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Energy and climate change challenges: some Chinese context

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Southern Cross University
Tweed Heads, Nov. 2009

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Growing Energy and Environmental Challenges

Complex, multi-dimensional & interacting drivers

Possible Conflicts

eg. Coal vs. Gas?

Equitable supply

Energy Security
- Oil, gas & coal prices increasing & more volatile, emerging stresses on energy industries worldwide
- Australia: 'energy rich' yet emerging challenges

Climate Change
- Growing global emissions and climate change concerns yet little evidence of an effective international or national policy response to date
- Australia: High & growing per-capita emissions, significant market-based policies (CPRS, eRET) coming yet coherent & comprehensive?

Societal welfare
- Unsustainable energy use & emissions in industrialised world, unsustainable growth in emerging economies & unsustainable lack of energy services in developing countries

Possible Synergies

Renewable Energy

Cost-effective Energy Efficiency

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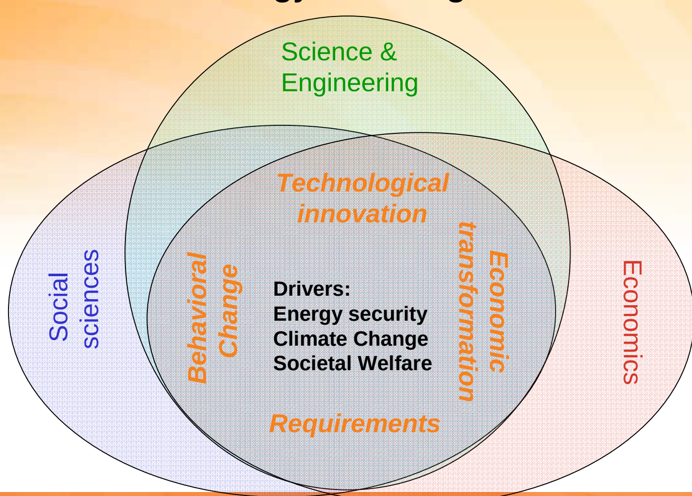
Key interdisciplinary perspectives & tools required to address our energy challenges



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Some current CEEM research efforts

- **Renewable energy policy support options in restructured electricity industries**
  - **expanded Renewable Energy Target, feed-in tariffs**
- **Emissions Trading Schemes + options for Australia**
- Facilitating wind and PV integration in the NEM
  - Energy market design, forecasting and operation
- Modelling participant behaviour in energy + environmental markets
  - Interactions between spot and derivative markets
- Technology assessment for sustainable energy policy frameworks
  - Energy efficiency, gas + cogeneration, renewables, CCS, nuclear
- Economic modelling of Distributed Energy
- Energy efficiency policy – regulation, financial mechanisms
- Policy frameworks for technology innovation
- Sustainable energy services in the developing world

Sustainability of energy systems

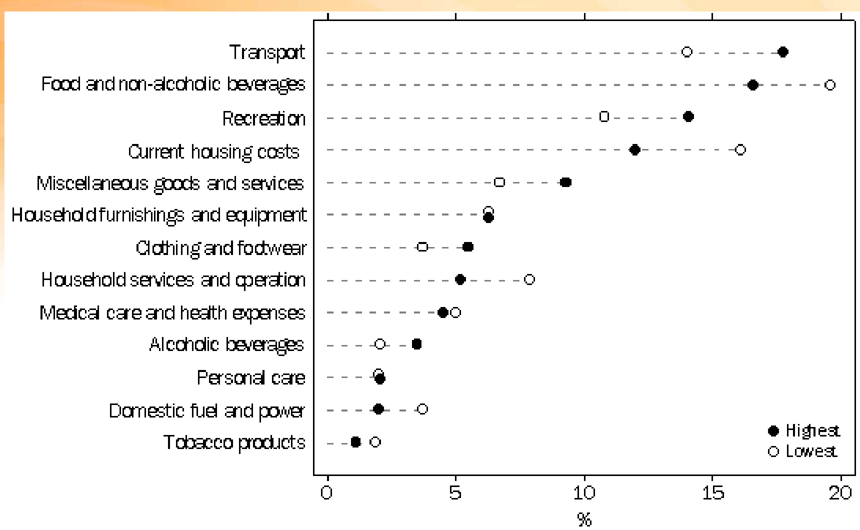
- Two key sustainability criteria
  - – delivery of adequate energy to meet societal needs and enable ongoing human development and welfare
    - *Note importance of energy security for assured delivery of services over the short to long term*
  - – the need for energy systems that don't threaten the prospects of future generations or the integrity of our ecosystem

A snap shot…

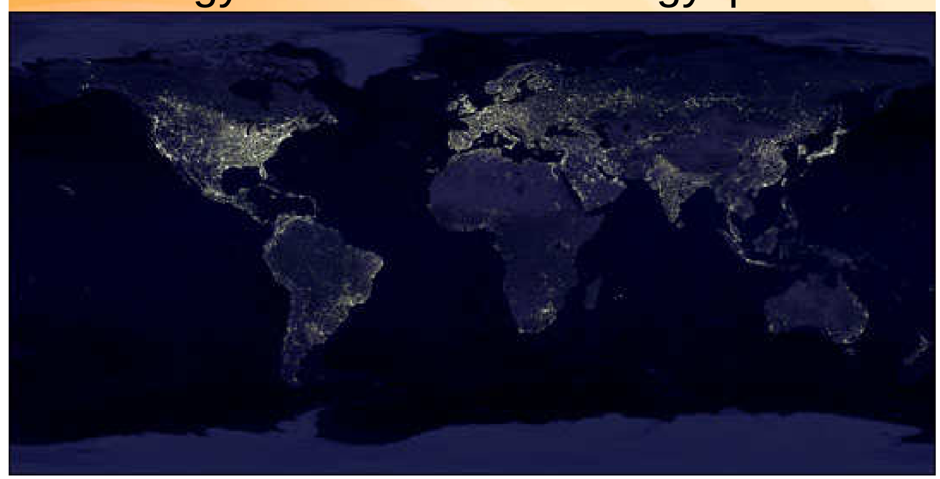
% of Global...	Population	GDP	Energy Production	Energy Consumption	Fossil-fuel GHG emissions
Australia	*0.3*	*1.3*	*2.3*	*1.0*	*1.3*
China	21	5.4	14	15	18
India	17	1.7	4.2	5.1	4.1
United States	4.6	31	15	21	22
Japan	2.0	14	0.9	4.8	4.6
Korea	0.8	1.8	0.3	1.9	1.7
Germany	1.3	5.6	1.2	3.1	3.2

