the transition; technical platforms and process principles
Level 4	**Actions**	Initiatives, technologies, projects
Level 5	**Metrics**	Analytical tools, reporting

Framing the exercise
more than an environmental problem

1. Understanding the climate change problem in terms of the complex inter-relationships between:
   - the way human needs are met in society
   - the way value is created in the economy
   - the consequent ecological impacts
2. Working within sustainability constraints
3. Building on strong foundations, based on science and fundamental principles
4. Bringing out the enormous potential for innovation
5. Learning from natural systems
6. Adopting the Precautionary Principle, as a call for action not delay
7. Alignment with best practice safety and risk management principles and approaches

The Precautionary Principle

Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

Innovation

Systemic problems need systems solutions; this demands 'whole system' innovation

Innovation is borne of constraints; sustainability provides "intelligent constraints"

The scale of the challenge is the size of the opportunity; The gap between desired future state and current reality (A – B in the backcasting sequence) becomes the creative tension for innovation

Learning from Natural Systems

Nature has evolved with great richness and diversity within a constant physical planet (mass is conserved)

Bio-geochemical evolution and the complex cycles of nature have created the conditions for human life on earth

- Predominantly sun-driven processes
- Cyclical systems
- Diversity supports system robustness and stability
- No net waste or emissions; No toxic build-up
- Energy and the photosynthesis process re-create order and material quality

The unfolding analysis

The work of the IPCC provides an anchor point in assessing the science of climate change, particularly the 2007 Fourth Assessment Report. Further important insights are drawn from more recent observations and analyses on the scale and speed in which climate change is unfolding. The arguments articulated in *Climate Code Red* for dealing with the climate crisis in emergency mode and striving for a safe climate, rather than a "tolerably dangerous one", have had a formative influenced on Safe Climate Australia and this Strategic Framework.

This document is about developing strategy as the driver for crafting solutions. It is not a resolution of uncertainties on the exact way the highly complex climate system might unfold in response to the stresses global society has placed on it.

Notwithstanding the uncertainties, there are already strong indications and unequivocal warnings of significant and accelerating climate change. This document builds on the most robust findings to date.

Strategy is about taking actions today to better position for the future. It is about managing risks and responding to opportunities. It is about developing the capacity to respond to the worst, while hoping for the best.

This document is grounded in what we believe the best and most recent science is telling us. The strategic analysis is then developed within a framework of safety and risk management. The emphasis is on strategic clarity and underlying principles, rather than on specific tasks and targets, although the sense of urgency and scale of response are already clear. Refinement of tasks and targets will emerge further with the detailed work on the Transition Plan to follow and any new insights into the climate system and solutions to climate change.

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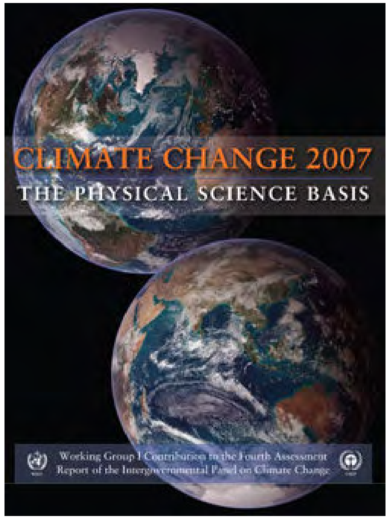

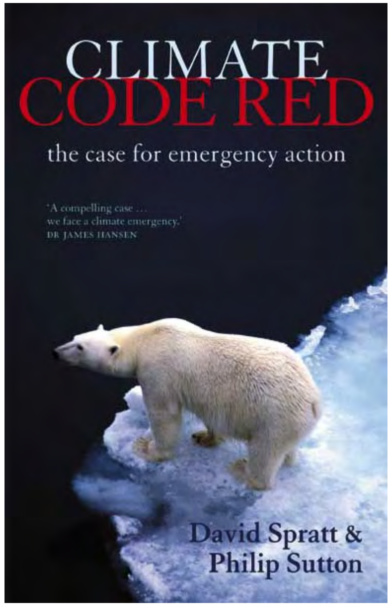

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2. Climate Change - the Global Context

Desired Future
expressed through principles

In a *Safe Climate:*

1. there are no systemic, unsustainable or unstable conditions driving climate change, such as global temperatures
2. greenhouse gases, such as carbon dioxide, do not accumulate in the atmosphere
3. concentrations of greenhouse gases in the atmosphere are stabilised at levels which are ecologically sustainable
4. climate related factors do not cause economic, political and social conditions which undermine the capacity for people to meet their needs
5. value can be created from natural energy and land resources without systemic degradation of the complex systems that constitute the ecology of the planet and its climate

Safe Climate Australia believes this is a future worth mobilising for.

It is the vision of a civilised society, whose economy operates in harmony with natural systems.

Its achievement implies a society capable of enormous innovation, at least on the scale of the industrial revolution and accomplished at greater speed.

Its achievement represents a true renaissance for the human condition, a redefining our relationship with nature, an affirmation of science and a blossoming of culture.

It does not compromise future generations.

This is a 'safe climate' in more ways than one.

In the remainder of this chapter, the current reality of climate change is judged against these five criteria.

Current Reality 1

1. In a *Safe Climate,* there are no systemic, unsustainable or unstable conditions driving climate change, such as global temperatures

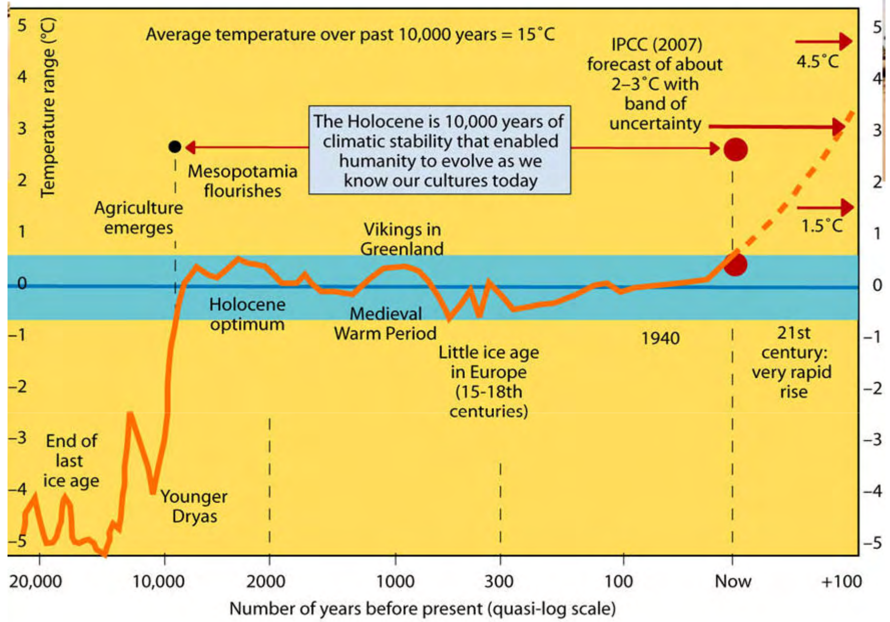
Historical perspective

The climate reflects the complex interactions of coupled and non-linear processes, which are strongly influenced by the distribution of temperature and energy throughout the system.

Average global temperatures have fluctuated considerably over geological time. Modern humans and our predecessors have been exposed to fluctuations over about a 7°C range. Average global temperatures for the past million years have not been significantly higher than they are today, but much colder periods have occurred during ice ages.

The establishment of human civilisation, underpinned by agriculture and the built environment, occurred since the last major ice age under the stable conditions of the Holocene. Global average temperatures have varied only within a 1°C range during this period (ie. +/- 0.5°C).

Civilisation has emerged over a 10,000 year period of climatic stability.



Current situation

In historical terms, we have very recently moved out of the steady temperature range experienced so far by civilised society. Warming of the climate system is unequivocal. Global average temperature has risen 0.8°C to date, but thermal inertia of the ocean hides an additional 0.6°C to come, bringing the extent of global warming essentially caused already to at least 1.4°C above pre-industrial levels, with more in the pipeline.

Warming trends

Further global warming

Given the complexity of the climate system, there is uncertainty in predicting the future, but there is no reasonable doubt that warming will continue apace. IPCC reports modelling of various scenarios where estimated additional average global temperature rise in the range 1.1-6.4°C by 2100.

As warming continues, this means we will be moving progressively deeper into climate territory not experienced on earth for at least a million years.

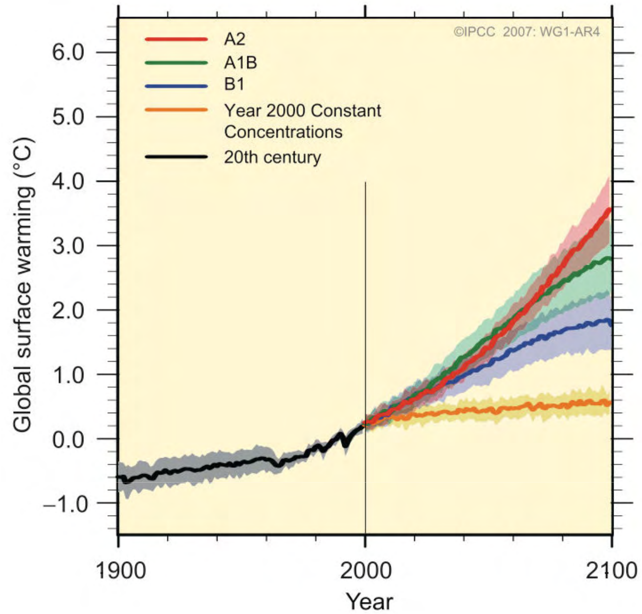
Accelerated warming

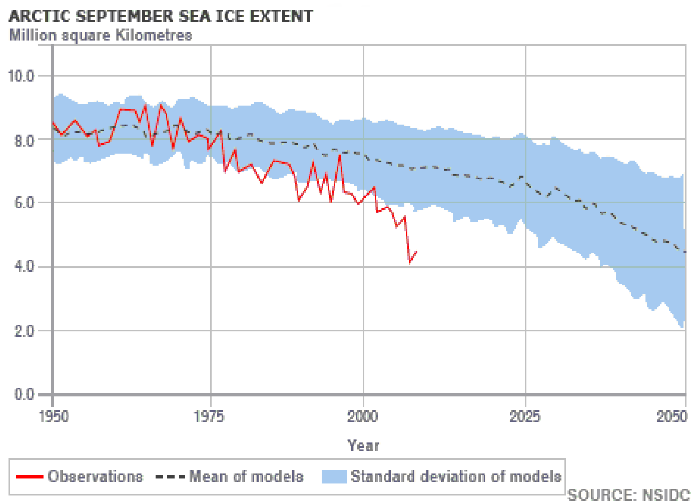
Recent observations suggest that warming may be accelerating much faster than original IPCC projections.

Since the ocean is the major heat sink within the climate system, the speed of sea ice melting is a strong indicator of global warming. 2007 was the highest ice melt in the Arctic on record. Scientists now fear an ice-free summer within the coming decade, some 80 years ahead of the IPCC predictions. This has enormous implications for the integrity of the Greenland ice shelf, and for climate change generally.

Amplifying feedback

When ice melts it creates a further driver for warming through what has been termed the 'albedo flip' (loss of reflectivity); ice reflects most of the incident solar energy, whereas the ocean absorbs most of the incident radiation.





The fundamentals

Albedo and greenhouse effects

Global temperatures and the climate system are influenced by:

(i) the fraction of incoming solar radiation (short wave) that is reflected back to space without absorption by the earth's surface; this is known as albedo and has a cooling effect

(ii) the extent to which thermal radiation (long wave) from the Earth is absorbed in the atmosphere and radiated back to the surface; this is the greenhouse effect, a warming factor

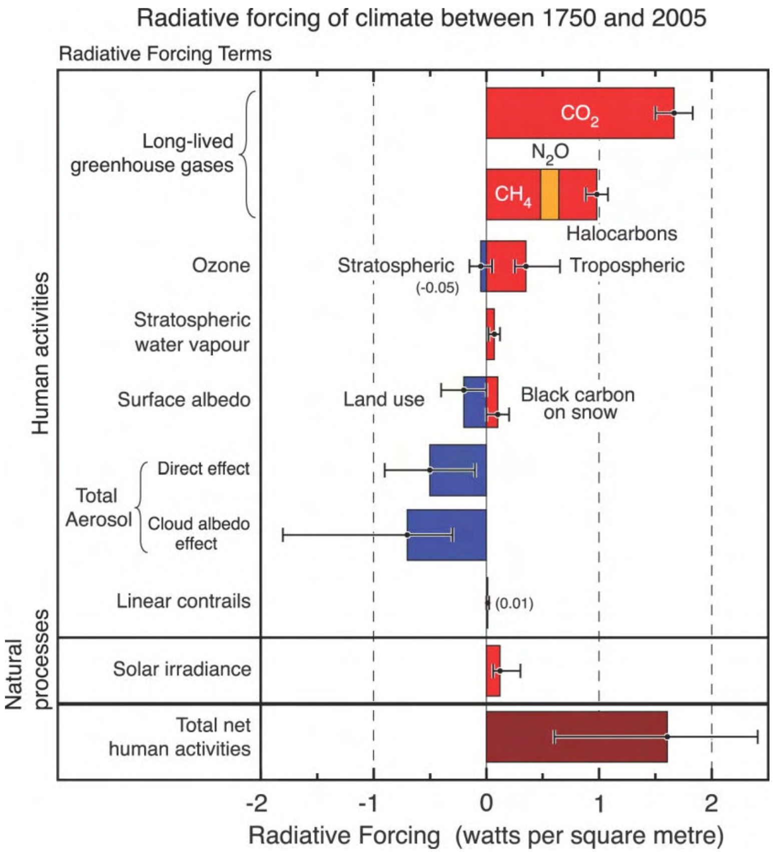
The natural greenhouse effect makes life as we know it possible, since without it the Earth's surface would on average be below the freezing point of water.

Climate change

Climate change occurs when radiative forcing factors alter the Earth's energy balance. Natural processes, such as solar irradiation changes and volcanic eruptions, cannot account for the extent of net warming observed over the past century or so.

The predominant cause of observed warming has been an enhanced greenhouse effect. This has been partially offset by the cooling effect of aerosols (estimated at about 0.9°C). Aerosols have a direct effect and also influence cloud albedo.

Clouds play a complex role in climate, as they can effect cooling (albedo) and warming (greenhouse) depending on their form and location. The science of cloud and aerosol impacts on climate change is currently less understood than the greenhouse effect.



The primary driver of net warming since the start of the industrial era has been increases in the atmosphere of greenhouse gases.

Summary: safe climate criterion 1

A. Desired Future	B. The Current Reality
There are no systemic, unsustainable or unstable conditions driving climate change, such as global temperatures	Global temperature depends on the extent to which incoming solar energy is reflected back to space (known as albedo, this has a cooling effect) and the extent to which thermal radiation from the earth is trapped by the atmosphere (known as the greenhouse effect, a warming factor) Net warming is happening as the consequence of an enhanced greenhouse effect. Average global temperatures are rising systematically, with amplifying feedback factors creating a real risk of tipping points for further 'runaway' warming. Current realised warming to date is 0.8^{o}C, but thermal inertia of the ocean hides another 0.6^{o}C to come. Pollution in the atmosphere provides a cooling offset (enhanced albedo through aerosols and their effect on clouds) of about 0.9^{o}C., which means the greenhouse warming potential already in the pipeline is around 2.3^{o}C, with additional warming likely due to longer term feedbacks. We are moving progressively out of the stable climate regime, which supported the establishment of civilised society, into conditions not experienced for a million years or more.

Current Reality 2

2. In a *Safe Climate,* greenhouse gases such as carbon dioxide do not accumulate in the atmosphere

Greenhouse gases

There are a multitude greenhouse gases and with very few exceptions they are all accumulating in the atmosphere.

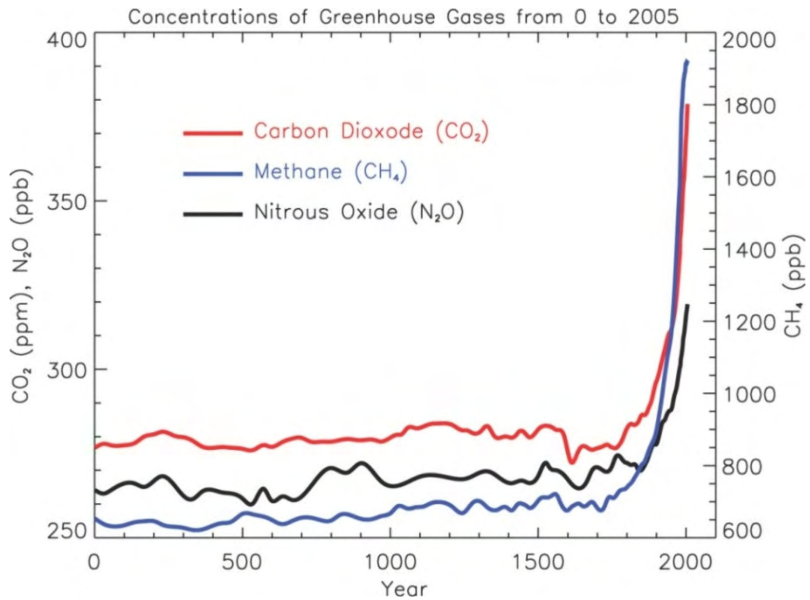
Water vapour

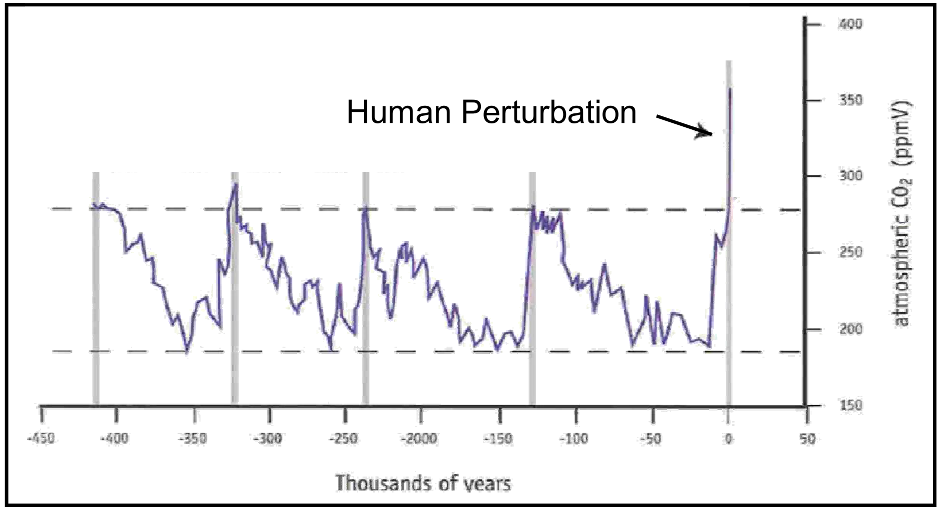
Water vapour is the most abundant greenhouse gas, although human activity is not a significant forcing factor. Indirectly, however, global warming increases atmospheric water vapour concentrations, which strengthens the greenhouse effect and influences climate in complex ways through changes in precipitation and cloud behaviour.

Carbon dioxide

The greenhouse gases with the strongest direct radiative forcing impacts on climate change are carbon dioxide, methane and nitrous oxide. The concentrations of these gases have risen sharply since the industrial revolution and there are no indications yet of stabilisation or reductions.

