Climate Change: What it means in terms of Energy

Future of Energy and the Interconnected Challenges of the 21 Century
University of Basel
19th October 2011

Ian T. Dunlop
Director Australia 21
Member, Club of Rome
Chairman, Safe Climate Australia
Deputy Convenor, Australian Association for the Study of Peak Oil
Facing Our Limits
World Population - a unique point in history

Source: J.E.Cohen, Columbia University, New York, 2005
Converging Limits

Peak Oil

Climate Change

Water

Food

Financial Instability

All Symptoms of an Unsustainable World

- and all inextricably linked
Climate Change
Our climate: past and future. Lessons from a warmer world.

PETM natural greenhouse event at 55 million years ago.

This is a graphical interpretation by David Spratt, Melbourne Climate Action Centre, of aspects of recent paleoclimate research by Hansen et al, available in draft form at:

http://arxiv.org/abs/1105.1140
Version 1.4 of 4 June 2011
Around 34 million years ago, glaciation of Antarctica as temperature drops from Eocene peak.
Around ~4.5 million years ago, northern hemisphere glaciation. Associated with the rise of the Panama Cordillera which isolates the Pacific from the Atlantic oceans and leads to intra-oceanic circulation (Gyres) which introduces warm currents and moisture to the North Atlantic – resulting in increased snow fall and formation of ice in Greenland, Laurentia and Fennoscandia.
Climate swings between ice ages and warm inter-glacial periods over last million years. CO2 between 180 and 300 parts per million.

The last million years...

Carbon dioxide and methane over last 500,000 years
The last 10,000 years – the Holocene

Holocene: after the last ice age, relatively stable temperatures (+/−0.5°C) and sea-levels over last 10,000 years – the period of human civilisation.
Today temperature rises above the Holocene maximum

CO2 level today (2011) is 391ppm but “thermal inertia” (delay as ocean mass warm) means temperature will increase further. Temperatures have risen ~0.83C since 1900 and are now ~0.6C over peak Holocene.
2 degrees – goodbye to Greenland ice sheet...

When climate system reaches equilibrium, present level of CO2 will produce >2C of warming with feedbacks...

Deep ocean temperature change (as proxy for surface temperature)

- **Peak Holocene**: over last 10,000 years up to 1900AD
- **Global average temperature now** ~0.6C above peak Holocene
- **2C of warming**: consequence of current level of greenhouse gases
... which is sufficient for large parts of Greenland and West Antarctic ice sheets to be lost, leading to at least a 6-7 metre sea-level rise over time.

“Goals to limit human-made warming to 2°C. are not sufficient – they are prescriptions for disaster” — Dr James Hansen
4 degrees – goodbye, goodbye ...

Best present emission reduction commitments by all governments (if implemented) will still lead to 4 degrees of warming by 2100...

Peak Holocene: over last 10,000 years up 1900AD

Global average temperature now ~0.6C above peak Holocene

2C of warming: consequence of current level of greenhouse gases

4C of warming
...and likely loss overtime of all ice sheets. No ice sheets on planet = 70 metre sea-level rise over time...

... amongst many devastating impacts. Read more about 4 degrees hotter at http://www.climateactioncentre.org/resources
Arctic Sea Ice Volume - accelerating melt

Source: Neven et al, PIOMAS, University of Washington 2011
Global Surface Temperature Changes

Decadal Surface Temperature Anomalies (°C)

Decadal mean surface temperature anomalies relative to base period 1951-1980.