(IEA, *World Energy Statistics 2006*)

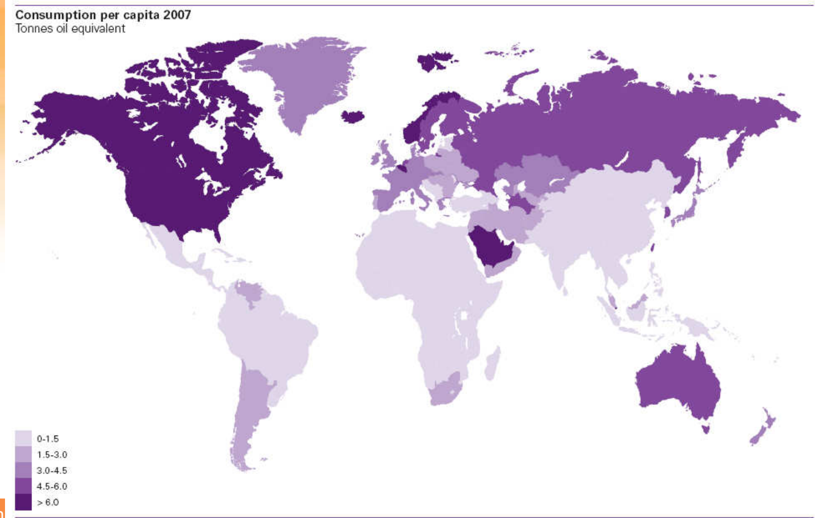
Energy services – the 'energy' rich



Energy services – the 'energy' poor



Energy consumption



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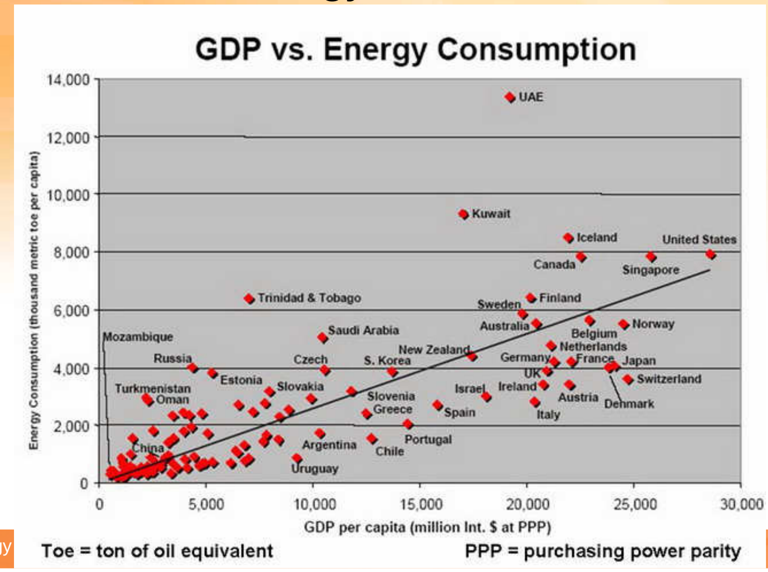
Wealth and energy



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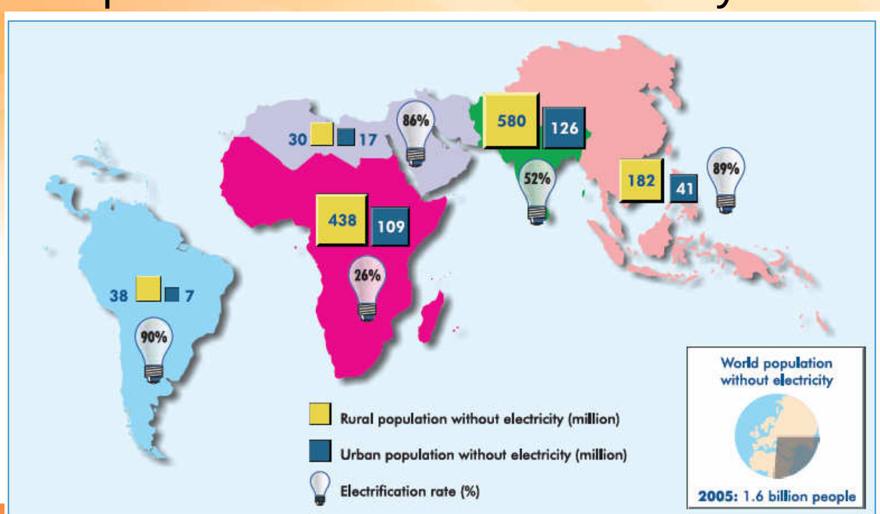
People without access to electricity