CO_2 , the strongest forcing agent, had cycled in the range 180 to 280 ppm for the past half million years or more. During the last 10,000 years of the Holocene period and human civilisation, it had been relatively steady at the upper end of this range (280 ppm). CO_2 levels are now some 40% higher, at about 387 ppm, a level not experienced for some 14 million years.

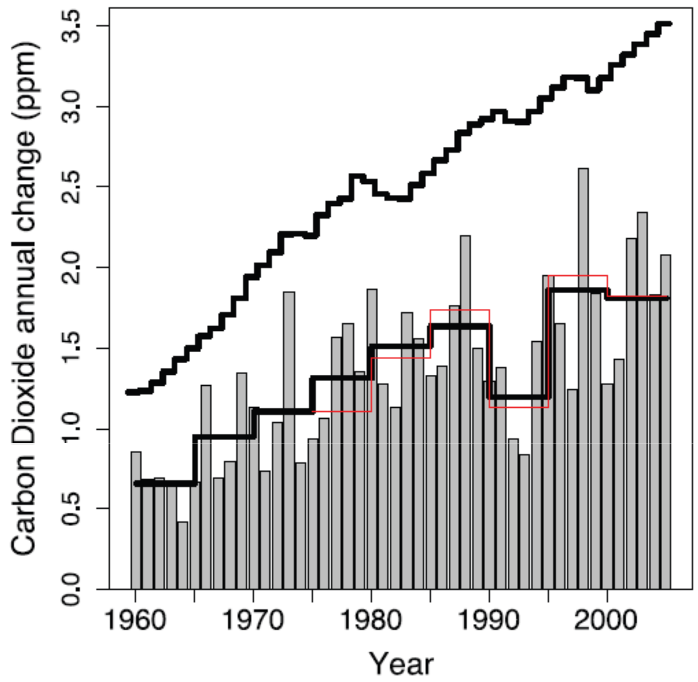




Amplifying factors

Accelerated greenhouse gas accumulation

Not only are greenhouse gases accumulating in the atmosphere, the rate of accumulation is increasing. For instance, the rate of increase in CO_2 concentrations in the atmosphere now (around 2 ppm each year) is about 3 times faster than 50 years ago. This means the primary driver of global warming (greenhouse gas accumulation in the atmosphere) is actually intensifying, not stabilising.



Degrading carbon sinks

The capacity of the Earth's major carbon sinks, such as oceans and forests, are being degraded. These sinks have protected the atmosphere to some extent from surplus greenhouse emissions, but their efficiency to do this may be declining:

- The Southern Ocean, representing some 15% of the global carbon sink capacity, has suffered a reduction in efficiency of up to 30% during the last 20 years.
- The Amazon: worsening drought, logging and livestock expansion are projected to rise in the coming years and could result in the loss of half or more of the rain forest.

Tipping points

As warming continues, there is an ever growing risk of major non-linear impacts on the climate system, that could drive abrupt changes with the potential for 'runaway' warming. These tipping points would in a practical sense for society be non-reversible.

For example, these might be manifest in reversal of the Gulf Stream, the melting of Greenland, the loss of the major mountain glacier systems, the shrinking of the Amazon, permanent El Nino, accelerated melting of Antarctica.

Vulnerable carbon stores

There are a number of enormous carbon stores in the Earth's system which have been protected by frozen permafrost and low ocean temperatures. This has kept them locked away from the day by day carbon cycling between terrestrial biomass, the ocean and the atmosphere.

Mobilisation of these carbon storage pools through warming would release vast quantities of CO_2 and methane, a gas with far greater greenhouse intensity than CO_2.

Scientists are beginning to detect methane emissions associated with thawing of permafrost and ocean warming, heralding major potential tipping points in the climate system.

Vulnerable Stores	Estimated Carbon Content, Gt
Methane locked by permafrost	1,600
Ocean floor methane clathrates & submerged	1,500
For Reference: Currently in Atmosphere Fossil Fuel Use to date	 820 350

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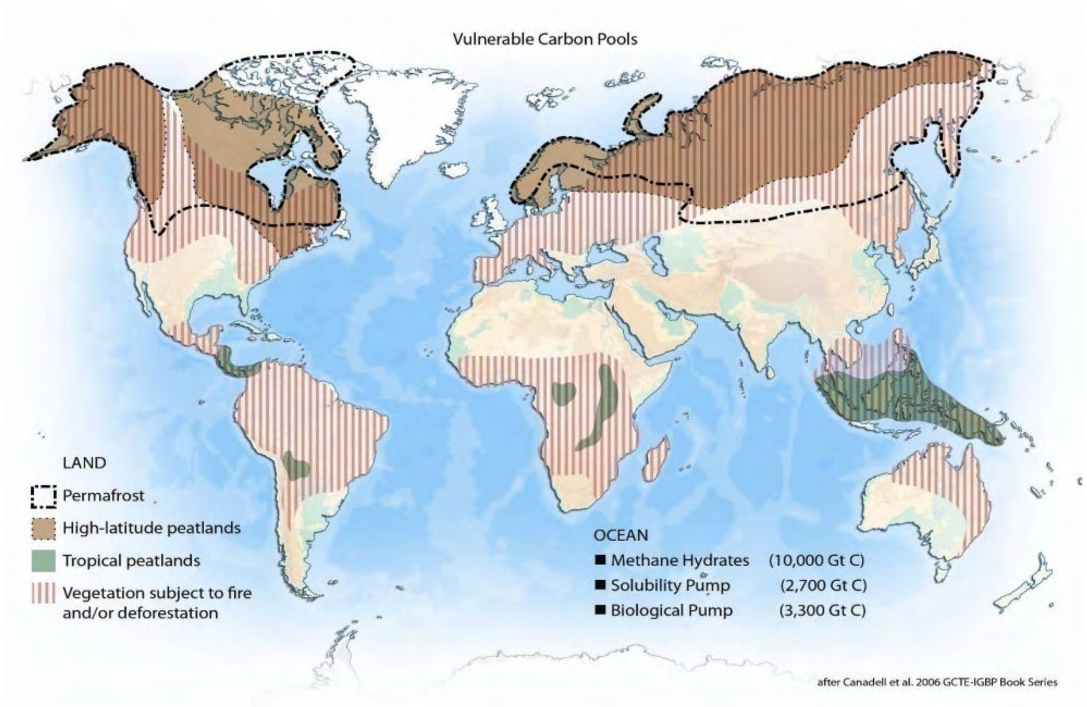
Feedbacks and Tipping Points

Primary Drivers	Amplifying Factors	Runaway Potential
Greenhouse gas accumulation in the atmosphere	Reduced albedo • Loss of ice cover	Methane mobilisation • Permafrost thaw • Deep ocean warming



The legacy so far

Accumulation of greenhouse gases

The greenhouse effect depends on the concentration in the atmosphere of greenhouse gases, not the rate of emissions at a particular time. Climate change is therefore a manifestation of accumulation over time.

Global carbon balance

Global warming reflects a human-induced redistribution of carbon at a planetary scale. On balance, the atmosphere has accumulated an estimated 220 Gt of carbon since pre-industrial times. Over the same period, the ocean has accumulated an estimated 150 Gt of carbon.

Ocean acidity

As CO_2 is absorbed in the ocean the acidity increases; this becomes an independent driver of marine eco-system degradation.

Systemic overload

The accumulation of carbon in the atmosphere and the ocean combined, 370 Gt, is an indication of system overload; this is mainly the consequence of an estimated 350 Gt of fossil carbon from the lithosphere entering the biosphere.

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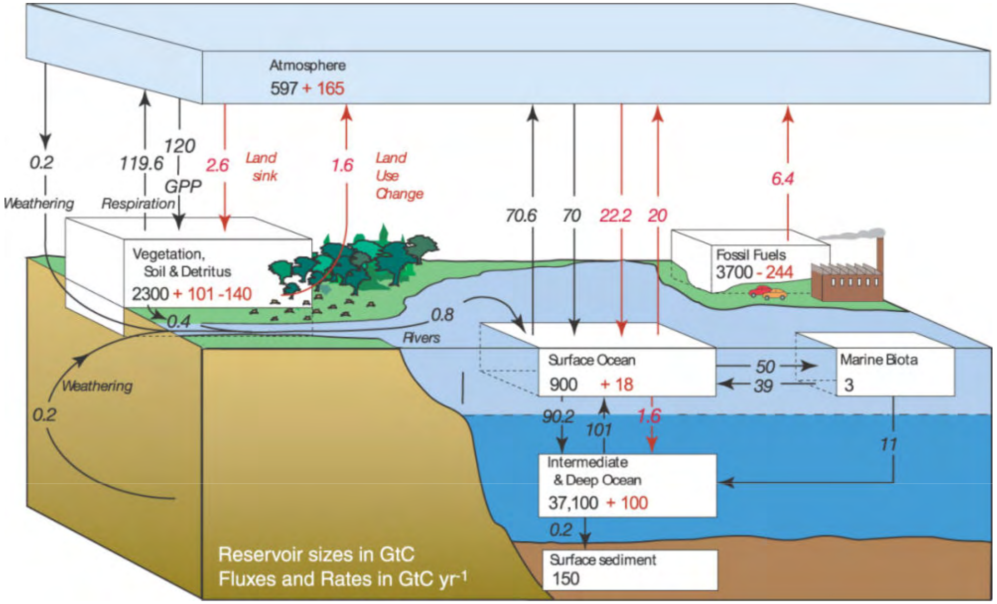
The carbon cycle (1994 analysis)



Estimate of Global Carbon Balance (Gt)

Carbon Sinks	"Natural" Pre-Industrial	Anthropogenic Change	
		1994	2009
Fossil Fuels	3,700	-244	-350
Terrestrial	2,300	-39 net	-20 net
Ocean	38,150	+118	+150
Atmosphere	597	+165	+220
Total/Net	44,747	0	0

Summary: safe climate criterion 2

A. Desired Future	B. The Current Reality
Greenhouse gases, such as carbon dioxide, do not accumulate in the atmosphere	There are a many greenhouse gases and with very few exceptions they are all accumulating in the atmosphere. Moreover, the rate of accumulation is increasing; thus the primary driver for global warming is intensifying. CO_2 levels have probably not been this high for fourteen million years. The capacity of the earth's ocean and forest carbon sinks are being degraded and there is a real risk of tipping points leading to even more rapid increases in greenhouse gas accumulation in the atmosphere, such as the mobilisation of methane rich carbon stores currently locked by permafrost and low ocean temperatures. As CO_2 is absorbed in the ocean the acidity increases, which is becoming an an independent driver of marine eco-system degradation. The atmosphere has accumulated an estimated 220 Gt of carbon since pre-industrial times and the ocean has accumulated an estimated 150 Gt. The total accumulation of carbon in the atmosphere and the ocean (370 Gt) is an indication of the extent to which the natural system has been pushed beyond its carrying capacity. This is primarily the consequence of an estimated 350 Gt of fossil carbon from the lithosphere entering the biosphere.

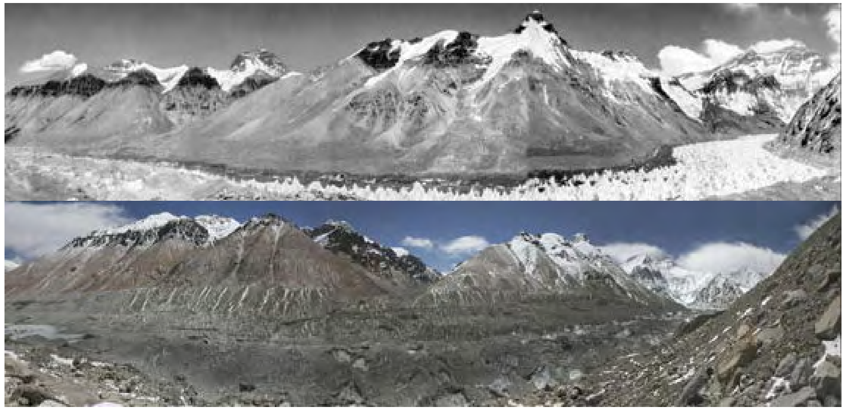
Current Reality 3

3. In a *Safe Climate,* concentrations of greenhouse gases in the atmosphere are stabilised at levels which are ecologically sustainable

Global warming by an average 0.8°C has already been caused by the current levels of greenhouse gases (ie. CO_2 at 387 ppm). This level of realised warming is already enough to systematically alter the climate system at a planetary scale and to stress ecosystems across the globe:

- **Extreme weather events:** the intensity and frequency of fires, floods, cyclones, hailstorms, heat waves and coastal erosion has significantly increased in recent decades
- **Ecosystem degradation:** biodiversity is being undermined by climate and weather changes, as the rate of warming outstrips the ability of species to adapt or migrate
- **Changing weather patterns:** for example the monsoon pattern, and ongoing drought in sub-Saharan Africa
- **Loss of global ice:** as well as accelerating loss of Arctic ice, there is already extensive retreat of mountain glaciers in the Himalayas, Andes, Rockies and Europe alps.
- **Desertification:** for example, the Mediterranean climates of Europe, South Africa, Australia and California are drying out
- **Imminent loss of coral reef systems:** temperature induced bleaching has caused major damage in the Caribbean and Australia; this will be exacerbated by ocean acidification

Four decades of global warming

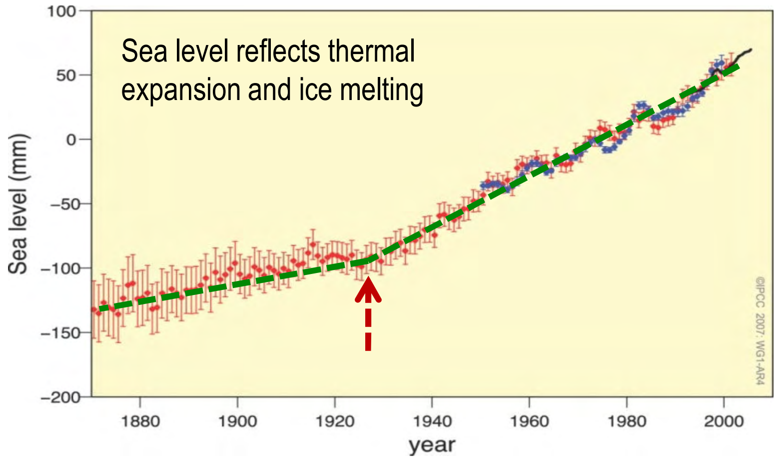


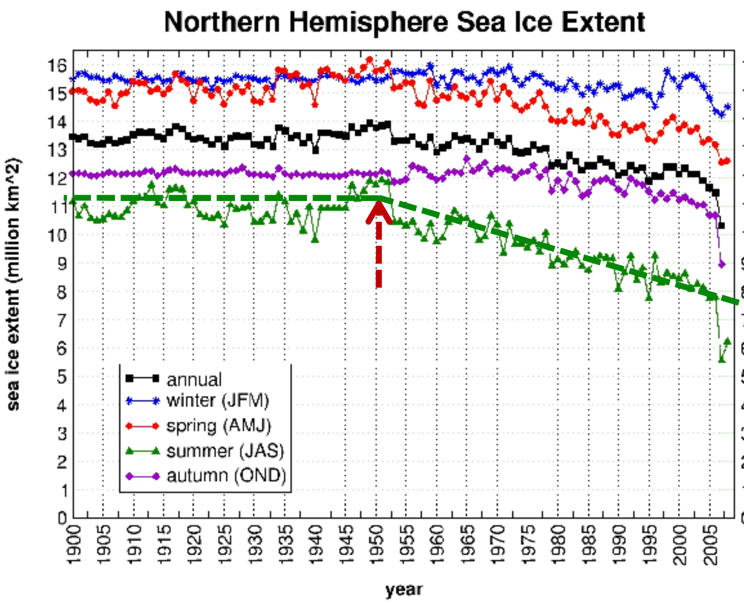
Rongbuk Glacier north of Mt Everest: 1968 (top), 2007 (below).

Given the impacts of warming actually realised to date (0.8°C), this means at 387 ppm CO_2 we are already above "safe" or sustainable greenhouse gas levels in the atmosphere, even before considering lags in warming or the future impacts of feedbacks which may have already been triggered.

‘With the benefit of hindsight’

From the vantage point of today and improved understanding of climate change, we can see that atmospheric greenhouse gas concentrations well below current levels (387 ppm CO_2) , were already enough to significantly alter the climate system and stress the ecology of the planet.





Coral reef systems:

Mass coral reef bleaching events were first observed in the late 1970’s, when global warming was about 0.2°C and CO_2 levels were at around 335 ppm. Taking time lags into account, concentrations well below 320 ppm would probably be required to avoid reef ecosystem degradation.

Ocean warming and sea ice melting:

Sea level is a strong indicator of global warming. Ocean sea levels have been rising progressively at least since 1850, when CO_2 was around 290 ppm, with a significant apparent increase in the rate around 1930, when CO_2 was around 310 ppm.

The extent of summer Arctic sea ice has been decreasing significantly since 1950, when CO_2 was about 315 ppm.

Early warning signs: With the benefit of hindsight, systemic warming was probably already putting significant strain on global climate systems by, or indeed before, the time CO_2 had risen 10% above pre-industrial levels (ie. from 280 to 310ppm).

Climate sensitivity

There is no reasonable doubt that rising greenhouse gas concentrations lead to rising temperatures, but there is uncertainty as to the exact sensitivity, given the complexity of the climate system.

Climate sensitivity is defined as the temperature increase expected with each doubling of CO_2 concentration in the atmosphere.

Projections reported by the IPCC are centred on 3°C Climate Sensitivity, which takes into account fast feedbacks and the thermal inertia of the ocean, but not the slower feedbacks of ice sheet disintegration (surface albedo loss) or major changes in vegetation distribution around the globe (greenhouse and surface albedo factors). When these additional feedbacks are taken into account, the climate sensitivity to greenhouse gases roughly doubles to 6°C. This has enormous implications for the amount of global warming to be expected as the lags and feedbacks work their way through the system.

On the basis of this latest science, if greenhouse gas concentrations were kept at current levels (387 ppm CO_2), global average temperatures would most probably continue to rise to around 2.8°C above pre-industrial, given enough time for ocean thermal inertia effects and amplifying feedback factors to fully work their way through the system.

CO_2 Levels in Atmosphere	Estimated Average Global Warming above Pre-Industrial Temperatures , °C	
Basis of Prediction	Original IPCC Projections (3° climate sensitivity)	Most Recent Analysis (6° climate sensitivity)
280	0	**0**
310	0.4	**0.9**
350	1.0	**1.9**
385	1.4	**2.8**
450	2.1	**4.1**

2°C warming

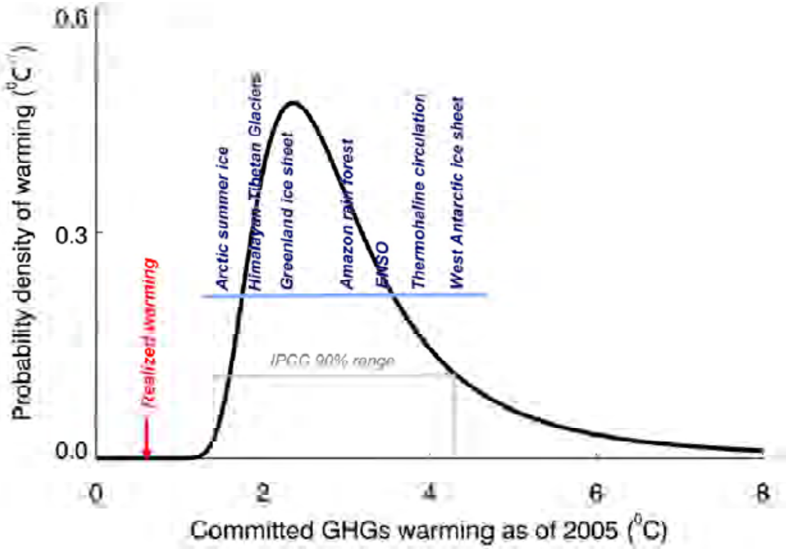
Whilst 2°C warming should certainly not be considered "safe" by any means, there is a widespread assumption that warming beyond 2°C becomes particularly dangerous; this is the 'guard rail' of European policy. It was believed that this 2°C threshold could be avoided if CO_2 were stabilised below 450 ppm.