Arctic is warming fastest
Amazon – from carbon sink to carbon source?
- the 2005 & 2010 droughts

Source: The 2010 Amazon Drought, Lewis et al, University of Leeds, Science, February 2011

A & B = anomaly of dry season rainfall from decadal mean

C & D = maximum climatological water deficit from decadal mean

2010 emissions release due to drought may have been in excess of 5 billion tonnes CO₂

= US total annual fossil-fuel emissions
Australia – record sea surface temperatures 2010 - 2011

Annual decadal mean sea-surface temperature anomaly with respect to 1961-90 average

September to December 2010 sea-surface temperature deciles with respect to 1900-2010

Source: Annual Climate Summary 2010, Australian Bureau of Meteorology
Current speed of emissions build-up - unprecedented

Source: The Last Great Global Warming, Lee R. Kump, Scientific American, July 2011
Global Warming did not stop in 1998

Source: Skeptical Science
Climate Lag – “Frog in Boiling Water”
- emissions today have impact for decades to come

Source: IPCC 2001
Potential Global Tipping Points

Source: Schellnhuber, after Lenton et al, PNAS, 2008
Committed Warming as of 2005
- probably $2.4^0\text{C}$, range (1.4 to $4.3^0\text{C}$)

Source: Ramanathan & Feng 2008 PNAS
Recent evidence shows that methane emissions are increasing from Arctic permafrost and seabed clathrates.

If the permafrost begins emitting CO₂ and methane in substantial amounts, we have little means of containing the warming impact.
Current policy commitments - a 4°C World

Increase in Global Temperature by 2100
Where will proposals from the climate negotiations lead?

- Business as usual
- Sept 2 proposals
- Goals

0% below 2006 levels by 2050
China: Carbon intensity 45% below

Source: Climateinteractive, updated 2nd September 2011
Much talk about adaptation to 4°C - what does it really mean?

“In such a 4°C world, the limits for human adaptation are likely to be exceeded in many parts of the world, while the limits for adaptation for natural systems would largely be exceeded throughout the world”

Royal Society – January 2011

“If political reality is not grounded in physical reality, it is useless”

“What is the difference between a 2deg C world and a 4deg C world?”

“Human Civilisation”

“A 4 deg C temperature increase probably means a global carrying capacity below 1 billion people”

Professor Hans Joachim Schellnhuber
Director, Potsdam Institute for Climate Impact Research
4°C Implications

Source: Drought Under Global Warming, NCAR, October 2010
Pattern of Warming by 2090
- mean global warming 5.4°C, A1F1 IPCC scenario

A1F1 assumes high economic growth, heavy fossil fuel dependence – business as usual

Source: Betts et al, Hadley Centre, UK Meteorological Office, 4°C+ conference Oxford University, September 2009
Climate Change
Risk Management on a Global Scale
Human Emissions
- continuing on worst case path

Source: Global Carbon Budget 2009, Global Carbon Project, January 2011
Global emissions and warming scenarios
Median projections and uncertainties of global-mean surface air temperature

Two scenarios are illustrated:

In each case the darkest shaded range for each scenario indicates the most likely temperature rise (50% of simulations fall within this range)

**Red scenario** illustrates potential temperature increases if no action is taken to curb global emissions.

**Blue scenario** illustrates potential temperature outcomes if cumulative global emissions between 2000 and 2050 are limited to 1000 billion tCO₂-e - gives a 75% chance of not exceeding 2°C.

(this requires net global emissions to peak before 2020 and then reduce rapidly to near zero by 2100)

**Implications:**
1 billion tCO₂-e shared among 7 billion people = 140 tCO₂-e per capita to 2050

Australian emissions = 20 tCO₂-e per capita. The budget runs out in 7 years

The global budget runs out in around 20 years

Exemplary emission pathways in order to remain within a budget of 750 Gt between 2010 and 2050. At this level, there is a 67% probability of staying below a warming of 2 °C.

(WBGU Special Report, 2009)
Emission trajectories

Examples of equal per-capita emissions of selected countries for 2010–2050, without emissions trading. Trajectories start from current emission levels.

Source: WGBU Special Report 2009
The Implications for Energy
World Primary Energy Demand
- “current policies put us on an alarming fossil-energy path”
IEA World Energy Outlook 2009 – reference scenario (BAU)

Global demand grows by 40% between 2007 and 2030, with coal use rising most in absolute terms

Source: © OECD/IEA – WEO 2009 – Reference Scenario
Climate & Energy are Inextricably Linked
- global carbon budget to avoid dangerous climate change

From 2010 onwards, we can only afford to burn 40 – 30% respectively of existing fossil fuel reserves to have:

- 50% chance of staying below 2°C
- 75% chance of staying below 2°C

So why are we continuing to explore for fossil fuels?