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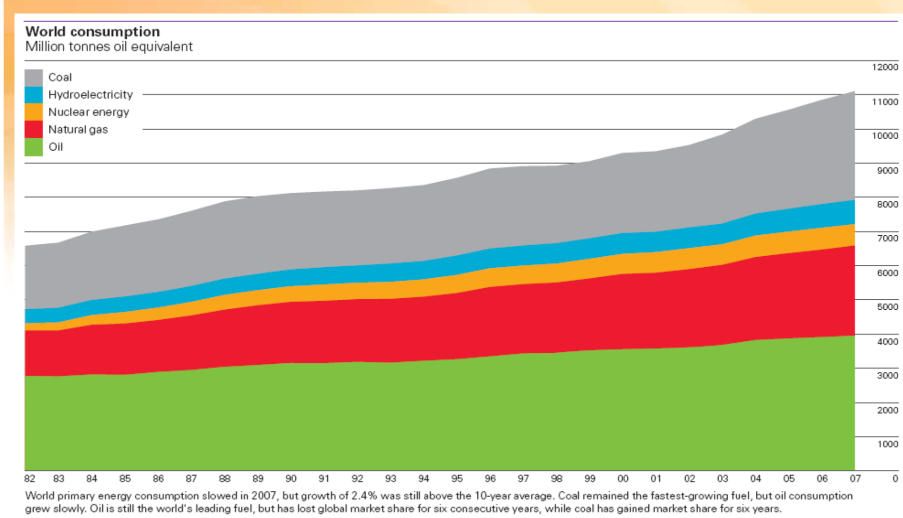
Energy security? World energy consumption



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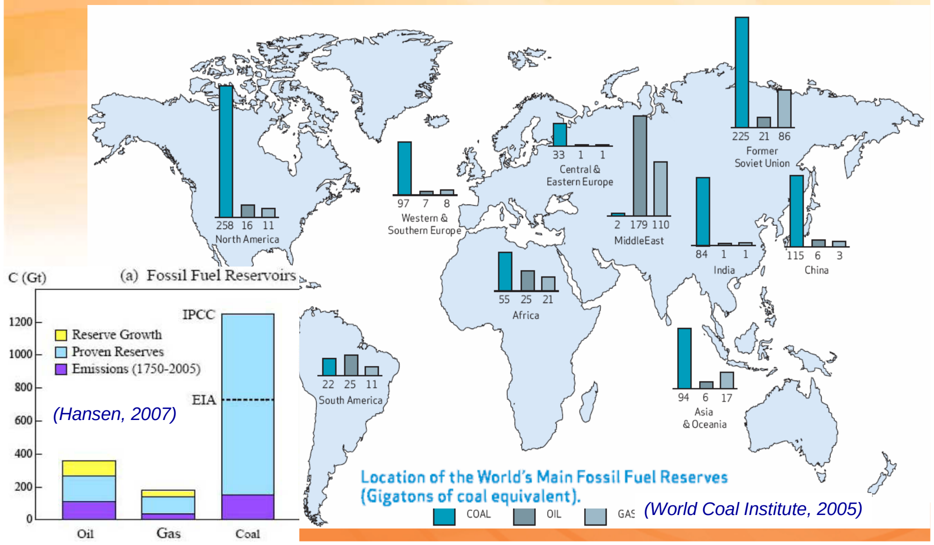
Estimated fossil fuel resources



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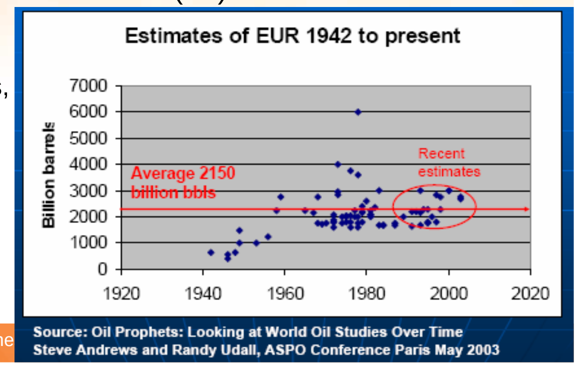
How much oil is there? The $64 trillion question

- Currently using around 31bbl/year / ~1000 bbl so far
- Reserves - the 3 Ps:
  - Proved reserves (1P)
  - Proved and Probable reserves (2P)
  - Proved, Probable and Possible reserves (3P)
- Conventional and non -conventional resources?
- Impact of new technologies, changing prices?



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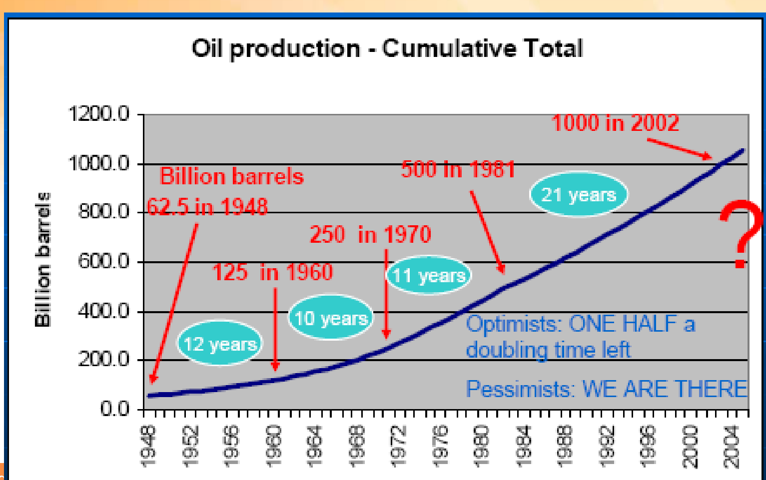
Given present trends in oil consumption..