But recent observations and modelling with longer term feedbacks indicates the 2°C threshold is more likely to be around 350 ppm CO_2, ie. well below current levels. On this basis, the 450 ppm figure translates into warming around 4°C.

The long term implications of present conditions

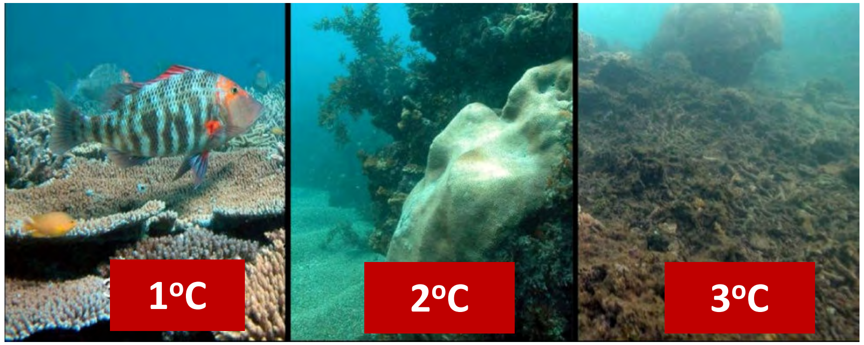
3 degrees warming in the pipeline

Without change and given sufficient time for feedbacks in the climate system to take effect, the drivers are already in place to reach 3°C global warming. This is the long term implication of 400ppm CO_2, which at current rates we could reach in as little as five years.



Degradation of the Amazon (120 Gt of stored carbon)
2°C rise: 20-40% dies off
3°C rise: 75% destroyed by drought
4°C rise: 85% destroyed within 100 years

Bleaching and acidification of the world's coral reefs



Mobilising the permafrost carbon stores

The tipping point for significant CO_2 and methane release due to permafrost thawing has been estimated to be about 8-10°C temperature rise locally in the Arctic, which requires 3°C average global warming or less. On that basis, we may already be above the threshold concentrations of greenhouse gas to unlock these massive sinks, given sufficient time for ocean thermal inertia effects and amplifying feedback factors to fully work their way through the system.

Time lags

The climate system is particularly complex in that different parts of the system have very different response times to change.

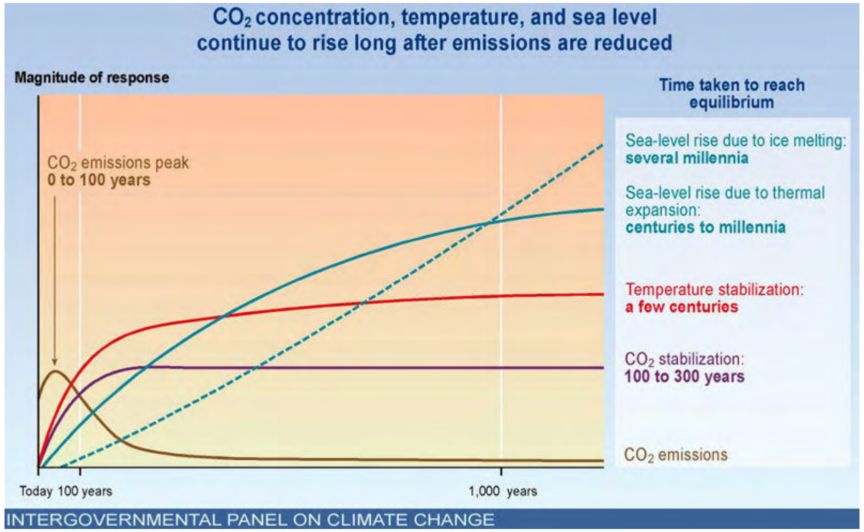
As an approximation, about half of any committed warming impacts might be realised in the short term (years to decades), another quarter in the medium term (decades to centuries) and the last quarter over the long term (centuries or more).

This has two implications:

On the one hand, it means that in a very real sense we are living on borrowed time, protected by the lags in the system, as well as the cooling effect of aerosols.

But on the other hand, it means we have some time to take effective action before the catastrophic impacts of global warming actually work their way through the system.

Time lags in the system mask the severity of what we have set in motion, but they also give us some time to take corrective action



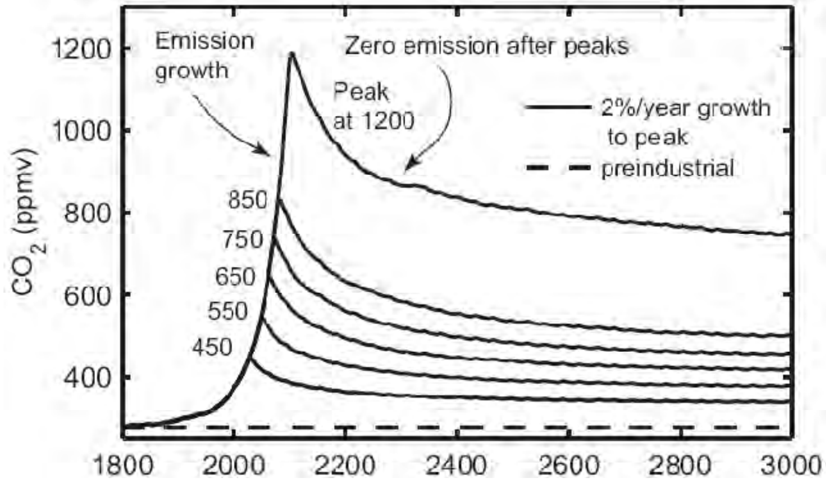
Time in Atmosphere	Natural Removal Mechanism	Time
Aerosols	Rain	Weeks
Methane	Breakdown by hydroxyl	About 12 years
Nitrous Oxide	Breakdown by sunlight	Over 100 years
Carbon Dioxide	Equilibration with ocean and terrestrial eco-systems	Millennia

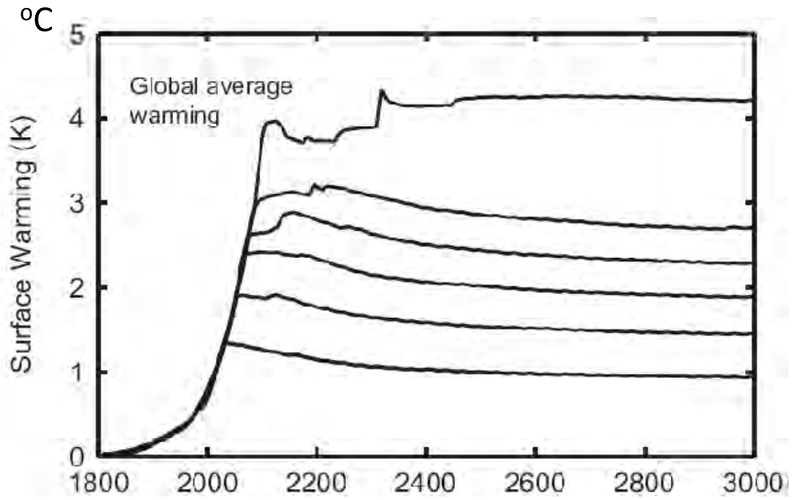
Time lags after corrective action

Inertia in the system also means that there can be slow response times, when corrective actions on emissions are taken.

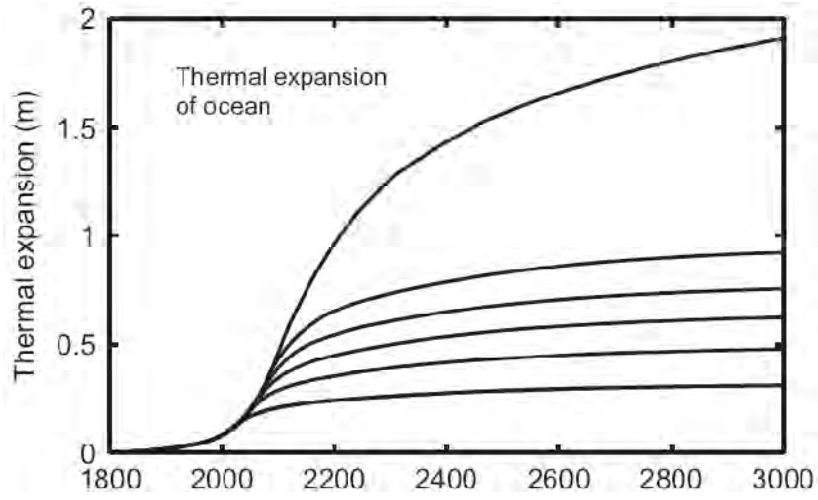
If emissions were brought to zero, carbon dioxide concentrations and temperatures would fall very gradually over many centuries and sea levels would continue to rise.

This highlights the need for urgency so that emissions and CO_2 levels peak as soon as possible to minimise the risks of extended periods at elevated temperatures .





Years



Years

Summary: safe climate criterion 3

A. Desired Future	B. The Current Reality
Concentrations of greenhouse gases in the atmosphere are stabilised at levels which are ecologically sustainable	We are already above sustainable levels of greenhouse gases. Net warming to date (0.8^{o}C), despite aerosol cooling and ocean thermal inertia, has been enough to drive extreme weather events, degrade eco-systems, cause loss of life, raise ocean acidity and cause the imminent loss of coral reefs and Arctic sea ice. With the benefit of hindsight, systemic warming was probably already putting significant strain on global climate systems by, or indeed before, the time CO_2 had risen 10% above pre-industrial levels (ie. from 280 to 310ppm). The latest science, with longer-term feedbacks taken into account, suggests that climate sensitivity (the rise in temperature for a doubling of greenhouse gas concentrations in the atmosphere) is about twice what was assumed in IPCC assessment reports. Current best estimate of Climate Sensitivity is 6^{o}C temperature rise for each doubling of CO_2e. On that basis, our current level of greenhouse gases are enough to generate some 3^{o}C of warming given sufficient time for lags and feedbacks to work their way through the system. This would have devastating impacts. We are therefore already above the level to unlock 2^{o}C of warming, a widely considered threshold for very dangerous climate change. Stabilisation at 450ppm CO_2 would mean 4^{o}C warming in time. Time lags in the system mask the severity of what we have set in motion, but they also give us some time to take corrective action if we accept responsibility for the full unrealised warming potential in the pipeline.

Current Reality 4

4. In a *Safe Climate,* climate related factors do not cause economic, political and social conditions which undermine the capacity for people to meet their needs

Stress on the climate system drives an array of environmental impacts:

- Extreme weather events
- Sea level rises
- Deterioration or loss of marine ecosystems (exacerbated by increasing acidity)
- Desertification
- Ice-melting effecting the major river systems
- Significant regional changes in weather patterns
- Biodiversity impacts, as weather and the temperature change faster than some species can adapt or migrate

Climate change undermines the robustness of natural ecosystems upon which we depend for vital goods and services, pleasure, health and survival.

The scale and risk of ecological impacts increase with the level of temperature and ocean acidity. This has a major capacity to impact on society and the economy, causing deepening inequity and real threats to water, food, employment and infrastructure as well as political security.

Impacts on society and the economy....

- Fires, droughts, hailstorms and cyclones impact on property and lives
- Sea level changes and storm surges put at risk major city infrastructure established near historic Holocene sea levels
- Loss of coral reefs and deterioration of marine environments has economic impacts on food supply, jobs, and tourism
- Loss or deterioration of available agricultural areas leads to food supply pressures and loss of employment
- Loss of mountain ice puts important river valley and delta farming and fishing systems at risk

....have the potential to create negative political impacts

- Conflicts over constrained resources (water, land, energy, weather)
- Environmental refugees at a large scale; mass migrations
- Increasing the inequity in society, widening the have/have not divide
- Disease pandemics and heat stress related deaths
- Financial collapse on local, regional, national and ultimately global scales
- Undemocratic responses to political crises
- Loss of economic capacity and political will to respond to climate change (a viscious spiral)

Extreme weather

Individual weather events cannot be proven to be caused by climate change. But global warming makes it inevitable that the frequency and severity of extreme weather events increases. Climate-related loss of life and property are already a reality on a significant scale.

Taken together the following are in line with global warming:

- European Heatwave, 2003
- Hurricane Katrina, New Orleans ,2005
- Greek Bushfires ,2007
- Californian Bushfires ,2007
- Cyclone Sidr, Bangladesh ,2007
- Cyclone Nargis, Myanmar, 2008
- Darfur, ongoing extreme drought
- North Queensland floods, 2009
- Victorian Bushfires, 2009

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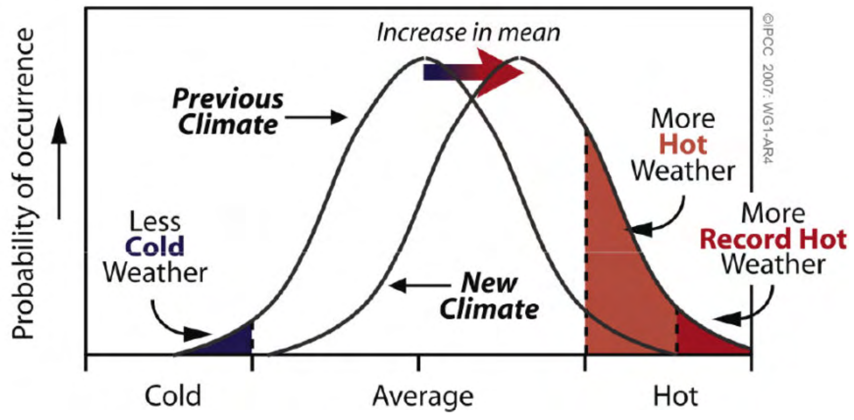

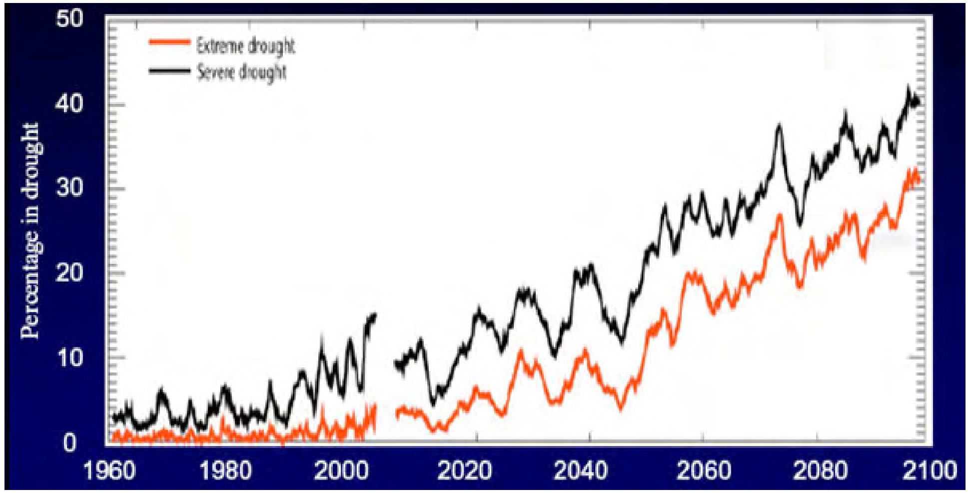

Rising sea levels

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The hallmarks of civilisation - the built environment and agriculture - were established during a period of very stable temperatures and sea levels. Hundreds of millions of people, extensive infrastructure and major river delta farming regions exist close to the historical sea levels of the past 10,000 years of the Holocene. These become extremely vulnerable to rising sea levels caused by global warming, especially when coupled with storm surges.

Projections reported by the IPCC of sea level rises by the end of this century are in the range 0.2 to 0.6 metres, but these are increasingly viewed as quite conservative, with rises of 1 metre or more now expected, given accelerated warming, amplifying feedbacks and concerns about ice sheet disintegration in Greenland and Antarctica. A one metre rise would effect up to 600 million people.

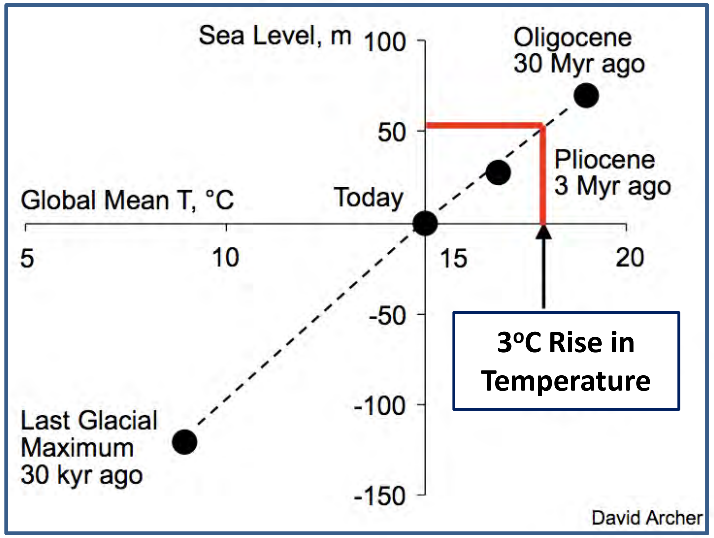
> *"I find it almost inconceivable that 'business as usual' climate change will not result in a rise in sea level measured in metres within a century" .*
>
> James Hansen, NASA

What legacy for future generations?

At system equilibrium, 1 degree temperature change ultimately causes 15 -20 metres sea level change. Current greenhouse gas concentrations, if maintained, would eventually trigger about 50 metres of sea level rise.


Erosion of dunes around house, Rodanthe, Cape Hatteras, 1999

Erosion of dunes around house, Rodanthe, Cape Hatteras, 2004 © Gary Braasch



Inequity

Climate change will exacerbate inequity in global society:

- In a world where the energy which underpins economic activity comes predominantly from fossil fuels, the accumulation of material wealth goes hand in hand with the accumulation of greenhouse gases in the atmosphere
- The more developed economies are therefore disproportionately responsible for the historical legacy of accumulated greenhouse gases; they are the main cause of the problem. Moreover, they have greater economic resources to direct at coping with the impacts of climate change.
- The least developed economies have contributed very little to the historical legacy. And they are under-resourced to deal with the impacts. Generally the poorest nations will be among the hardest hit by global warming and climate change.

- One-sixth of the world's population face water shortages because of retreating glaciers
- 1 billion of the poorest people on Earth will lose their livelihoods to desertification
- There could be some 200 million environmental refugees by 2050
- Around 17 million Bangladeshis could find themselves without homes by 2030 due to flooding, cyclones and tornadoes
- More than 60 million more Africans will be exposed to malaria if temperatures rise by 2 degrees Celsius
- 182 million sub-Saharan Africans could die of disease "directly attributable" to climate change by the end of the century
- 12 of the 16 countries likely to be the worst affected by climate change are in Africa




Summary: safe climate criterion 4

A. Desired Future (Safe Climate):	B. The Current Reality
Climate related factors do not cause economic, political and social conditions which undermine the capacity for people to meet their needs	Climate change creates diverse ecological impacts, which increase in scale and risk with the level of global warming and ocean acidification. These impacts have a major capacity to effect society and the economy, causing deepening inequity and real threats to water, food, employment, infrastructure and political security. Climate-related loss of life and property are already a reality on a significant scale. Hundreds of millions of people, extensive infrastructure and major river delta farming regions exist close to the historical sea levels of the past 10,000 years during which civilised society was established. These become extremely vulnerable to rising sea levels caused by global warming, especially when coupled with storm surges. Sea level rises of a metre or more are quite possible by the end of this century. Climate change will intensify inequity in global society. The more developed economies are disproportionately responsible for the historical legacy of accumulated greenhouse gases and they have greater economic resources to direct at coping with the impacts of climate change. The situation is the reverse for the least-developed economies. Generally the poorest people and nations will be among the hardest hit by global warming and climate change.