Coal to Gas:
- the influence of methane leakage

Note: temperature change relative to baseline warming of roughly 3°C in 2100

Source: Coal to Gas: the influence of methane leakage, T Wigley, NCAR, September 2011
IEA CCS Growth Path to 2050

Realism needed on CCS

- Sequestering say 20% of current global CO₂ emissions requires an industry around 170% the size of the world oil industry.
- CCS may make a significant contribution to addressing climate change, but:
  - not in the short term, to prevent atmospheric carbon concentrations above 450ppm CO₂e
  - not at the scale to be the global panacea for coal & gas
- Extremely dangerous to put all our eggs in the CCS basket, as we are doing
- Irresponsible to lock-in “carbon-ready” facilities before viability of CCS at scale is proven
- Research should be accelerated to prove its real potential
  - we need to keep all our options open, but be objective!

CCS is a classic case of Moral Hazard

“The world’s leaders are counting on a fix for climate change that is at best uncertain and at worst unworkable”

The Economist, 5th March 2009
The Alternatives to Fossil Fuels
The Alternatives to Fossil Fuels

- Demand reduction via efficiency & conservation
- Hydro
- Wind
- Solar PV
- Concentrating solar thermal
- Passive solar
- Geothermal
- Wave
- Tidal
- New generation nuclear
- Biomass
- Biofuels
- The unknown unknowns?
The Net Energy Cliff
- the next big thing!

Source: Euan Mearns, The Oil Drum Europe 2009
Technology takes decades to become “material”

Figure 1 | Global production of primary energy sources. When a technology produces 1,000 terajoules a year (equivalent to 500 barrels of oil a day), the technology is ‘available’. It can take 30 years to reach materiality (1% of world energy mix). Projections after 2007 taken from Shell’s Blueprints scenario³.
An Emergency Response is Essential
Why an Emergency Response?

- If we wish to avoid a 4°C world:
  - We have less than 5 years to see global emissions peak, then decline rapidly at 5-9% pa.
    - an unprecedented challenge
  - Existing political & corporate processes will not deliver either:
    - the level of technological, social and economic innovation and implementation required
    - in time, or in substance
  - A circuit-breaker is required to move:
    - from incrementalism to rapid transformation
  - There is no alternative to an emergency war-footing approach, akin to:
    - Marshall Plan for re-construction of Europe post-WW2
    - Apollo Project
    - Mobilisation of US, UK, German economies pre-WW2

Rapid change can occur with the right incentive
we now have that incentive
Honesty is a pre-requisite
- the challenge is far greater than we are being told

- Emission reductions of:
  - 50% by 2020, not 5%
  - 100% by 2050, not 60%
  - and re-absorption of some carbon from the atmosphere

- Take Peak Oil seriously
  - and prepare

- Mitigation & Adaptation to climate change and resource scarcities must become major focus of global and national security policies now:
  - not deferred to the medium – long term
How to do it?
- initial steps

- Set out real risks & time frame of response
- Change context of debate:
  - not incremental change
  - emergency response
- Build coalition of champions, committed and prepared to speak out:
  - NGOs
  - Corporates
  - Military
  - Government – at any level
- Form “Occupy Wall-street” movement for climate emergency
- Mandate critical policy outcomes:
  - not solutions a priori
- Encourage local action
  - solutions will vary globally
Final Thoughts

This is not a “Gloom & Doom” story, but what we are currently doing is not sustainable. The climate challenge provides our great opportunity to break out of the fossil-fuel straightjacket

“The difficulty lies not in the new ideas, but in escaping from the old ones.

John Maynard Keynes

Thank you

www.safeclimateaustralia.org

itdunlop@ozemail.com.au