- A key issue is non-conventional resources



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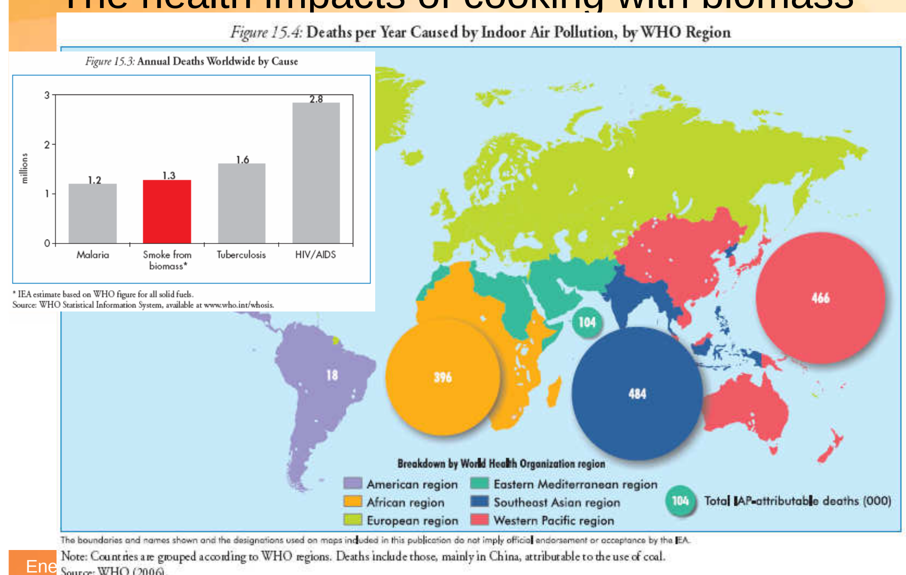
The health impacts of cooking with biomass



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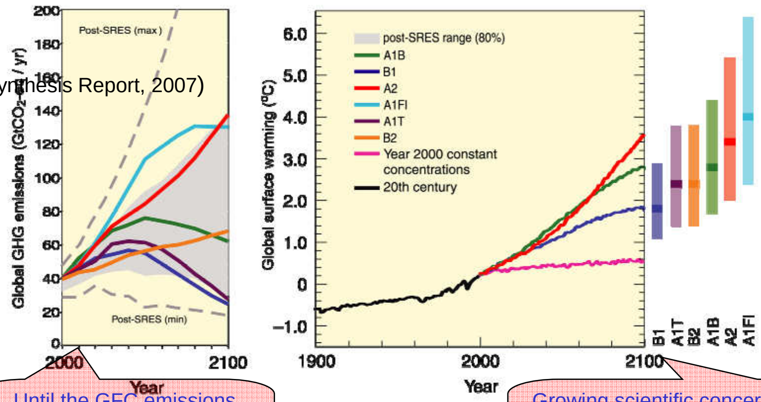
Global warming scenarios from IPCC FAR

Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies) and projections of surface temperatures

(FAR Synthesis Report, 2007)



Until the GFC emissions had been tracking above 'worst case' IPCC scenario

Growing scientific concerns that FAR significantly under-estimates potential warming

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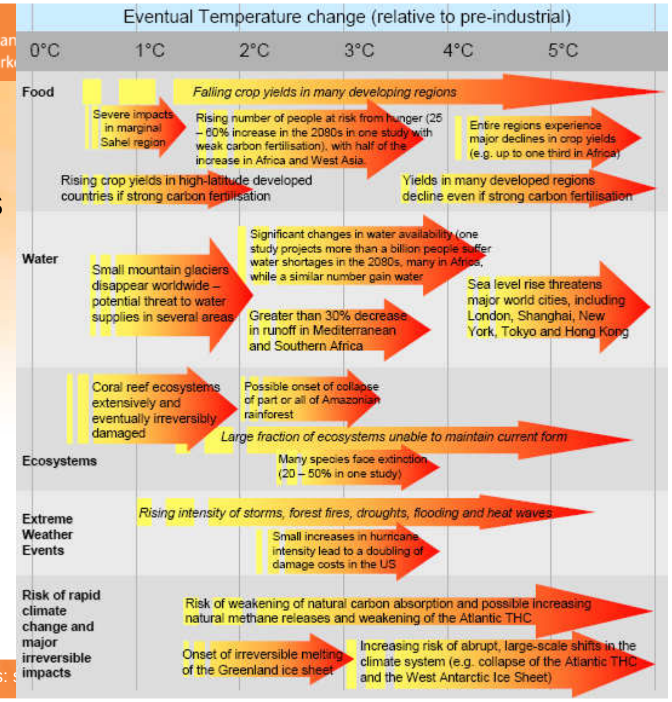
Stern Review take on impacts



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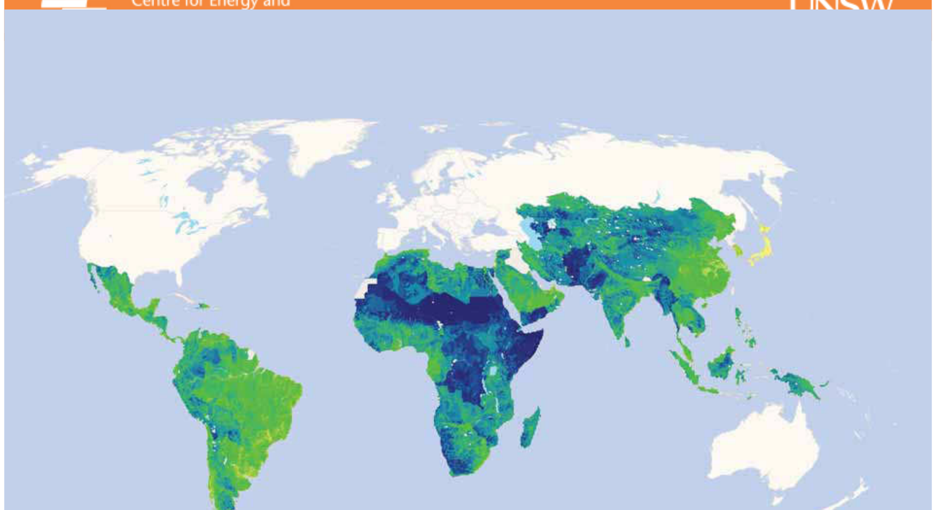