Current Reality 5

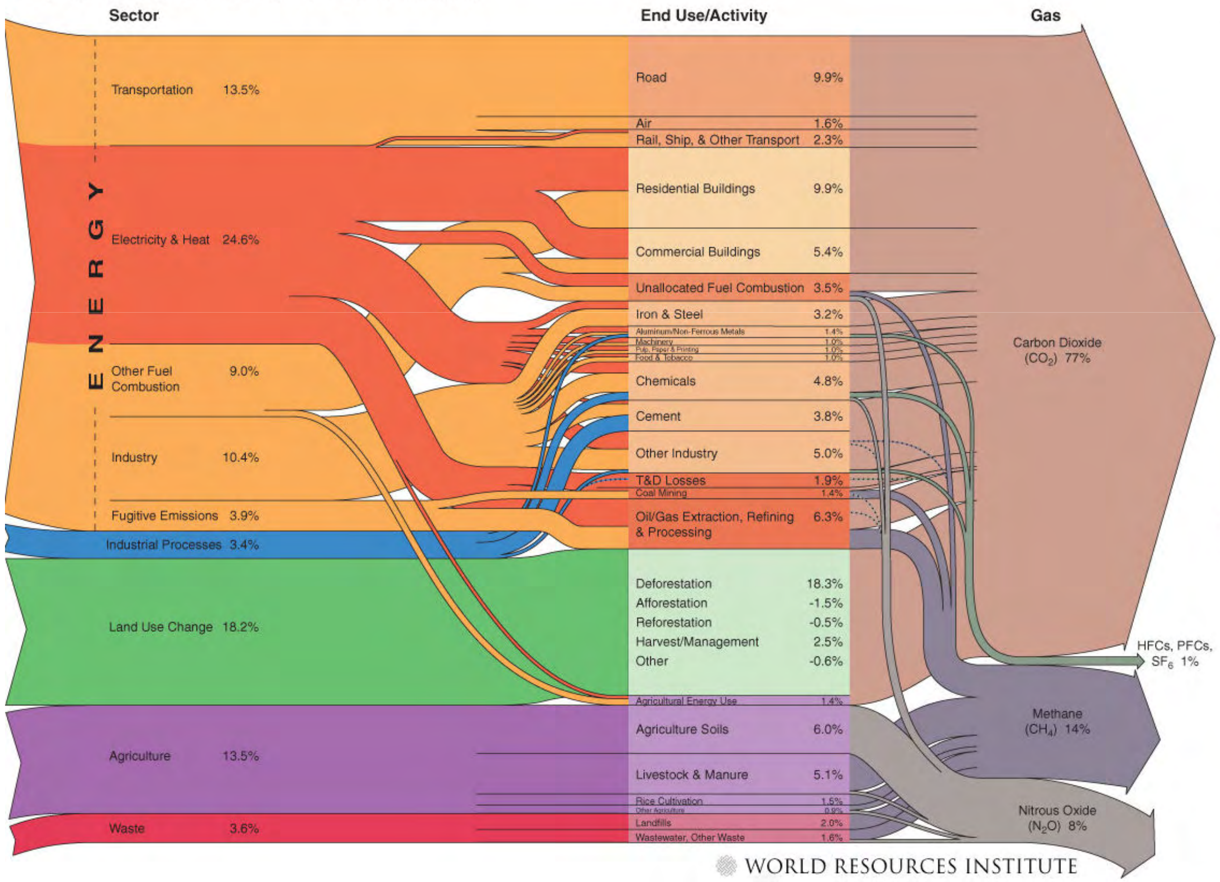
5. In a *Safe Climate,* value can be created from natural energy and land resources without degradation of the complex systems that constitute the ecology of the planet and its climate

The main causes of rising greenhouse gas emissions are society's use of :

- fossil fuels for energy and materials; this involves a net transfer of fossil carbon from the lithosphere to the atmosphere through the processing of oil, natural gas and coal
- land for agriculture and the built environment; this involves a net loss of above and below ground biomass and soil carbon due to land clearances, deforestation and agricultural practices.

Total greenhouse emissions in 2000 (41.8 Mt/a CO_2e) were made up 77% by CO_2, 14% by methane and 8% N_2O. Close to 2/3 of emissions are associated with energy and industry, with the other 1/3 coming mainly from land use changes and agriculture.

World GHG Emissions Flow Chart (2000 Analysis)



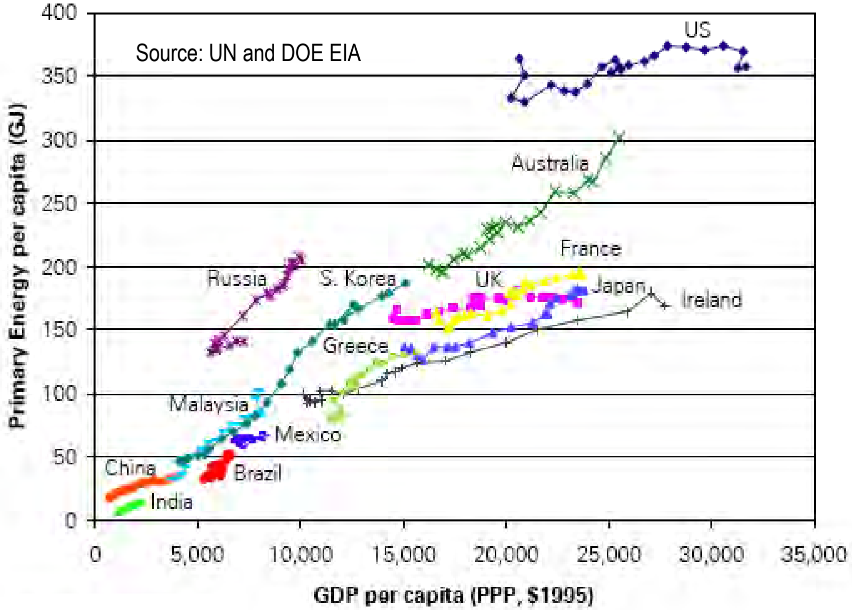
Current global emissions of greenhouse gases are about 50 Gt/a CO_2e

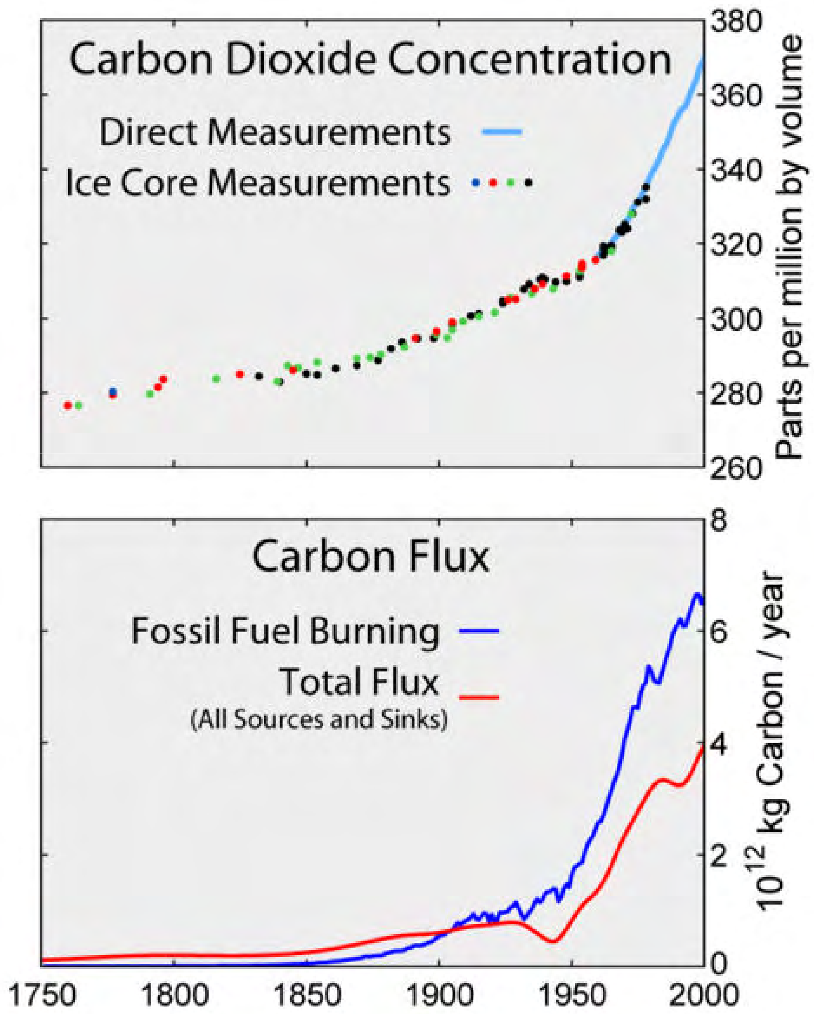
Emissions and the economy

Energy underpins the world economy. Since current energy use is heavily dependent on fossil fuels, greenhouse gas emissions closely reflect the level of economic growth.

In our current economic paradigm, an increase in world GDP by 1% corresponds to a 0.7% increase in energy use and about 0.65% increase in CO_2 emissions.

The total carbon flux to the atmosphere therefore refelects the economy closely, with a major upturn in emissions associated with the post WW2 boom.



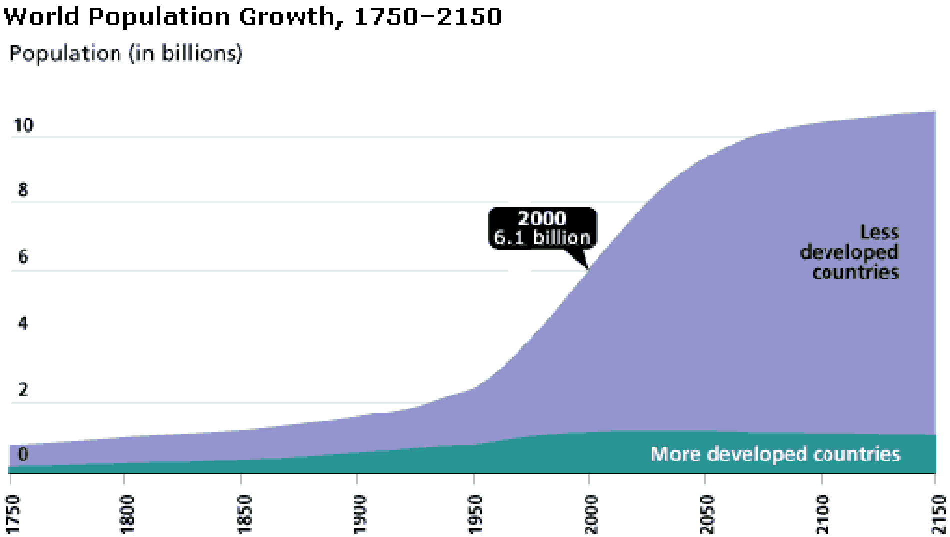


Amplifying factors

Population and living standards

Without fundamental change in the way society impacts on nature, rising population and living standards cause added stress to the ecology of the planet, through increased demand for energy and land resources and a consequent increases in emissions.

The most effective means of limiting population growth (security in old age, women's emancipation) tend to come with higher GDP, which in the current paradigm means a higher energy and emissions economy. Population growth, together with aspirations for improved living standards, are a powerful amplifying drivers of climate change.



"Peak Oil"

Conventional crude oil supply has or will soon peak. Without a rapid shift to carbon neutral energy sources, this will drive up the pressure to use alternative fossil resources, such as tar sands, oil shales, coal to liquids. The production of petroleum products from lower quality fossil resources is more energy intensive, resulting in more GHG emissions.

Peak oil adds another complex, destabilising factor to the global energy system, making it all the more urgent to address climate change effectively.

Clean air

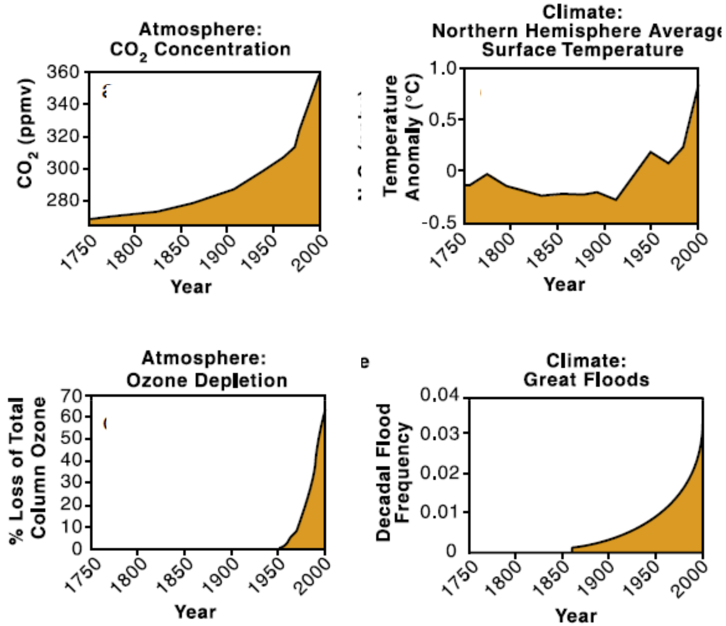
Aerosols and black carbon (soot) emissions to atmosphere are the result of pollution mainly from fuel combustion (eg. the Atmospheric Brown Cloud). Removal of aerosols and soot will improve air quality, but there are feedbacks to warming.

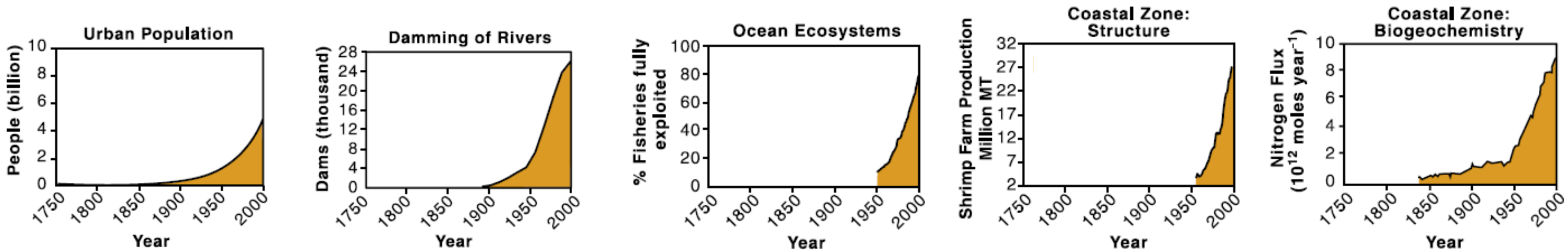
Black carbon deposits on snow and ice, decreasing the albedo. Reducing soot, will thus provide a cooling contribution, a win-win for the climate and pollution. However, lowering the generation of aerosols will reduce their direct and cloud albedo cooling effects, thus adding another amplifying factor to the global warming process.

System overload

The economy is out of balance with the ecology of the planet, not only with respect to climate change, but also to biodiversity and to the functioning of the major biogeochemical cycles (C, N, P).

Earth System Process	Parameters	Pre-Industrial	Current
Climate Change	Atmospheric CO_2 concentration(ppm)	280	387
	Net change in radiative forcing (W/m2)	0	1.5
Biodiversity Loss	Extinction rate (species per million species per year)	0.1 - 1	> 100
Imbalance in Biogeochemical Cycles	Nitrogen removed from atmosphere for human use (Mt/a)	0	121
	Phosphorus flowing to oceans (Mt/a)	~ 1	~ 9





The ecological debt crisis

Climate change is a manifestation of a deeper sustainability challenge facing global society.

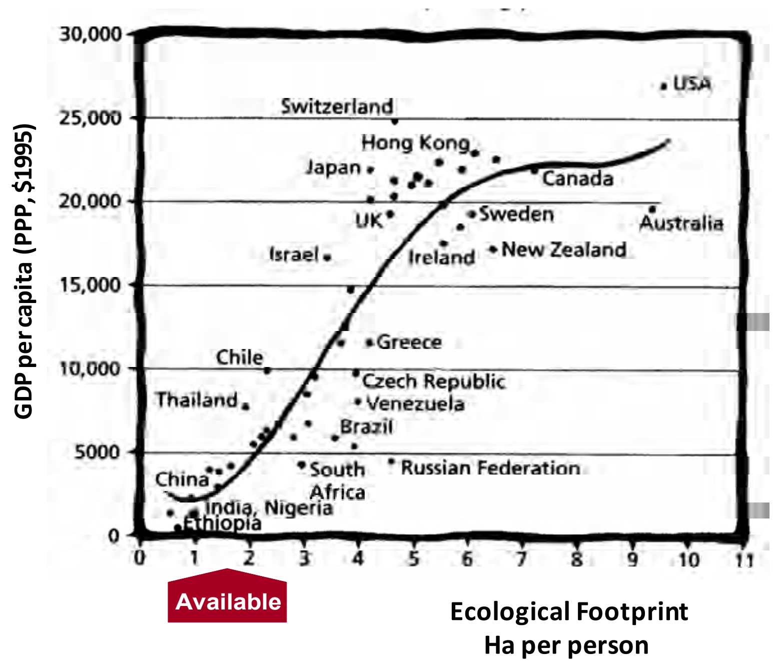
We have a fundamentally flawed value proposition operating within the global economy:

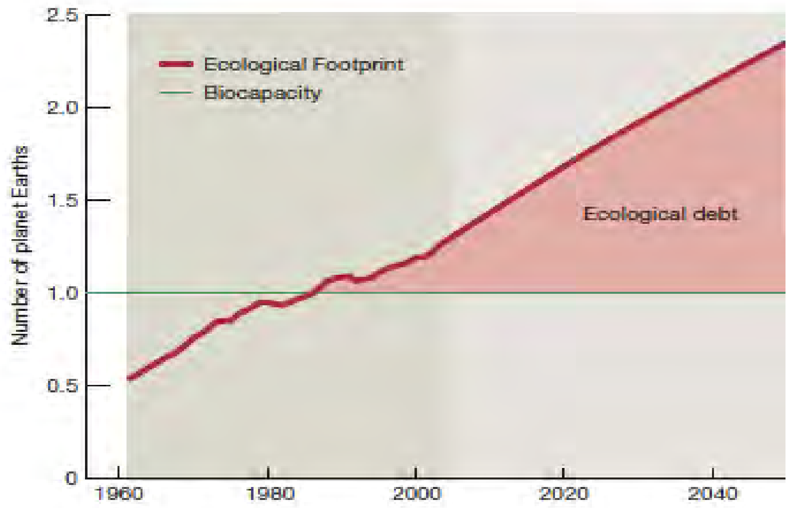
- As economic value increases, so too does the impact on nature; as GDP rises, so too does the ecological footprint.
- The post-war boom has seen an increase in the demands that global society places on natural services and in the impacts on the environment; our collective ecological footprint now exceeds the carrying capacity of the planet.

We are in an ecological debt crisis, to which greenhouse emissions is a major contributor.