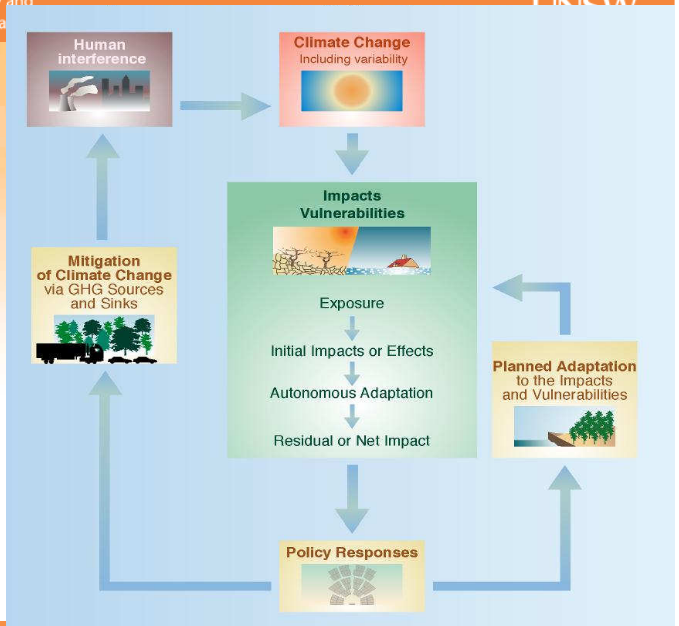
Estimated "Overall human vulnerability based on a combination of natural, human, social, financial and physical factors. Areas shown in darkest blue are likely to be most at risk if exposed to extreme weather, such as floods, cyclones and droughts, or other impacts of climate change"
(OCHA, Humanitarian Implications of Climate Change, 2008)

Global meltdown

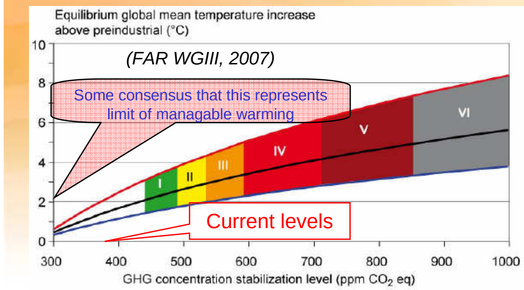
A tipping point is the place of no return. This map shows the risk of different tipping points being passed this century if global warming continues at 3-5C

(Lenton et al, National Academies of Science, 2008)

Our challenge *and/or* opportunity – adapt and/or mitigate



Avoiding dangerous warming - stabilisation



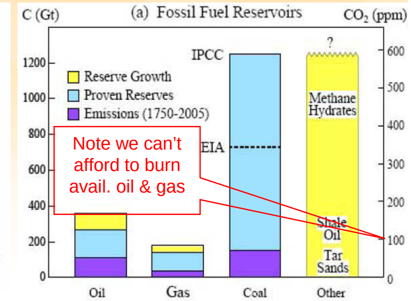


Table SPM.5: Characteristics of post-TAR stabilization scenarios [Table TS 2, 3.10][a)]

Category	Radiative Forcing (W/m[2)])	CO_2 Concentration[c)] (ppm)	CO_2-eq Concentration[c)] (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[b), c)] (°C)	Peaking year for CO_2 emissions[d)] (year)	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[d)] (%)	No. of assessed scenarios
I	2.5 – 3.0	350 – 400	445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50	6
II	3.0 – 3.5	400 – 440	490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30	18
III	3.5 – 4.0	440 – 485	535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5	21

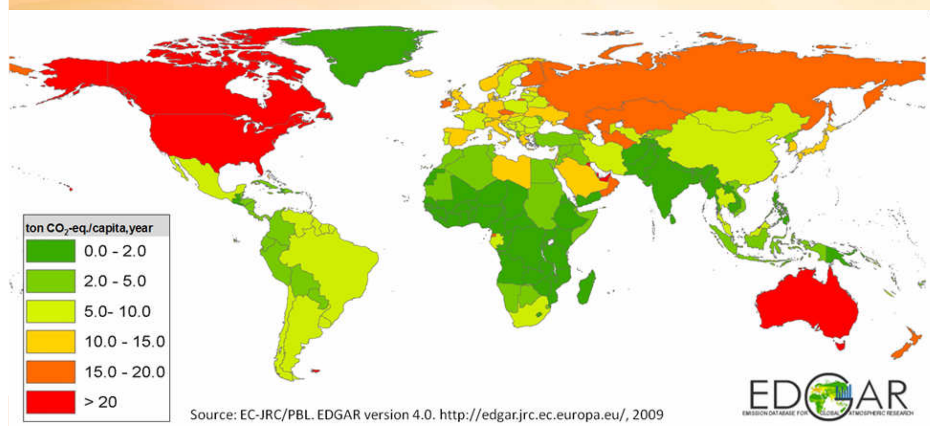
Another viewpoint – the carbon budget…

- "Applying [Potsdam Institute Director Hans Joachim Schellnhuber in The Guardian of 10 September: Developed countries are 'carbon insolvent'] logic to Australia...
  - The total carbon budget 2050 to have a 2-in-3 chance staying below a 2-degree temperature increase is 750 billion tCO2.
  - If you take the world population now at 6.9 billion people … and
  - then assume that the world's population has an equal right to emit carbon (a starting point which ignores historic carbon debt and responsibility), then...
  - The carbon budget per person to 2050 is 110 tCO2...
  - Australian emissions today are 20.58 tCO2 per person per year, the world's highest per capita emissions from energy use.
  - Divide that budget of 110 tonnes by the yearly figure of 20.58 and the result is :
  - The carbon budget for Australians to 2050 for a 2-degree target runs out in 5 and a bit years!
  - Or do we reckon that we have some inherent right to pour more CO2 into the air that the billions in the developing world who lack the infrastructure and standard of living that our historically high emissions have bought us?"

(David Spratt, http://climatecodered.blogspot.com, September 2009)

Who and how should we respond?

- Onus on those who've most contributed to problem + have resources to respond



Source: EC-JRC/PBL. EDGAR version 4.0. http://edgar.jrc.ec.europa.eu/, 2009

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Responsibility and capacity

(Cao, Reconciling Human Development and Climate Protection: Perspectives from Developing Countries on Post-2012 International Climate Change Policy, 2008)

FIGURE 1: ILLUSTRATION OF INCOME AND CAPACITY

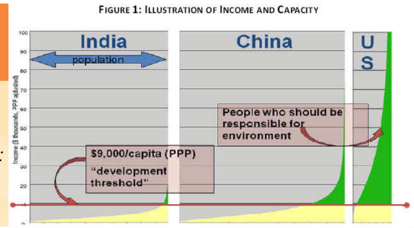

TABLE 1: GLOBAL PERCENTAGE SHARE OF POPULATION, INCOME, CAPACITY, CUMULATIVE EMISSIONS, CARBON SINK, RESPONSIBILITY AND GLOBAL RCI FOR SELECTED COUNTRIES AND GROUPS

Country	Population	Income (2005 PPP Adjusted)	Global Capacity	Cumulative Emissions 1850-2004	Carbon Sink	Global Responsibility	Global RCI*
United States	4.7	22.2	33.7	29.5	8.04	43.3	39.3
United Kingdom	0.9	3.4	4.7	6.2	0.04	8.8	6.4
Germany	1.3	4.5	6.1	7.2	0.49	10.0	7.8
France	0.9	3.3	4.5	2.9	0.43	3.9	4.5
Russia	2.2	3.0	2.0	8.2	16.77	2.8	2.4
Japan	2.0	6.9	9.4	3.9	0.70	5.2	7.8
South Korea	0.8	1.8	2.1	0.8	0.11	0.9	1.6
China	20.4	10.0	2.3	8.1	2.78	1.8	2.2
India	17.0	4.2	0.1	2.3	0.97	0.0	0.0
Brazil	2.9	2.8	2.2	0.8	19.46	0.0	0.0
South Africa	0.7	0.7	0.5	1.2	0.74	0.8	0.7
All High Income	15.6	59.1	83.4	62.1	15.70	86.7	86.9
All Middle Income	47.7	33.5	16.5	33.7	62.97	13.2	13.0
All Low Income	36.7	7.4	0.2	4.2	21.34	0.1	0.1

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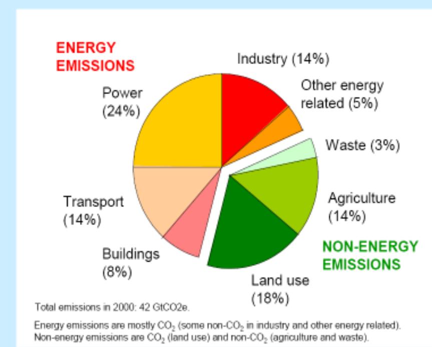
Abatement options *(Stern, 2006)*

- Reducing demand for emissions-intensive goods + services
  - Energy conservation / frugality
- Increased efficiency
  - Particularly end-use efficiency, but also in supply + distribution
  - Can save both money and emissions
- Action on non-energy emissions
  - Land-use, agriculture, waste
  - non-CO2 industrial emissions
- Switching to lower-carbon technologies for power, heat and transport
  - Renewables, Nuclear, Gas Carbon Capture and Storage

Figure 1 Greenhouse-gas emissions in 2000, by source



Source: Prepared by Stern Review, from data drawn from World Resources Institute Climate Analysis Indicators Tool (CAIT) on-line database version 3.0.

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How much of which options maximises our chances of success in meeting societal objectives, and
how best to drive such changes?

…. **is** the policy challenge

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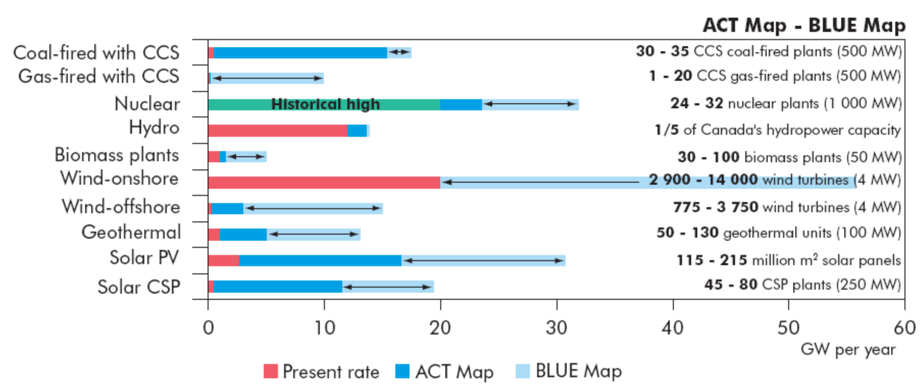
Renewables – a likely key role in low-carbon futures

- Eg. IEA *Energy Perspectives Scenarios* (BLUE = 450ppm for 2050) suggest wind, geothermal, PV and solar CSP could each make a greater contribution than coal-fired generation with CCS

Figure ES.3 ▶ Additional investment in the electricity sector in the ACT Map and BLUE Map scenarios (compared to the Baseline, 2005-2050)



China's high coal dependence for elec. gen

Table 1: Percentage of electricity generated from coal in selected countries

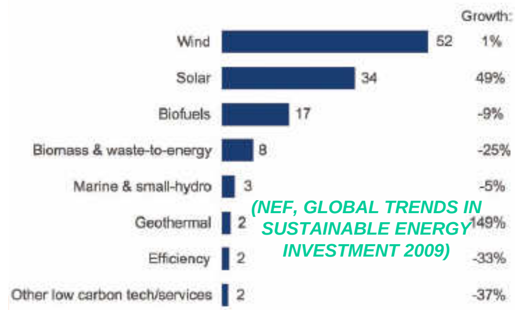
(WWF, *Coal-fired electricity and its impact on global warming*, 2003)

Country	Year	Percent of electricity from coal	Trend since 1990
Poland	2000	96	Steady at saturation
South Africa	2000	about 92	rising slightly towards saturation
Australia	2000	78	Steady
PR China	1999	75	small increase over the decade
India	1999	75	small increase
Czech Republic	2000	73	Steady
Germany	2000	53	fallen slightly
USA	2000	52	Steady
Denmark	2000	47	big decline as gas and wind increase
Korea	2000	42	big increase
UK	2001	37	big decline since 1986
Japan	2000	22	big increase
Thailand	1999	18	small decrease
Vietnam	1999	12	big decrease