Economic growth is a magnifier of unsustainable dynamics. Without change, 'business as usual' economic growth to 2050 would see annual greenhouse gas emissions rise from 50 to 120 Gt of CO_2e.

A sustainable future will depend on essentially de-coupling economic growth from greenhouse emissions and environmental harm.





Summary: safe climate criterion 5

A. Desired Future	B. The Current Reality
Value can be created from natural energy and land resources without degradation of the complex systems that constitute the ecology of the planet and its climate.	The accumulation of greenhouse gases in the atmosphere results from society's use of fossil fuels and land, which fundamentally underpins how human needs are met and value is created in the economy at present. Economic growth is currently closely linked to increased energy use and increased greenhouse gas emissions. In present circumstances, population growth and rising living standards are a powerful amplifying driver for climate change. Peak Oil is a destabilising factor in global energy supply, which adds urgency to addressing climate change effectively. Clean air developments are important for health, but perversely pollution has offset global warming to some extent. Improvements in air quality, particularly with respect to aerosols, will increase warming in the short term, thus adding to the climate challenge. The economy is out of balance with the ecology of the planet, with respect to climate change, biodiversity and the functioning of the major biogeochemical cycles. There are clear signs of system overload. At present, as GDP rises so too does our ecological footprint. We are in an ecological debt crisis, with greenhouse gas emissions a major contributor. Climate change is a manifestation of a deeper sustainability crisis.

Current state of play

Climate change arithmetic

We can get a clear sense of the serious situation we are in, if we look at some key climate change parameters and compare now with 1990. This is done below on the basis of best estimates and approximations.

The main points are:

1. All parameters are getting worse; our responses to date have been quite inadequate.
2. 1990 to now is the period during which the political process has recognised global warming as a problem; our political approaches have been ineffective, since the situation has worsened.
3. If we were able to cut emissions, even to zero, warming would continue because the level of greenhouse gases would remain high, unless there was major draw down from the atmosphere. Some 370 Gt of mainly fossil carbon has now accumulated in the atmosphere and ocean.
4. The additional emissions since 1990 have created the drivers for a warming close to 3ºC, after lags and feedbacks work there way through the system. This represents the risk of extremely dangerous climate change *per se* and the additional risk of 'runaway' warming triggered by the mobilisation of permafrost CO_2 and methane.

Climate Parameters	Units	1990	2009
Greenhouse Gas Emissions			
• Total GHG emissions	Gt CO_2e/year	37	50
• CO_2 in atmosphere	ppm	353	387
• Rate of CO_2 accumulation	ppm/year	1.3	2
Carbon Flows			
• Accumulation in atmosphere	Gt carbon	150	220
• Accumulation in ocean	Gt carbon	110	150
• Fossil fuel use to date	Gt carbon	225	350
Global Warming Implications After thermal lags and feed backs	ºC	2	2.8 +

Since 1990 we have created a very unsafe situation. It is really only the lags in the system that give us some time to create effective solutions and mobilise effective responses.

Our safe climate scorecard

SAFE CLIMATE AUSTRALIA

	A. Desired Future	B. The Current Reality	
1	There are no systemic, unsustainable or unstable conditions driving climate change, such as global temperatures	Average global temperatures are rising systematically, with amplifying feedback factors creating a real risk of tipping points for 'runaway' warming. We are moving progressively out of the stable climate regime which supported civilised society and into conditions not experienced for a million years or more.	✗
2	Greenhouse gases, such as carbon dioxide, do not accumulate in the atmosphere	Accumulation of greenhouse gases in the atmosphere is intensifying, with CO_2 at a fourteen million year high. A massive legacy of mainly fossil carbon is now in the atmosphere and ocean. The earth's carbon sinks are being degraded and there is a real risk of carbon stores locked by permafrost becoming mobilised.	✗
3	Concentrations of greenhouse gases in the atmosphere are stabilised at levels which are ecologically sustainable	We are already above sustainable levels of greenhouse gases. Net warming to date, despite aerosol cooling and ocean thermal inertia, has been enough to drive extreme weather events, degrade eco-systems, cause loss of life, raise ocean acidity and cause the imminent loss of coral reefs and Arctic sea ice.	✗
4	Climate related factors do not cause economic, political and social conditions which undermine the capacity for people to meet their needs	Climate change creates diverse ecological impacts which increase in scale and risk with the level of global warming. These have a major capacity to impact on society and the economy, causing deepening inequity and real threats to water, food, employment, infrastructure and political security.	✗
5	Value can be created from natural energy and land resources without degradation of the complex systems that constitute the ecology of the planet and its climate	The accumulation of greenhouse gases in the atmosphere results from society's use of fossil fuels and land, which at present underpins how human needs are met and value is created in the economy. Climate change is a manifestation of a deeper sustainability crisis.	✗

3. Strategy Development

The fundamental challenge

Market failure, moral failure

The inadequate response to date on climate change represents the '*widest-ranging market failure ever seen*'. But it is also a failure at a deeper moral and ethical level.

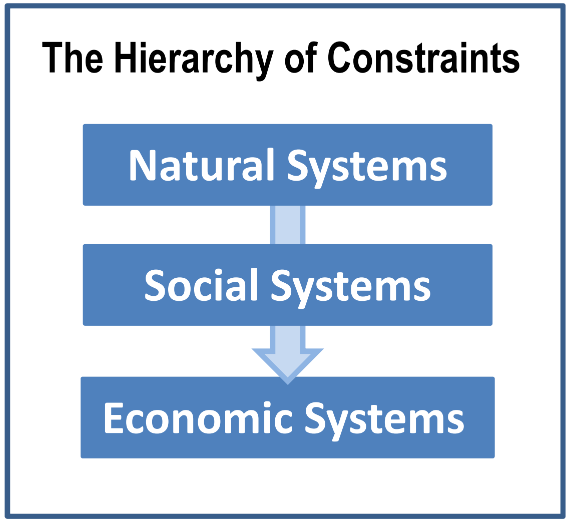
The challenge cannot be overstated. In a very real sense, the future of civilised society is at stake and mass species extinction would occur, if time were allowed for the impacts of global warming to take full effect.

Civilisation

The fundamental hallmark of civilisation is the capacity to use forethought, informed by science, to take actions now for future common good (delaying instant gratification when necessary). The climate crisis will put these qualities of humanity to the test.

From a systems perspective, society is currently operating in a dysfunctional, unsustainable manner. Clearly there has to be a change of approach, where the economy serves society's needs and operates within ecological and moral constraints.

Business is the main way goods and services are delivered to society and business will be the arena for much of the innovation required in the industrial revolution ahead. But it will be a business model based on maximum value creation, minimum impacts and elimination of systemic ecological harm.



We can learn from how individual organisations have approached complex moral, social and economic challenges, for instance in the way the best have approached safety, quality, stewardship, governance and risk.

For all of us, at work and in our communities, it will be a renaissance.

Safety and risk

Global warming, climate change and the associated degradation of ecological systems represent a safety problem for humanity at an unprecedented scale.

Moreover the risk management issues are extremely challenging, given the complexity of the climate system, remaining uncertainties in the science, time lags between cause and effect, the existence of magnifying feedback mechanisms and the possibility of tipping points for abrupt change and 'runaway' warming.

Framing the Safe Climate proposition

Once we recognise climate change as a safety and risk management problem, the strategic question becomes **"how can we move to a safe climate"**, not "how dangerous a climate are we prepared to risk".

Best practice safety is based on:

- a vision of zero harm, not 'acceptable' danger
- taking a systematic approach to assessing risks and impacts
- learning from all accidents and near misses
- open sharing of information
- placing safety ahead of production
- a collective commitment to a safe environment

The safety culture is directly relevant to the challenges of an unsafe climate, where the strategic aim becomes zero human induced warming.

SAFE CLIMATE AUSTRALIA

Steps to safe workplaces

- Business leadership and senior management commitment
- Establish concern for people's safety as a core business value
- Reinforce the fundamental principle that 'all accidents are preventable'.
- The vision and ultimate goal is 'zero accidents' - regardless of current performance
- Tailor improvement targets and plans to local situations
- Engage the hearts and minds of the workforce and families
- Provide resources and cultural and technical training
- Incorporate into management systems
- See safety as an investment in business improvement, not a cost

A cyclical economy

Effective use of resources

Eco-Efficiency

A Safe Climate is about delivering value within the constraints of sustainability. The concept of a Safe Climate is therefore more than an environmental proposition. It is well aligned with the World Business Council for Sustainable Development 's notion of "Eco-Efficiency".

"The delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's carrying capacity"

Stewardship

The concept of a Safe Climate is also aligned with the notion of stewardship of material and product life cycles.

"Stewardship means sharing responsibility for the performance of product and material value chains, within and beyond the boundaries of one's direct control

Effective stewardship builds on partnerships between companies, governments and diverse community stakeholders to ensure sustainable production, use and end-of-life management of materials and products through their life cycles"

Elements of Eco-Efficiency
for business and environmental improvements:

1. reduction of the material intensity of goods and services
2. reduction of the energy intensity of goods and services
3. reduction of toxic dispersion
4. enhancement of material recyclability
5. maximisation of sustainable use of renewable resources
6. extension of product durability
7. increase in the service intensity of goods and services

The principles of Eco-Efficiency apply to the greenhouse challenge

Innovation

Creativity driven by sustainability

Climate change is not simply an environmental problem, since it is fundamentally a consequence of how human needs are currently met in the economy through the use of land and energy resources. It is a sustainable development problem.

Our responses to climate change therefore need to place particular emphasis on solutions which enhance value creation while addressing ecological impacts.

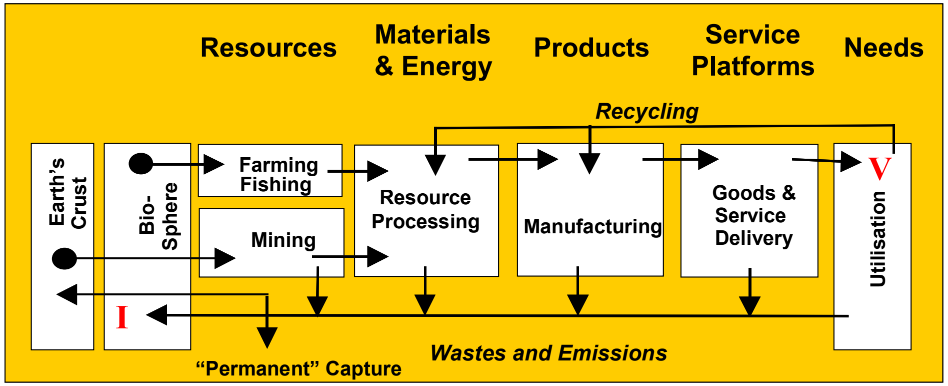
In this sense, the scale of the challenge becomes the size of the opportunity. A successful response to climate change will harness innovation at least on a par with the industrial revolution, in less time.

The opportunity is to drive innovation through the economy to:

1. maximise societal and economic value (improve V)
2. minimise ecological impacts (decrease I)
3. improve our overall capacity to create value relative to impacts (increase V/I)

Furthermore there is an overarching requirement to eliminate systemic harm (systemic ecological degradation ultimately destroys economic and social value)

Value and impacts in a cyclical economy



Value	Meeting human needs , in economically viable fashions	**V**
Impacts	Degradation of natural systems, including people and social systems	**I**
Innovation	Major increases in the capacity to create Value relative to Impacts	**V/I**

Strategic clarity in the face of uncertainty

Risk management does not mean delaying action until there is certainty

SAFE CLIMATE AUSTRALIA

Robust Assumptions	Addressing Uncertainty	Recommendations
Average global temperatures rise with increasing concentrations of greenhouse gases	The exact relationship is uncertain. Projections reported by IPCC (without longer term feedbacks) centred on Climate Sensitivity around 3^0C of warming for a doubling of CO_2. Recent evidence and modelling with feedbacks suggests a Climate Sensitivity of about 6^0C is more likely, given time for ocean thermal inertia effects and fast and slow feedbacks to work their way through the system.	Assume a Climate Sensitivity of 6^0C for planning and risk management purposes
Systemic global warming creates fundamentally unsafe ecological and social conditions	The precise conditions for a return to a Safe Climate are uncertain, in terms of speed and final greenhouse gas levels. The stable climate conditions under which civilisation was established was around 280 ppm CO_2. The climate system showed signs of already being significantly stressed by the time CO_2 concentrations were 310 ppm, with faster warming driven by post-WW2 economic growth. Human induced global warming will occur until there are no significant forcings.	Aim for zero human induced warming and develop capacity to draw down to or near to pre-industrial GHG levels (280 ppm CO_2),
The severity and risks of climate change increase with the extent of warming and the time at elevated temperatures	The exact unfolding of climate change with global warming is uncertain. The concentrations of greenhouse gases and the time lags for tipping points for runaway warming are difficult to predict. Climate change beyond 2^oC warming becomes particularly dangerous and probably enough to trigger abrupt climate change. On that basis, extended times at or above 350 ppm CO_2 has to be avoided; we are already above that, which means the draw down of atmospheric carbon is essential .	Do what is humanly possible to stay below temperatures to avoid critical 'overheating' in the transition
Aerosols in the atmosphere provide a cooling effect that partially offsets greenhouse warming	Major substitution of fossil fuels by carbon neutral energy would reduce aerosol levels and improve air quality. But aerosols are removed by natural processes from the atmosphere at a much faster rate than CO_2, so the net effect in the short term is likely to be additional warming despite the reduction in greenhouse gas emissions.	Plan to deal with short term warming effects associated with aerosol reductions

The importance of draw down

Carbon dioxide is a very long lived molecule in the atmosphere. The natural processes for bringing CO_2 levels down, even when net emissions are zero, have slow response times.

Modelling indicates that it would take many centuries for concentrations to reduce even halfway to pre-industrial levels, with a slow decrease in temperatures over centuries.

CO_2 draw down

To bring forward the cooling effect of reduced greenhouse gases in the atmosphere will require faster draw down, in addition to natural processes.

Various options for accelerated CO_2 draw down from the atmosphere exist. They will most likely rely on photosynthesis , where the carbon coming from the atmosphere is then stored in terrestrial or ocean biomass sinks, in soil carbon, or in biochar buried in the ground. The latter stores carbon in a recalcitrant form, providing a high level of carbon storage security.

All these methods of carbon draw down can be managed to provide benefits with respect to land practices and soil quality. But to make a difference, they will be very large scale interventions in the biosphere, so sustainable practices on a full life cycle basis will be critical.

Methane

Methane is an important greenhouse gas. However, in this case there would be a relatively short lag between reducing emissions and lowering concentrations in the atmosphere, because the natural process of breakdown is rapid.

SAFE CLIMATE AUSTRALIA

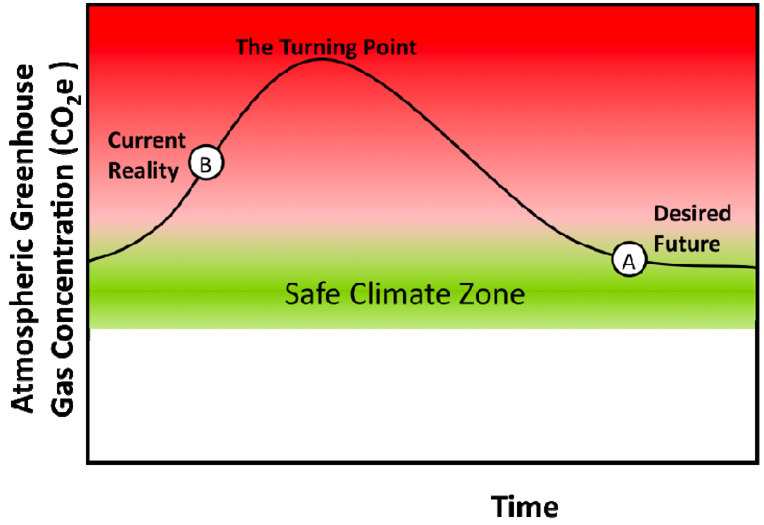
"Our survival would very much depend on how well we were able to draw down carbon dioxide to 280 ppm"

Prof. Hans Joachim Schellnhuber
Director, Potsdam Institute
Climate advisor to EU
and German government

Developing the Safe Climate transition strategy

Despite uncertainties, we can say with some confidence:

1. At 0.8^{O}C realised warming, we are already at unsafe levels (ecological degradation, loss of life and property damage); therefore temperatures will need to come down.
2. At 387 ppm CO_2, we are already at unsafe levels of greenhouse gases; therefore we need to bring net GHG emissions to zero, and then draw down CO_2 from the atmosphere to 'safe' levels , ultimately down to or near to pre-industrial levels.
3. While we are reducing our emissions, all the way to the zero net emissions turning point, things will actually be getting more dangerous, because
   - concentrations of greenhouse gases will continue to rise (albeit at a progressively slower rate), thereby enhancing the greenhouse effect
   - temperatures will continue to rise, even at zero net emissions, since warming delayed by ocean thermal inertia and from feedbacks already triggered will work its way through the system
   - reductions in fossil fuel use will reduce aerosols, giving rise to some short term warming due to loss of aerosol and cloud albedo.



4. The longer it takes to make the transition to a safe climate zone, the longer we remain at elevated temperatures, the greater are the risks of dangerous climate change, including the triggering of feedbacks for abrupt or 'runaway' warming.
5. Consideration will need to be given to direct cooling options (based on enhanced surface or above surface albedo), to avoid critical 'overheating' during the transition period to a safe climate regime.
6. The draw-down task becomes bigger, the slower we reach the carbon neutral turning point, the higher the peak CO_2 concentration and the longer it takes to phase out fossil fuels.

Strategic solutions

The purpose of the Transition Plan will be to guide the transformation needed to put society on the pathway to a safe climate. Getting on to a safe climate trajectory will be based on a three parallel, complementary, but hierarchical strategies.

	The Safety Analogue	Focus	Safe Climate Strategic Objectives	Strategic elements
1	*Establishing Safe Practices*	**Carbon Neutral Solutions**	The economy operates to meet human needs within balanced carbon cycles; sustainable use of energy and land resources; zero net greenhouse emissions	• Renewable and carbon free energy • Reducing gross consumption • A cyclical materials economy • Regenerative land practices
2	*Addressing Unsafe Legacy*	**Carbon Negative Capacity**	Atmospheric CO_2 levels are at socially and ecologically sustainable levels; no accumulation in atmosphere or ocean; capacity to draw down to pre-industrial levels	• Building up carbon stores in land or ocean biomass (eg. reforestation) • Increasing soil carbon levels • Carbon capture and storage in biochar
3	*Ensuring Safe Passage*	**Protecting System Viability**	The transition to the safe climate zone is accomplished without ecological, social or economic system collapse; capacity for extraordinary adaptation, inc. direct cooling	• Adaptation measures • Socio-political crisis management • Biodiversity, ecosystem maintenance support • Direct cooling (ie. albedo engineering)

These strategies are strictly hierarchical in the sense that Strategy 2 must not become an off-setting substitute for Strategy 1. And Strategy 3 must not be a technology fix or an adaptation substitute for Strategies 1 or 2. Having said that, all three strategies need to be planned for concurrently and mobilised in an integrated fashion.

The size of the task

Carbon neutral solutions

We will be able to reach zero net emissions by a combination of reducing energy and material consumption, using renewable and carbon neutral energy and introducing regenerative land practices.

Current global greenhouse emissions are about 50 Gt/a CO_2e. Economic growth will increase this target, until we decouple energy and emissions and avoiding imbalances in biogeochemical cycles (C, N etc).

Carbon negative capacity

If we were able to draw down all the excess carbon currently in the atmosphere (~ 220 Gt), ocean re-equilibration would release CO_2 back to the atmosphere. This will offset the rate of atmospheric draw down, but it will reverse the ocean acidification process.