China a serious player in an increasingly serious sustainable energy global market

2008 was the first year that new power generation investment in renewables was greater than investment in fossil-fueled technologies

Figure 8: Financial new investment by technology, 2008, and growth on 2007, $ billions



(NEF, GLOBAL TRENDS IN SUSTAINABLE ENERGY INVESTMENT 2009)

China launches green power revolution to catch up on west

- Plan to hit 20% renewable target by 2020
- $30bn for low-carbon projects

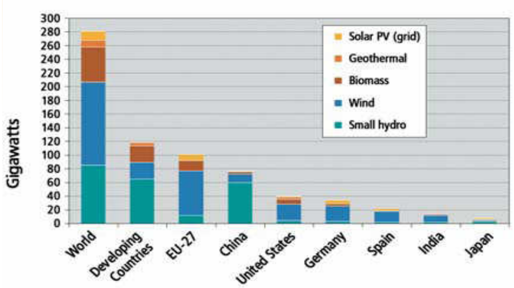
阅读中文 | Read this in Chinese

China's ambitious wind and solar plans represent a direct challenge to Europe's claims of world leadership on cutting carbon emissions. Photograph: Keren Su/Getty

China is planning a vast increase in its use of wind and solar power over the next decade and believes it can match Europe by 2020, producing a fifth of its energy needs from renewable sources, a senior Chinese official said yesterday.

Current renewables status *(REN21, 2009 Update)*

Figure 4.
Renewable Power Capacities, Developing World, EU and Top Six Countries, 2008



Note: Excludes large hydropower

Figure 2.
Wind Power Capacity, Top Ten Countries, 2008

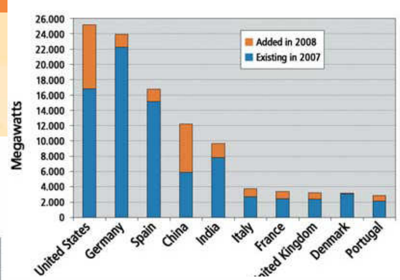
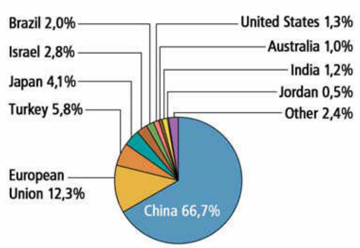


Figure 5.
Share of Solar Hot Water/Heating Capacity Existing, Top 10 Countries, 2007

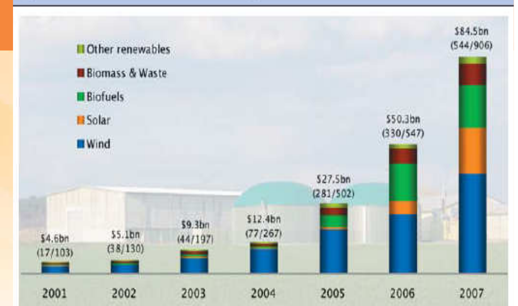


Total = 126 gigawatts-thermal

China $investment in sustainable energy

(NEF, GLOBAL TRENDS IN SUSTAINABLE ENERGY INVESTMENT 2008)

Figure 30. Asset finance new investment by Sector, 2001-2007



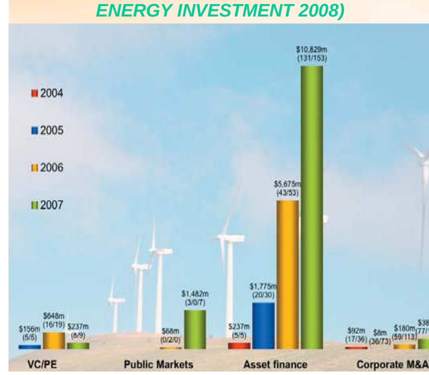
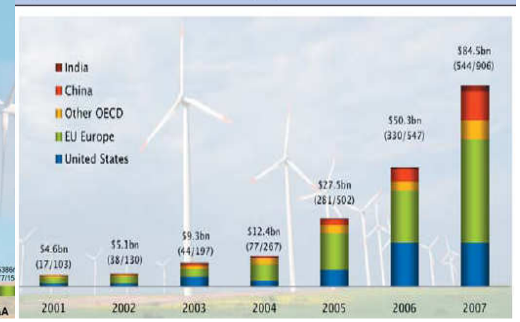


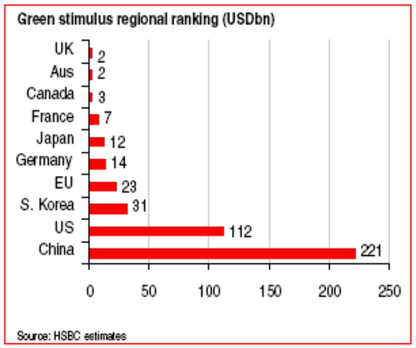
Figure 31. Asset finance new investment by region, 2001-2007

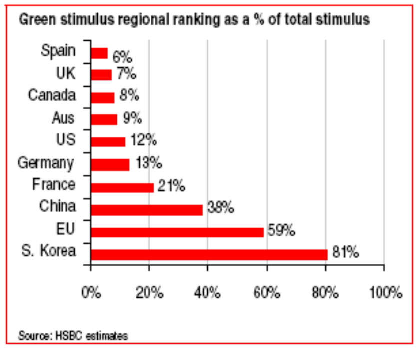


GFC and green stimulus *(HSBC, 2008)*

A Climate of Recovery? The climate change investment dimension of economic stimulus plans

Country	Fund USDbn	Period Years	Green Fund USDbn	% Green Fund	Low-Carbon Power Renewable	Low-Carbon Power CCS/Other	Energy Efficiency (EE) Building EE	Energy Efficiency (EE) Lo C Vech+	Energy Efficiency (EE) Rail	Energy Efficiency (EE) Grid	Water/Waste
Asia Pacific											
Australia	26.7	2009-12	2.5	9.3%	-	-	2.48	-	-	-	-
China	586.1	2009-10	221.3	37.8%	-	-	-	1.50	98.65	70.00	51.15





Carbon markets: How does emissions trading work?

Mechanics of a cap and trade scheme

Emitters of greenhouse gases need to acquire a permit for every tonne of greenhouse gas that they emit.

The quantity of emissions produced by firms will be monitored, reported and audited.

At the end of each year, each liable entity will need to surrender a permit for every tonne of emissions that they produced in that year.

The number of permits issued by the Government in each year will be limited.

Firms will compete to purchase the number of permits that they require. Firms that value the permits most highly will be prepared to pay most for them, either at auction or on a secondary trading market. For some firms, it will be cheaper to reduce emissions than to buy permits.

Certain categories of firms will receive an administrative allocation of permits, as a transitional assistance measure. Those firms could use the permits or sell them.

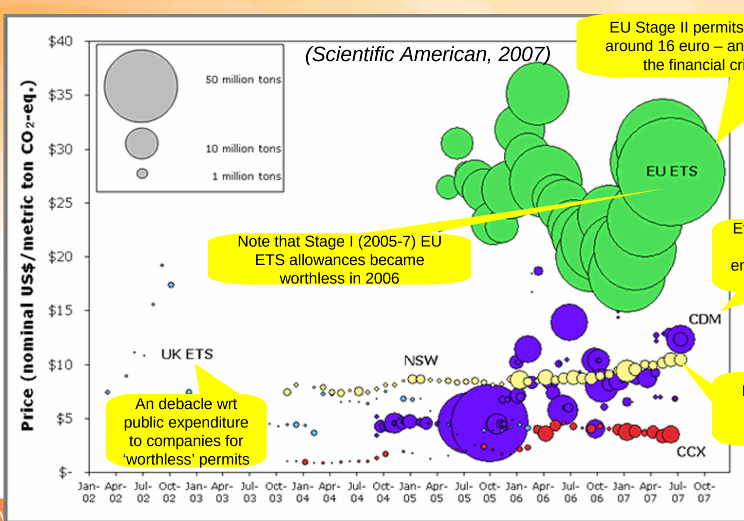
What policy role can ETS play?

- *Nothing new about a price on carbon – some carbon already highly valuable: change is to add an additional price reflecting climate externality*
- ETS only effective wrt its ability to drive changes, operational but especially investment, in markets that drive physical emissions
- In theory, assuming idealised markets,
  - universal ETS only policy required
  - any additional climate change policies can only increase the cost of meeting the cap while not changing its environmental effectiveness
- In practice, emissions trading markets + the markets they have to drive
  - suffer from wide range of market failures
  - may struggle to appropriately 'price' uncertainties about future
  - Established by political process inevitably involving adverse compromises
- ETS contribution to policy mix
  - Major role is for driving substitution – ***if it can't do this, try another approach***
    - Will still require other policies to drive behaviour + technology innovation
  - In theory, highly compatible with other policies including market-based
    - Prices of ETS and/or other policies adjust wrt changing marginal costs

Do carbon markets actually work?

- Share many of usual policy challenges with any regulatory approach + potentially add new ones
  - Novel – learning likely required + mistakes will be made: do we have time?
  - Key decision making is investment: have to establish 'markets' that drive this appropriately
  - Inevitable complexity in attempting to match commercial market with physical actions that reduce emissions
  - Potential loss of control on decision making might see adverse impacts with other policy objectives….
  - ***These are designer markets:*** *Greatest competitive advantage for participants may lie in gaming rules and especially design process*
  - Growing appreciation of the limitations of markets? eg. GFC
  - *However, emissions trading appears to be the key policy of choice for much of the developed world – at least in part, due to its 'politics'*

Carbon market performance to date mixed



Current market status

(Ecosystem Market Place and New Carbon Finance, 2009)

Transaction Volumes and Values, Global Carbon Market, 2007 and 2008

Markets	Volume ($MtCO_2e$)		Value (US$ million)	
	2007	2008	2007	2008
Voluntary OTC	43.1	54.0	262.9	396.7
CCX	22.9	69.2	72.4	306.7
Other exchanges	0	0.2	0	1.3
Total Voluntary Markets	**66.0**	**123.4**	**335.3**	**704.8**
EU ETS	2,061.0	2,982.0	50,097.0	94,971.7
Primary CDM	551.0	400.3	7,426.0	6,118.2
Secondary CDM	240.0	622.4	5,451.0	15,584.5
Joint Implementation	41.0	8.0	499.0	2,339.8
Kyoto [AAU]	0.0	16.0	0.0	177.1
New South Wales	25.0	30.6	224.0	151.9
RGGI	-	27.4	-	108.9
Alberta's SGER[a]	1.5	3.3	13.7	31.3
Total Regulated Markets	**2,919.5**	**4,090.0**	**63,710.7**	**119,483.4**
Total Global Markets	**2,985.5**	**4,213.5**	**64,046.0**	**120,188.2**

China a key CDM player … but where next?

Figure 41. Expected CERs by country (non risk-adjusted), April 2008: (units: 2012 MtCO2e)

Carbon trade on brink of boom - or backwater

Wed Nov 18, 2009 8:44am EST

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By Nina Chestney - Analysis

LONDON (Reuters) - Emissions trading stands at a crossroads -- a future as a $2 trillion market if the United States bolsters it, or as a modest sideline to energy and commodities trade if a new climate treaty is not agreed.

Some players have bet on the growth of the $126 billion global carbon market after 2012 but regulatory uncertainty will be drawn out for another year as a deadline for a binding treaty on greenhouse gas emissions was pushed back to 2010 this week.

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Thank you… and *questions*

Comments, suggestions and corrections regarding this presentation are all welcome. Please contact Iain at i.macgill@unsw.edu.au

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