Therefore, as a first approximation, the target draw down should be the excess carbon in both the atmosphere and the ocean, that is an estimated 370 Gt of carbon (driven primarily by historic fossil fuel emissions of ~350Gt).

If it takes between 1-5 decades to become carbon neutral, the draw down task will have risen further to between 400 and 500 Gt carbon. Another reason for urgency.

SAFE CLIMATE AUSTRALIA

	Strategic Objective	Task	Target
1	**Establishing Safe Practices** Carbon neutral solutions	**Abatement**	**50 Gt CO_2e per annum**
2	**Addressing Unsafe Legacy** Carbon negative capacity	**Draw down**	**370 Gt Carbon**
3	**Ensuring Safe Passage** Avoid critical overheating	**Direct Cooling**	**To be determined**

How long to draw down?

This is a complex problem that will require modelling. For perspective, if 10% of Net Primary Production (a measure of biomass gain from photosynthesis) were available for draw down purposes (clearly a stretch target) that would represent some 5Gt per annum carbon, about 1% of the total draw-down target.

We have overloaded the system so much that it will probably take at least a century to return to relatively safe greenhouse gas concentrations in the atmosphere.

The sense of urgency

The climate will become more dangerous at least until we reach the carbon neutral turning point. How long do we have? That requires extensive modelling, but simplified calculations indicate how temperatures increase significantly even if we achieve the turn around in a few decades.

If it takes us more than a few decades to get to the carbon neutral turning point, we risk increasingly dangerous temperatures in the immediate term and we become more dependent on direct cooling measures to avoid critical 'overheating'.

If we achieve zero net emissions within a few decades, with CO_2 peaking well below 450ppm, temperatures would continue to rise as ocean thermal inertia and feedbacks continue to work their way through the system, unless concentrations could be drawn down quickly. Given extended time at stabilised greenhouse gas concentrations, warming in the pipeline would mean temperature rises of 3 to 4ºC above pre-industrial. This is both inherently dangerous in the short term, and enough to trigger further abrupt/runaway warming in the long term.

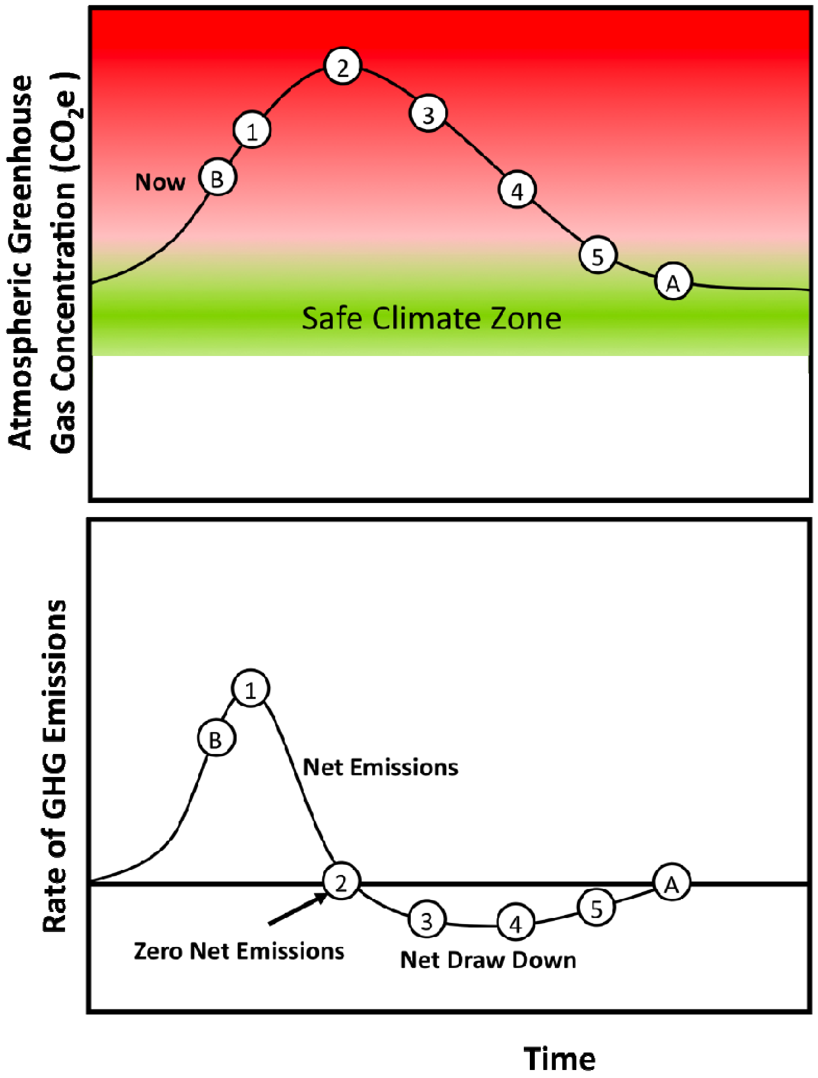
Conditions at the Carbon Neutral Point (Zero Net Emissions)			Longer Term Implications
Time Taken	Peak CO_2	Actual Warming	Future Warming
Decades	ppm	ºC	ºC
1	399	1.3	3.1
2	411	1.5	3.3
3	423	1.7	3.6
4	435	1.9	3.8
5	447	2.1	4.0

The very notion of stabilising temperatures by holding greenhouse gas concentrations constant once emissions have peaked is a fundamentally flawed concept. The zero net emissions turning point needs to be followed by persistent draw down of the legacy carbon in the atmosphere to reduce the greenhouse warming potential in the pipeline.

The trajectory to the safe climate zone

Milestones on the journey

B	**Current Reality** Greenhouse gas emissions, (GHG) are rising at a progressively faster rate; Currently at 387 ppm CO_2
Milestone 1	**GHG emissions have peaked** Emissions are actually reducing; atmospheric concentrations still rising, but at a slower rate
Milestone 2	**The carbon neutral turning point** Zero net emissions, with carbon negative activities offsetting remaining fossil fuel use
Milestone 3	**Fossil fuel phased out** Energy and land use are essentially carbon neutral, with carbon negative activities now fully focused on draw-down
Milestone 4	**Back to1990 GHG concentrations** (350ppm CO_2) 1990 was the symbolic point when climate change was recognised as a major problem
Milestone 5	**Back to pre-1950 concentrations** (310ppm CO_2) The early signs of system stress, driven by the start of the pos-war boom
A	**The safe climate zone** Aim is zero human-induced warming; probably to pre-industrial levels of greenhouse gases (around 280ppm CO_2)



4. The Australian Perspective

Australia in the world

SAFE CLIMATE AUSTRALIA

Climate change is a global problem with specific geographic features. Australia has an overwhelming vested interest in there being an effective international response to climate change, because:

- neighbouring countries in the Asia Pacific region are amongst the most vulnerable to ecological, social and political impacts driven by climate change
- our major agricultural areas are threatened by shifting temperature and precipitation patterns
- we have already been exposed to extreme weather events, which will intensify with continued global warming
- our most important and iconic ecosystems are being degraded and seriously threatened by climate change

A good outcome for Australia is unimaginable if the world doesn't take effective action. However, even if the world does act effectively, we have an enormous challenge here, because:

- our economy currently derives huge benefit from the exporting of fossil fuels and emission intensive products
- we are amongst the most greenhouse gas intensive economies in the world

This means we are extremely exposed, unless there is deep change in the way our economy and society works.

Translating the challenge into opportunity, we have abundant but relatively untapped non-fossil fuel energy resources and a capacity to innovate

An unsafe regional climate

Continued global warming and climate change would create geo-political insecurity in our region, with potential conflict over water , food, energy and land resources and mass migration of environmental refugees.

Losing the Himalaya ice sheet

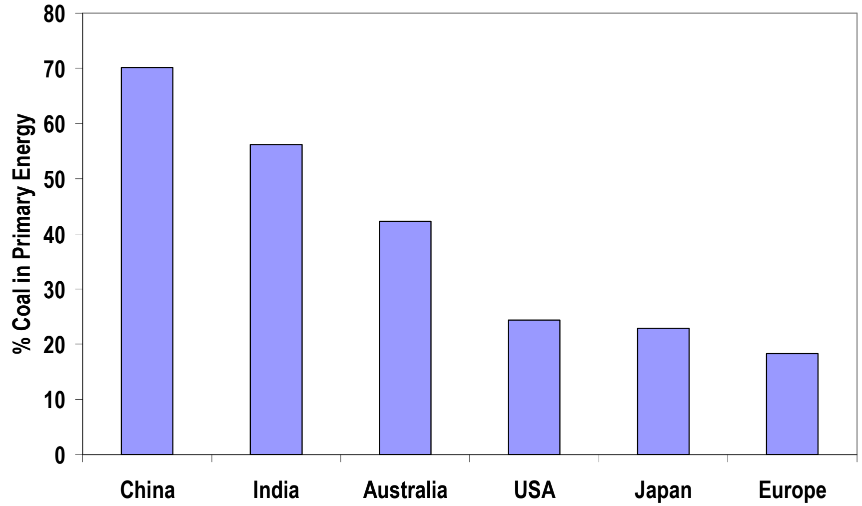
Over a billion people depend on the annual snow and ice thaw for water that feeds many of the world's largest river systems. Glaciers in the Himalaya are receding faster than in any other part of the world; the likelihood of them disappearing by mid-century or sooner is very high if the earth keeps warming at current rates.

Rising sea levels and coastal storms

- The very existence of many low lying island nations in the Pacific and Indian oceans is at risk from sea level rises and storm surges
- Coastal flooding and sea level changes put at risk major low lying food production systems, such as the Ganges, Brahmaputra, Mekong, Yangtze and Yellow River delta regions

Developing nations

Climate change will also pose a particular challenge for the rapid growth economies of our region, especially China and India, who like Australia are currently heavily dependent on coal.

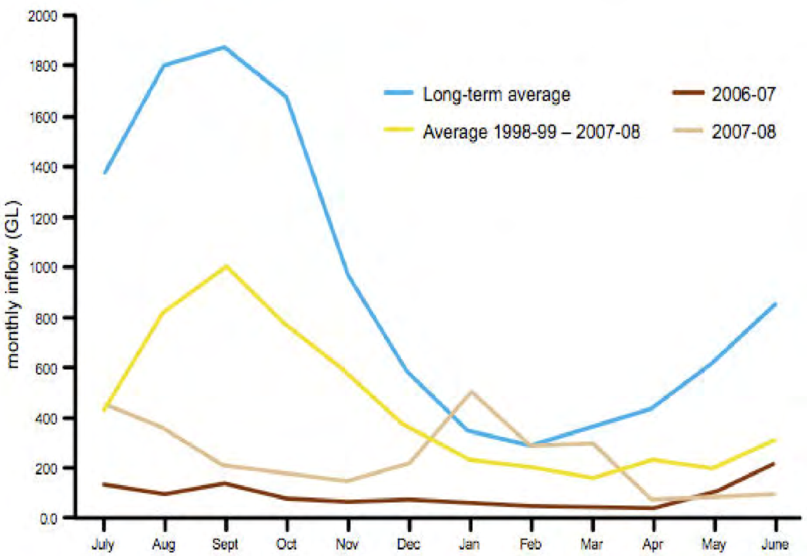


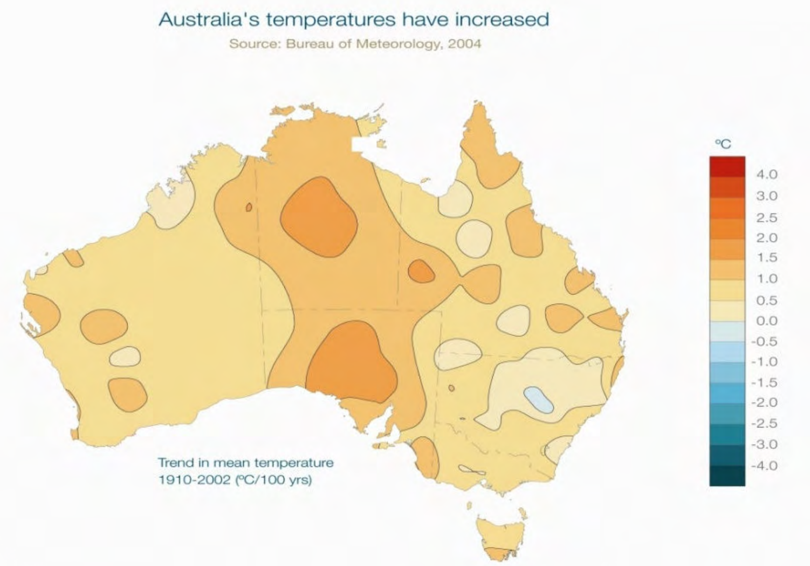
Changing temperatures and rainfall patterns

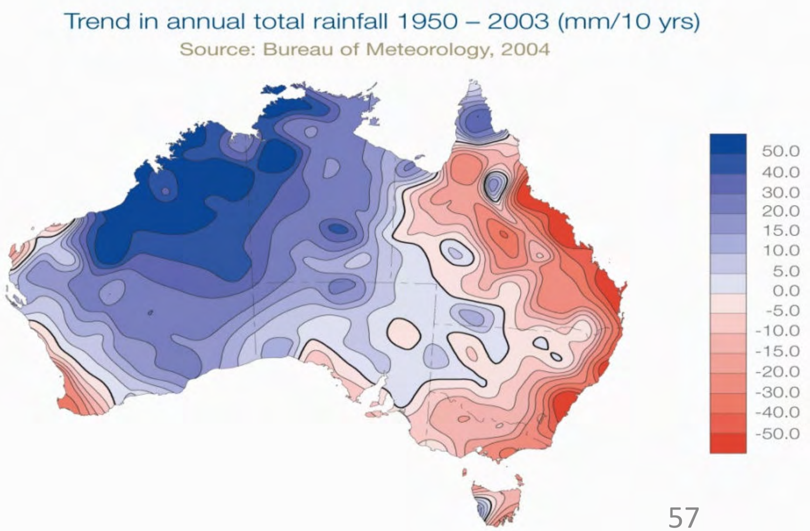
Temperatures across Australia have been systematically rising over the past century.

Climate change is changing rainfall patterns. The north west of Australia, a region influenced by monsoon weather systems, has become wetter. The eastern states of the continent and the south west of Western Australia (areas with the greatest population and agricultural activity) have generally become drier.

Water inflows to the Murray-Darling basin have been greatly reduced. From 2001 to 2003, water loss above ground was 12 cubic km; ground water loss was even greater at 80 cubic kms.







Australian impacts
The costs of climate change

Australia is already and increasingly vulnerable to climate change, through extreme weather events, desertification, drought, loss of agricultural capacity, infrastructure damage and risks to health.

Extreme weather

Climate change has increased severity and frequency of bushfires, cyclones, hailstorms and floods.

The heat wave in south east Australia in early 2009 was associated with power supply reductions, rail delays as well as 173 deaths associated with the fires and over 300 deaths from heat-related problems.

Mediterranean climates

As elsewhere around the world, the south east of Australia and the south west of WA, are getting hotter and dryer with major impacts in the cities and the country.

Iconic ecosystems

Climate change is making the tropical rainforests, including the Daintree, vulnerable to drying out, fire and degradation. Temperature-induced bleaching threatens the existence of the Great Barrier Reef . Snow and ice dependent Alpine ecosystems are at risk due to warming.

February 2009

- Extreme heat waves in South Australia & Victoria
- Devastating Victorian bushfires
- Cyclonic events hit northern coasts
- Severe flooding in Queensland and NSW
- Dengue outbreak in Cairns, with more than 350 cases

Rising sea levels with storm surges…

425,000 Australian addresses less than 4 metres above sea level and within 3km of shoreline are "vulnerable"

Insurance Council

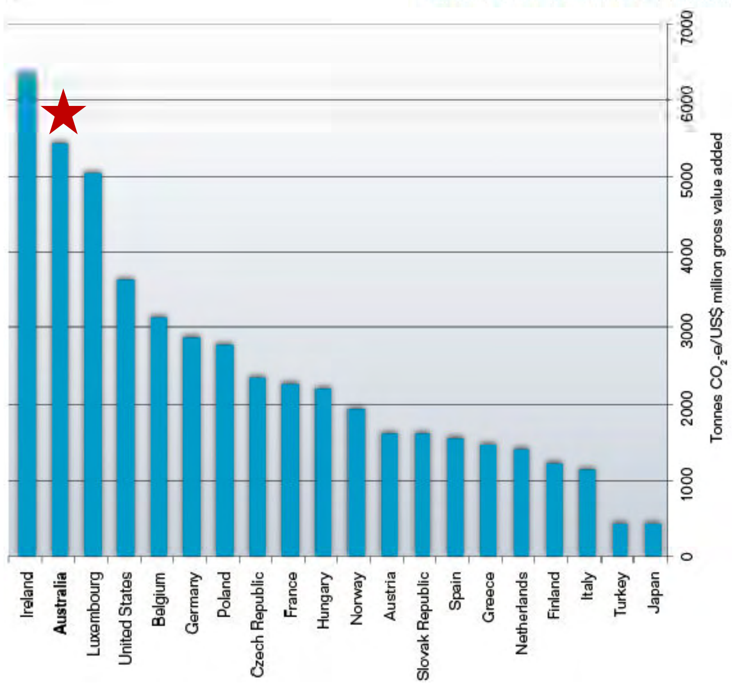
Greenhouse gas intensity of our economy

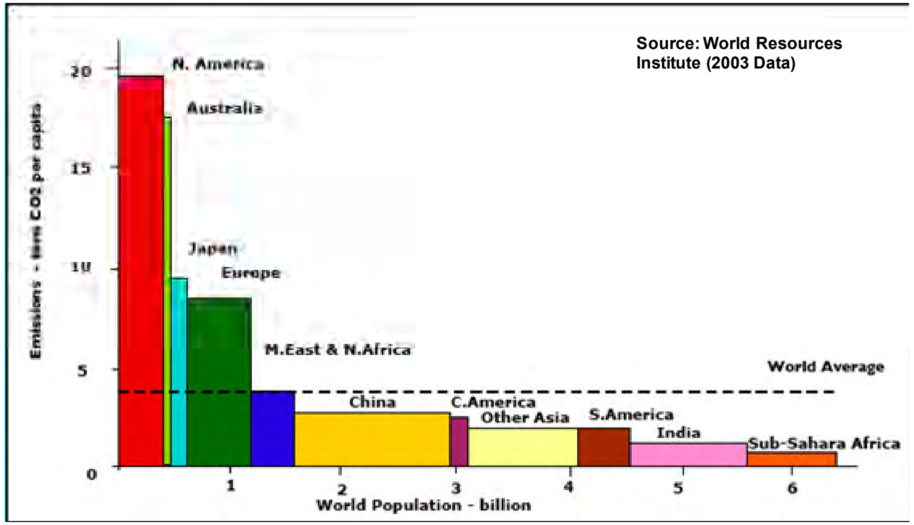
Australia is one of the most greenhouse intensive economies in the world, in terms of

- the GHG emissions intensity of our GDP
- per capita GHG emissions
- export earnings from GHG intensive products

This means that without leadership Australia will be at a relative disadvantage when the world moves effectively to low carbon emissions.

Australia will need to reduce GHG intensity at a faster rate than the world generally or risk losing competitiveness in a carbon-constrained future.





Source: World Resources Institute (2003 Data)

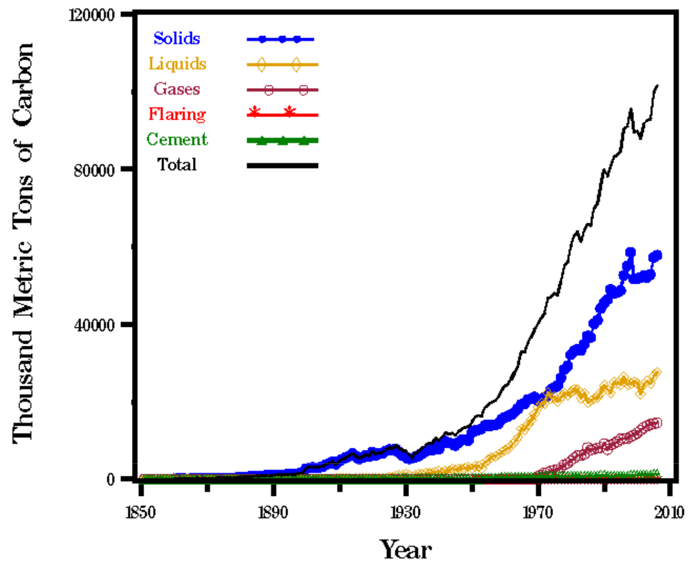
GHG Intensive Exports	Export Value Billion $Aus	Proportion of Total Export Value (%)
Coal	24.4	11.1
Petroleum Products	20.3	9.2
Refined Metals	13.0	5.9
Ruminant Livestock	11.7	5.3
Total	69.4	31.5

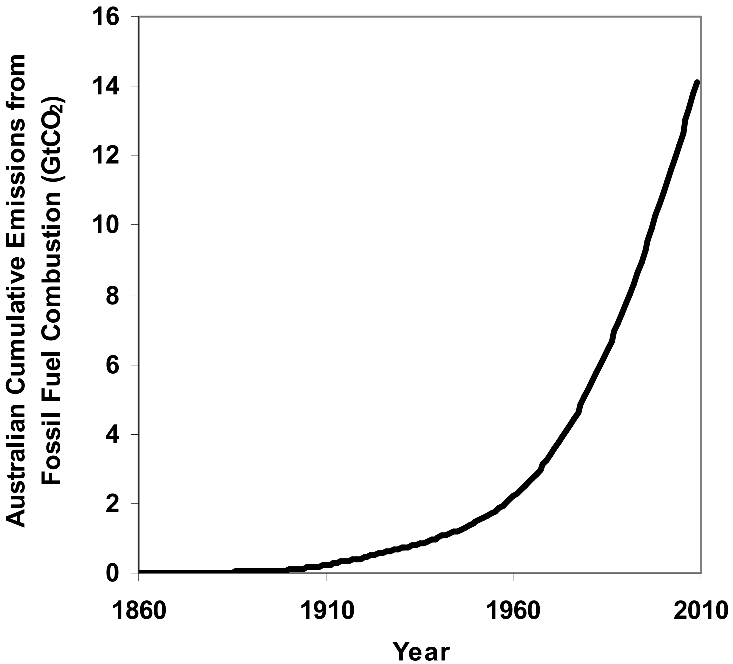
Historical perspective

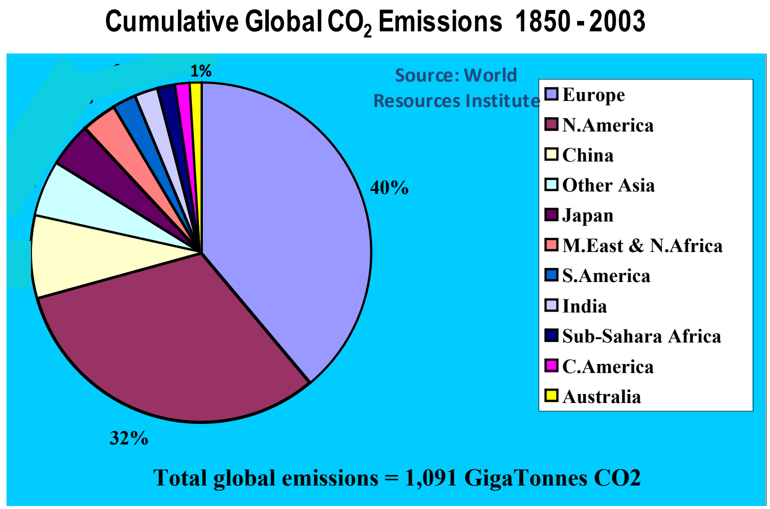
Since 1850, Australia has emitted almost 4 billion tonnes of carbon to the atmosphere (14 Gt of CO_2) through fossil fuel use, excluding land use changes.

The rate of emissions is increasing. Half of our total fossil fuel emissions since European settlement have been in the last two decades, 90% since the second world war.

Our cumulative greenhouse gas emissions since 1850, and our current emission rates are somewhat above 1% of the global total, around 4 times our population percentage.







Australian emissions profile

Carbon dioxide

Greenhouse gas emissions from Australia are predominantly associated with CO_2:

- By far the biggest contribution is from the burning of fossil fuels
- The second significant factor is land use change (deforestation/clearances)
- There is a small ‘carbon negative’ offset from afforestation/reforestation

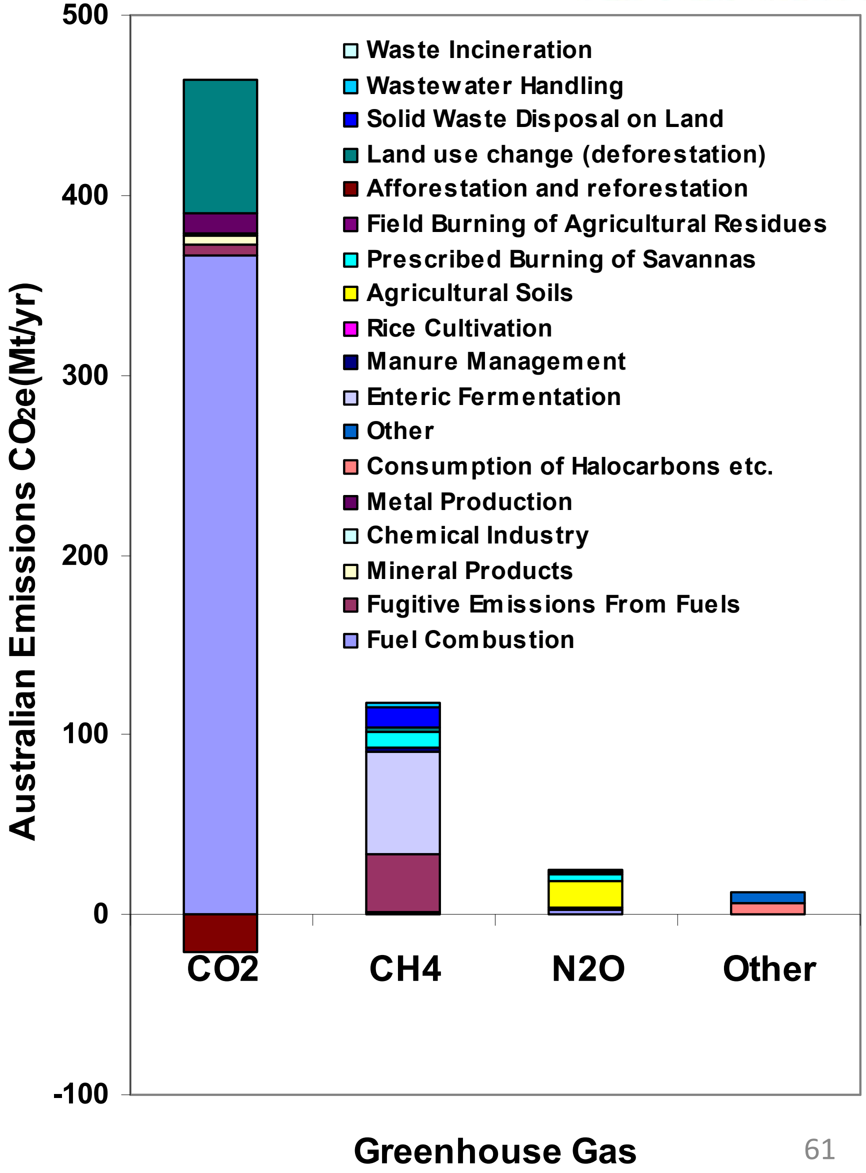
Methane

The two main methane emissions are from:

- enteric fermentation, associated with ruminant livestock
- fugitive emissions from fuels, especially coal bed methane

Nitrous oxide

N_2O emissions arise primarily from agricultural soils, linked to nitrogen fertilisation of crops.



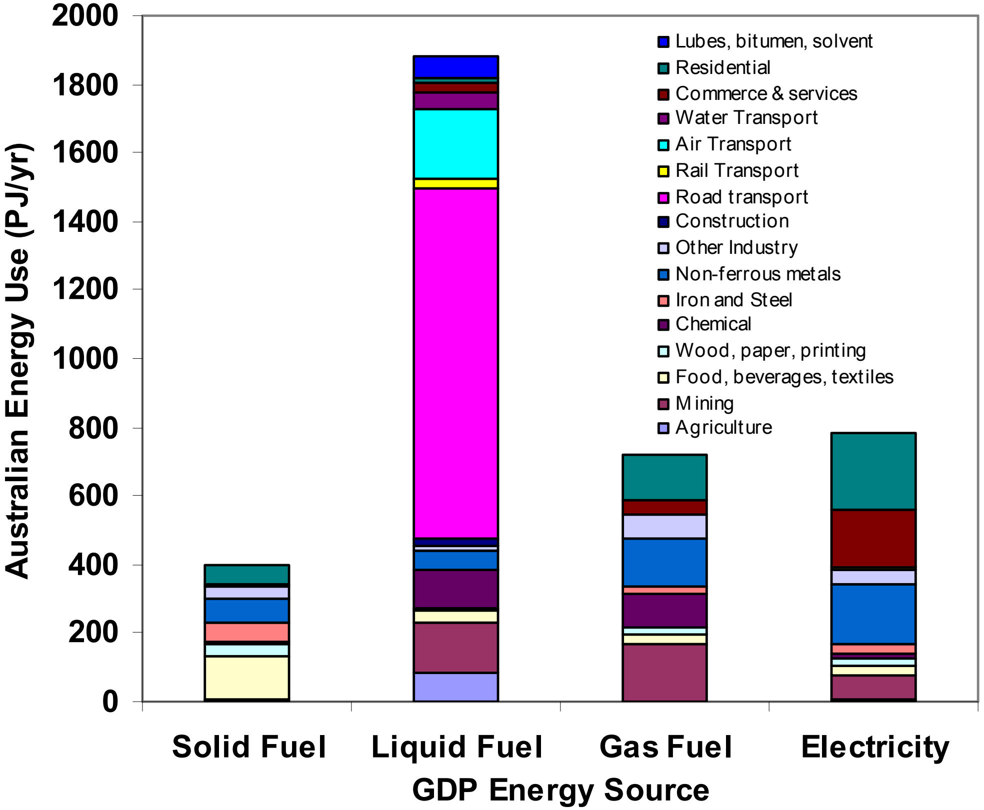
> Data here, and the following pages, are for 2007, a year where total emissions were 597 Mt CO_2e.

Australian end-use energy and emissions

Energy to the economy

The value from energy in the economy comes from the use of electricity , solid, liquid and gas fuels. Liquid fuels provide the biggest share of end-use energy, with road transport the major component, followed by air transport and mining.

About half the electricity use in Australia is in domestic and commercial buildings, and about a quarter to aluminium production.

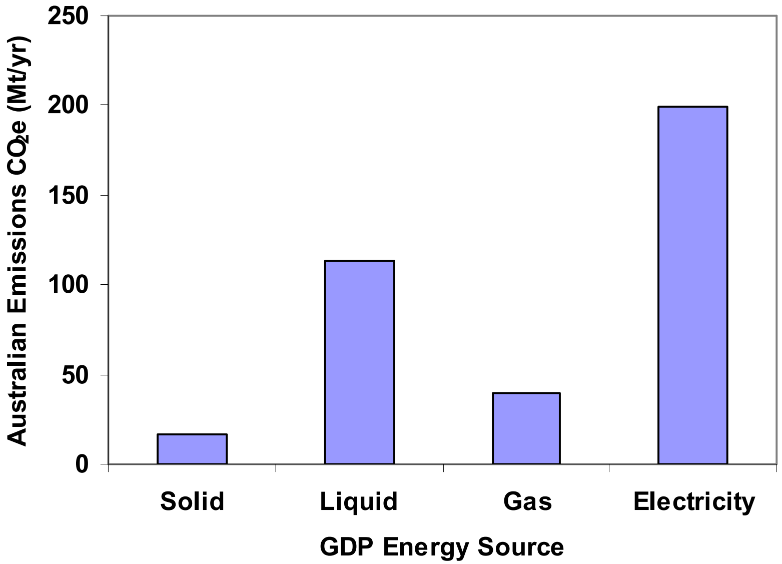


Emissions from the economy

The main contribution to greenhouse gas emissions comes from electricity generation (~ 80% coal based).

Electricity emissions can be avoided, eg. by the use of renewable energy or geothermal power.

Emissions from liquid transport fuels can be avoided by using biofuels or by electrification of road transport (eg. using batteries charged by renewable energy)



A closer look at the most significant emissions

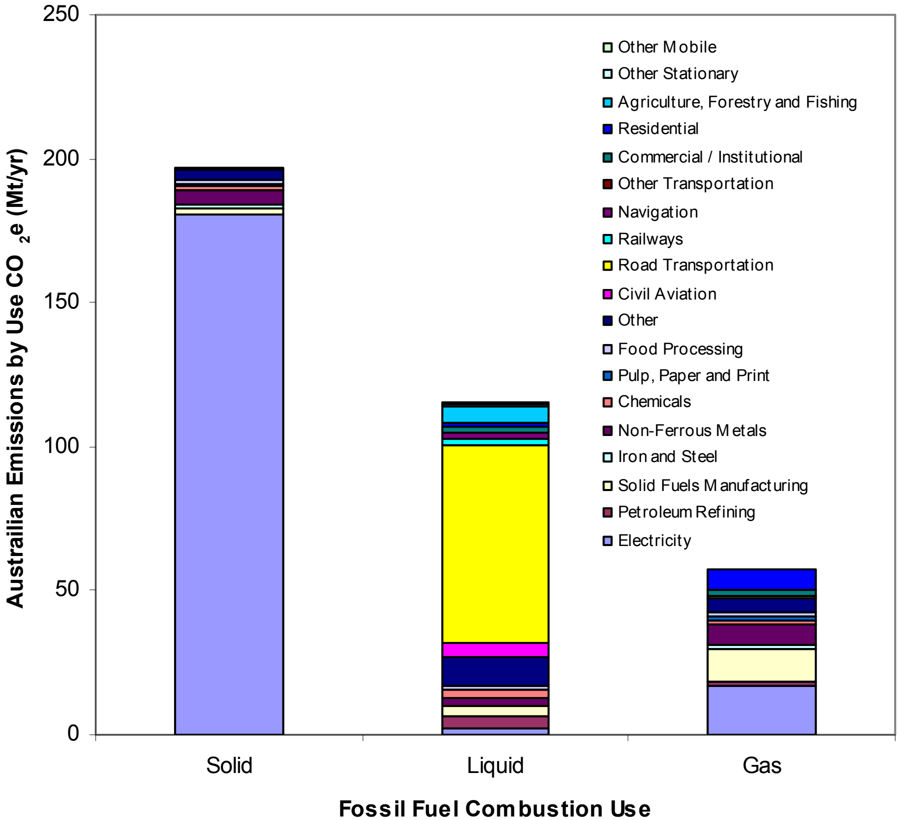
Greenhouse gas emissions from fuel combustion, land clearing, enteric fermentation and fugitive emissions make up 87% of Australia's total.

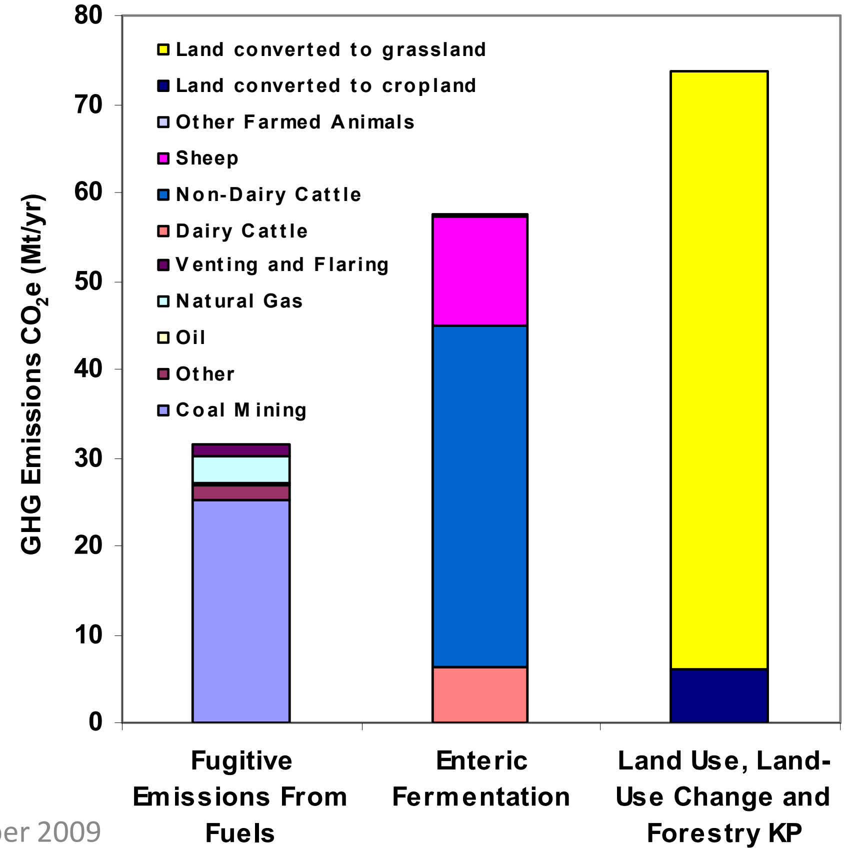
Fuel Combustion

The greatest contribution to greenhouse gas emissions from fossil fuel combustion are related to burning coal for electricity and the use of liquid transport fuels (petrol, diesel etc.)

The greatest contribution to GHG emissions from land use change is clearance to create grassland primarily for livestock grazing. Non-dairy cattle (ruminants) are the principal source of enteric fermentation.

Coal mining is the main source of fugitive emissions (ie. coal bed methane)

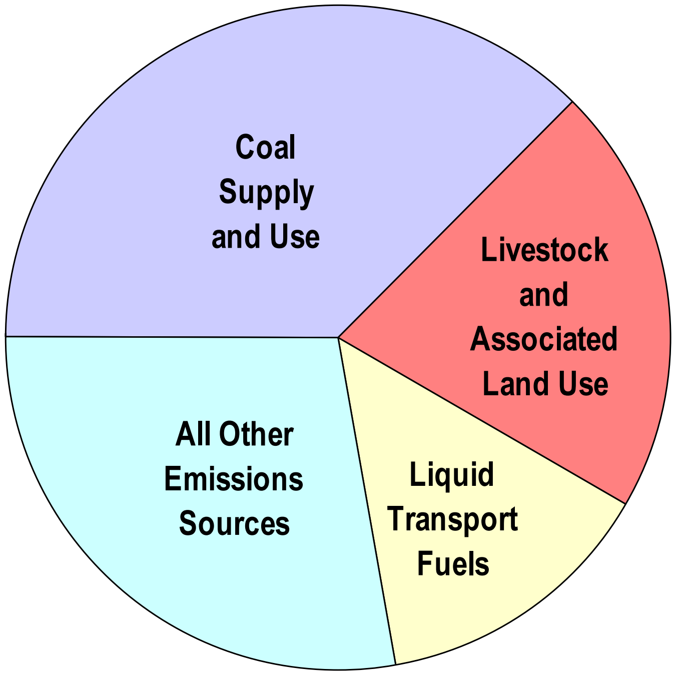




Key challenges for Australia

High priority areas

Given Australia's greenhouse gas profile, the primary focus for work on the Safe Climate solutions platform will have to be on finding carbon neutral solutions to meet the social and economic needs currently delivered by the supply and use of coal, livestock and the associated land use, and liquid transport fuels.



Carbon neutral solutions

To achieve a net zero emissions economy, the abatement required is 600 Mt CO_2e per year. This target will go up with economic growth until energy supply and land use are de-coupled from greenhouse gas emissions.

Carbon negative capability

Australia's historic contribution to the accumulation of carbon in the atmosphere and the ocean is estimated to be some 15 Gt of carbon. If we take responsibility for our legacy, then this becomes our draw down target, which will be further increased by the accumulated emissions until zero net emissions neutral turning point is reached.

The Safe Climate Task for Australia	
Abatement	600 Mt CO_2e/a
Draw down	15 Gt CO_2

Australia in the world

Climate change is a world problem, so there may be opportunities for Australia to benefit by doing more than this amount of abatement and draw-down - through the export of carbon neutral energy resources or by greater contribution to bio-sequestration (carbon capture and storage).

Opportunities and Australian geography

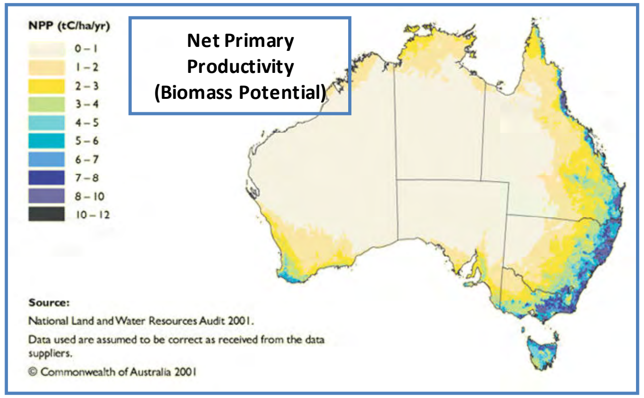
The Australian economy has derived great value from fossil energy resources. But Australia is also very well endowed with non-fossil fuel energy resources.

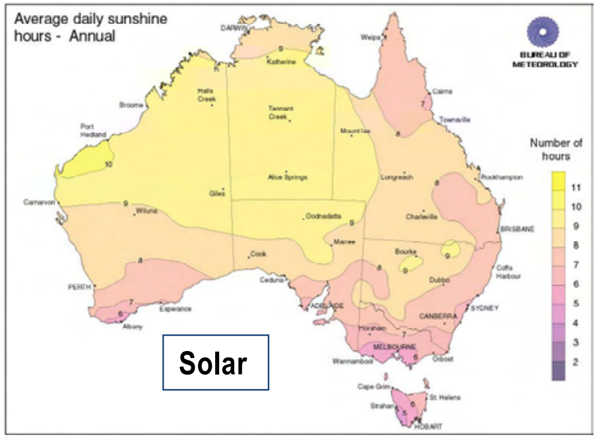
The energy resources available in solar, wind, wave, biomass and geothermal are all more than enough to meet our current energy needs. This gives us a robust platform to design the carbon neutral energy system, with potential for export to neighbouring regions.

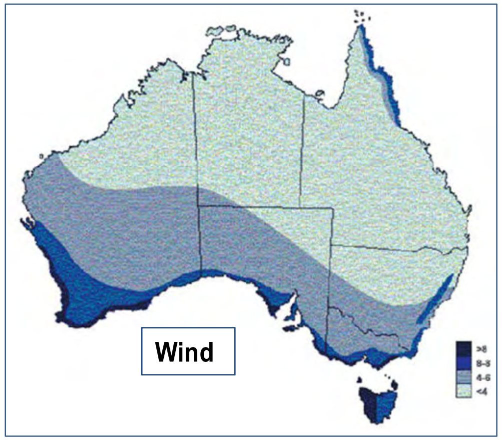
Australia is a major exporter of uranium.

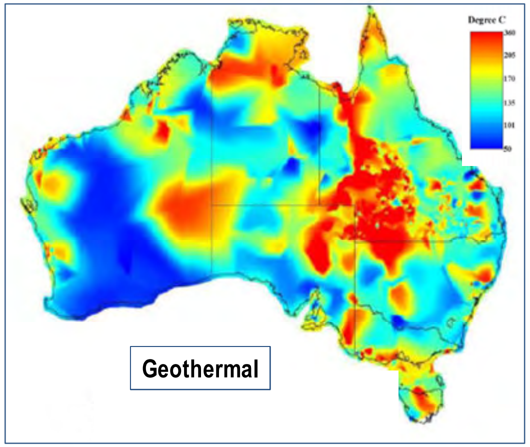
The ability to unlock these resources will depend on

- the capacity to proliferate the enabling technologies
- the building of supporting infrastructure, eg. for power transmission from remote areas, energy storage, electrification of the transport system
- The agricultural sector becoming an integral part of the solution, through the bio-economy (bioenergy and carbon capture and storage opportunities).









5. Developing the Transition Plan

The transformational challenge

An effective response to climate change cannot be carried out in a piecemeal fashion; it implies a transformation in the way physical and financial resources are allocated and how political priorities are set. Moreover, it will depend on a cultural transformation in attitudes and behaviours right across all aspects of society . Australia will need:

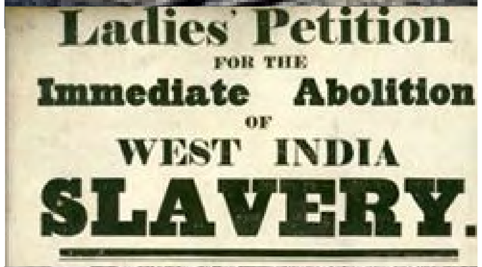
- a complete restructuring of the energy base of the economy away from fossil fuels.
- extremely rapid proliferation of existing, emerging and new technologies that together will deliver a zero net emissions economy, draw-down of atmospheric carbon on an enormous scale and extraordinary adaptation and protection measures during the transition to a safe climate.
- an enormous wave of creativity and innovation in business, government and the community.

Emergency

We face an emergency that should be addressed in emergency mode, akin to national mobilisations on the scale of WWII or the Marshall Plan. That does not mean panic. In fact, effective responses to crises can bring out the very best in people. It requires a coherent, integrated plan, commitment of resources and persistent action.

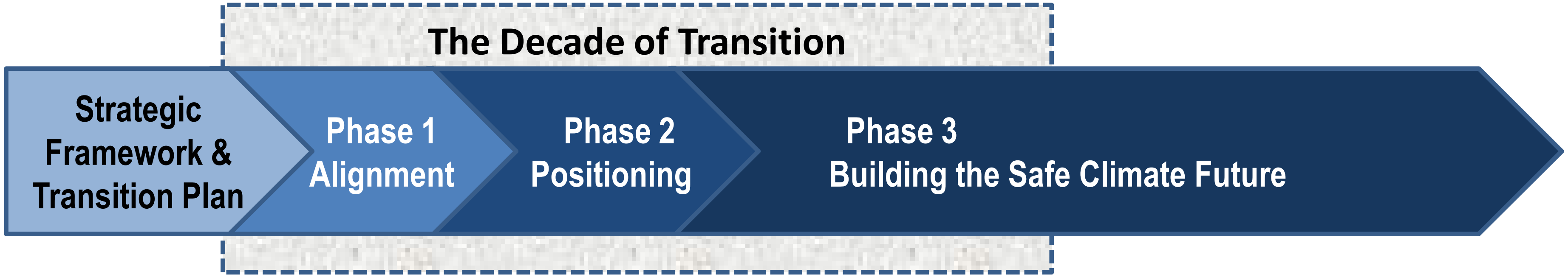
Honesty is essential, otherwise we will never develop appropriate solutions. With so much at risk, our goals and targets should be based on the latest, considered science, not on a political view of the art-of-the-possible.

SAFE CLIMATE AUSTRALIA



Planning for the transition

The Safe Climate Australia Strategic Framework and the Transition Plan are being designed to advocate and facilitate a Decade of Transition in response to the urgent challenge we face.



The Objectives of the Decade of Transition	
Phase 1 Focus *Getting to "Yes"*	**Alignment in society that the climate challenge must be dealt with in emergency mode** • Agreement across government, business and community that this is a transformational issue • Agreement on strategic intent, the broad platform of solutions and the general pathway to the safe climate zone • Mobilising opinion to ensure there is a willingness to act, innovate, prioritise and commit resources
Phase 2 Focus *Getting Prepared*	**Creating the foundations for a rapid transition** • Putting the policy and organisational foundations in place and committing the resources • Rapid acceleration of short-term initiatives; achievement of first milestone, ie. emissions are actually coming down
Phase 3 Focus *Full Steam Ahead*	**Restructuring the economy and the proliferation of solutions** • Building the enabling, integrated infrastructure • Rapid progress towards the major 'carbon neutral' turning point, ie. when net emissions reach zero • Large scale demonstrations of bio-sequestration to underpin 'carbon negative' draw-down of atmospheric CO_2 • Understanding what special adaptation activities are needed to counteract warming • Mobilising the resources and building momentum and confidence in our capacity to reach the safe clime zone

The working groups

Taking the planning process forward

The **Strategy and Integration** team will provide overarching direction to the working groups as the planning process proceeds to more detailed analysis and solutions. It is essential that strategic clarity and the whole-system approach is maintained.

1. The **Strategic Imperatives w**orking group will focus on defining more accurately the parameters and the trajectory of the safe climate transition; how to protect ecological and social needs to the extent possible by human action.
2. **The Solutions Platform** working group will develop a broad, integrated physical platform to achieve the safe climate trajectory in technically and economically viable ways.
3. The **Managing the Transition** working group will address the policy, governance, risk management, economic, culture change and engagement aspects of a rapid transition to a safe climate.

The **Communications and Engagement** team will focus on how to get alignment across government, business and community on the strategic intent, the broad range of solutions and the pathways to the safe climate zone.

The Working Group Structure	
Strategy and Integration	
1	Strategic Imperatives
2	The Solutions Platform
3	Managing the Transition
Communication and Engagement	

Although these activities will be developed in parallel, there will be a natural shifting of focus from strategic imperatives to the solutions platform and then to managing the transition (from why to how to who). The work will start from a high level perspective and then progress to more detail.

Organisations and individuals can support these activities through personal participation and by sponsoring projects.

Working Group 1

Strategic Imperatives

The Strategic Imperatives working group will engage with experts from Australia and around the world to get the best and latest understanding of the behaviour of the climate system, the people and ecosystems most vulnerable to climate change and the implications.

Modelling will be commissioned to analyse the expected response to an early achievement of zero net emissions followed by persistent draw-down.

Key questions to be addressed are:

1. How are global average temperatures, sea level and ocean acidity likely to change over time?
2. What are the consequences of delays in reaching the carbon neutral turning point?
3. What amount of draw down will be necessary before there is a significant cooling effect and how fast does draw down need to proceed?
4. To what extent can natural processes contribute to the return to ecologically sustainable climate conditions?
5. What are the critical species and ecosystem vulnerabilities that should be considered on the trajectory back to safe climate conditions?
6. What adaptation strategies can be put in place?
7. At what temperature thresholds should direct cooling options be implemented to avoid 'overheating'?

Protecting

- Vulnerable human communities and assets
- Biodiversity
- Food production and water supply
- Survival of coral reefs
- Arctic summer ice cover
- Himalayan glaciers

Avoiding

- Tipping points for abrupt warming
- Accelerated species loss or mass extinctions
- Extreme weather events and catastrophic bushfires
- Increasing ocean acidity
- Ecological, social and economic system collapse in the transition

Working Group 2
The Solutions Platform

The Solutions Platform working group will explore the technologies to support a sustainable, carbon neutral economy, large scale draw-down and direct cooling options. A robust platform will be integrated, have redundancy (avoiding dependence on single solutions), and build on the concepts of a circular economy.

Some key questions to be addressed are:

1. What technologies and suppoirting systems be part of the solution? How fast should and could solutions be developed and proliferated? What are the perceived limits , challenges and obstacles and how might they be overcome?
2. What solutions are available now? What role can innovation play in the transformation? What are the pivotal breakthroughs needed?
3. What are the opportunities for significant new industry growth?
4. What are the critical sustainability criteria?
5. What are the important enabling infrastructure requirements?
6. What are the projected energy and material demands of the future
7. To what extent does the required trajectory demand early retirement of existing assets?
8. Can fossil-fuel-based carbon capture and storage make a significant contribution to the transition?
9. What role if any should there be for nuclear energy?
10. When could/should we have the capability to deploy direct cooling measures?
11. What synergies could be built between the solutions for a sustainable, carbon-neutral economy and for the carbon-negative draw-down of CO_2?

The Evaluation Process

1. Strategies and Principles
2. Generic platforms; solution clusters
3. Scaling considerations
4. Technology assessment
5. Techno-economics
6. Sustainability evaluation
7. Breakthrough parameters for proliferation
8. Scenarios
9. Implementation

Working Group 3

Managing the Transition

The Managing the Transition working group will examine how society can get to 'yes' in a very few years, given the enormous transformational challenges implicit in the transition to a safe climate. The scale and speed required are completely beyond the boundaries of 'business as usual'.

Given the transformational aspects of the transition, what is the 'theory of change'? What are the most important things that government, business and the community must do to manage, resource, advocate and mobilise for an emergency mode response to climate change?

Some key questions to be addressed are:

1. What can be learnt from the past, with respect to major economic mobilisations and major socio-political attitude changes?
2. What developments can blossom bottom-up and what require a degree of command and control?
3. Where will the leadership come from and how will it be initiated?

It is anticipated that the 'getting to yes' process will be strongly influenced by the perceived feasibility of carrying out the transition. Is it possible? For this reason SCA is developing in detail how the solutions platform can be created and implemented with sufficient urgency (Working Group 2).

The Managing the Transition work will be focused in three areas: (a) the economy, (b) the organisation and management of the transition and (c) social and political change. These areas are explored further overleaf.

The economy

The organisation and management of the transition

Social and political change

Working Group 3

The economy

1. Approximately how much investment are we facing for the transition?
2. What are the economic implications of early retirement of assets?
3. How will the necessary funds be mobilised and repaid?
4. What economic policy structures will be needed to drive/guide the transition at the macro-, meso- and micro-economic levels?
5. How can the transition be kept on track?
6. How will the skills needed for the transition be developed and mobilised?
7. What economic opportunities are opened up by the transition?
8. What effect will the transition have on existing and new export industries?
9. What are the implications and opportunities with respect to economic growth?
10. What role can each sector of the economy play in the transition? (ie private, public, civil society and household sectors).
11. What are the critical issues to be considered for the post transition period?

SAFE CLIMATE AUSTRALIA

The organisation and management of the transition

1. What aspects of the problem are unprecedented, requiring new modes of action from governments, businesses and communities ?
2. How important are legislation, regulation, price mechanisms, solutions-driven investment (by the finance industry or governments) and education in facilitating the change?
3. How can society ensure that strong measures to drive the transition are not carried over unnecessarily into the post-transition period?

Social and political change

1. What will motivate the community, governments and businesses to undertake a full-strength transition?
2. How will current blockages to effective action be overcome (psychological, business and political)?
3. Where will the leadership come from (in all sectors of society) and how will it be initiated?
4. How can society avoid intense social or political divisions?
5. How can political and social diversity be protected and respected in the change process?

Safe Climate Leadership Workshops

SAFE CLIMATE AUSTRALIA

To take the planning work of Safe Climate Australia forward, we will adopt an engagement model, based around a generic approach to "Safe Climate Leadership Workshops".

Workshops will start by establishing a common understanding of the strategic framework for the transition to a safe climate. Each workshop will then be focused around particular issues and structured towards solutions.

The workshops will be a creative and interactive process of learning, networking, stimulating innovation and developing business and risk management strategies.

The outputs of the Safe Climate Leadership Workshops will feed into the emerging Transition Plan and at the same time will help participating organisations position for the transition ahead.

- Safe Climate Australia
- Transition Plan Working Groups
- Experts
- Participating Organisations

Workshop Design and Preparation

Safe Climate Leadership Workshop

Part 1. The Strategic Framework for the Transition to a Safe Climate

Part 2. Translating the Challenges and Opportunities into Effective Responses, Innovation and Solutions

Follow Up Work

7. Strategic Conclusions

Strategic insights

Our analysis of climate change is grounded in ethics, science, safety and risk management, and sustainable value creation. The strategic conclusions are:

1. Climate change represents a safety problem for humanity at an unprecedented scale and should be addressed as such. The strategic question therefore becomes “how can we move to a safe climate”, not “how dangerous a climate are we prepared to risk”.
2. Conditions are already unsafe, with greenhouse gas emissions already causing global warming, ocean acidification, ecological degradation, loss of life and property damage.
3. The climate system is highly complex with time lags, amplifying feedback mechanisms and tipping points for abrupt or ‘runaway’ warming; this means our current position is intrinsically more dangerous than it is perceived.
4. Emissions to date (unless there is active removal of carbon dioxide from the atmosphere) are enough to take global warming to around 3°C or even more, as ocean thermal inertia and feedbacks work their way through the system.
5. The notion of stabilising temperatures at elevated levels of global warming is a fundamentally flawed strategy that does not address the safety risk; temperatures need to come down.
6. We have to reach the zero net emissions turning point as fast as is humanly possible, in a few decades at most, followed by persistent draw down of the accumulated carbon in the atmosphere and ocean, with the capacity to bring carbon dioxide in the atmosphere back to or near pre-industrial levels.
7. Moreover, we will need to consider options for adaptation, managing socio-political crises, stemming ecosystem degradation and biodiversity loss, and direct cooling to avoid critical overheating during the transition.
8. Australia’s greenhouse gas profile highlights the requirement of finding carbon neutral or negative solutions to meet the societal value currently derived from coal, livestock and the associated land use, and liquid transport fuels.
9. Climate change represents a transformational challenge for society to be approached in emergency mode.
10. We need to plan for a decade of transition, with urgent work to clarify the trajectory to a safe climate, to develop the details of the solutions platform and to address the challenges of mobilising for and managing the transition.

The foundations of the solution

The sense of scale and urgency is already clear. The tasks of achieving carbon neutrality, draw down and avoiding overheating in the transition will all get harder the longer it takes to turn things around.

Having said that, significant uncertainty remains in framing concrete targets. In the coming months, a priority will be to commission modelling and to engage with the best minds, in order to get a more precise understanding of just how quickly we have to reach the zero net emissions turning point, how fast we need to draw down historic emissions, and what the critical temperature thresholds are for the people and ecosystems most vulnerable to overheating.

Strategies for the Transition to a Safe Climate			Task: Global	Task: Australia
1	**Establishing Safe Practices**	Move to a carbon neutral economy; delivering value with zero net emissions	50 Gt/a CO_2e abatement	600 Mt/a
2	**Addressing Unsafe Legacy**	Draw down historic carbon emissions; no accumulation in atmosphere or ocean	370 Gt Carbon draw down	15 Gt
3	**Ensuring Safe Passage**	Avoid ecological, social or economic system collapse; consider cooling options	Avoid critical overheating during the transition