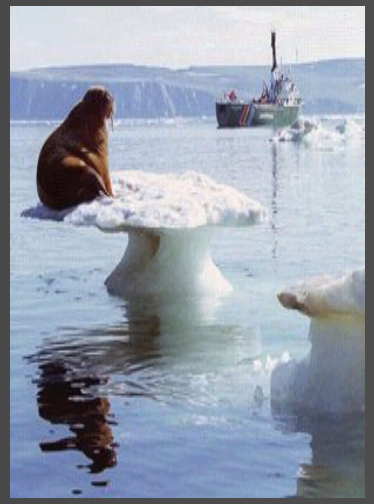


Climate Change

Rising to the challenge

Eur. Ing. Fred Dinning, C.Eng FEI FIET FCMI

Declaration of Interest



- Formerly Energy & Environment Director of ScottishPower
- Board Member SEPA (Chair of SW Board)
- Chair Carbon Trust Consultant Accreditation Panel
- Chair Energy JRI, Edinburgh Research Partnership (Edinburgh and Herriot Watt Universities)
- Convenor Church of Scotland Church and Society Council Energy/Environment Sub Group (Transport and Electricity Reports)
- Member of Sustainable Development Panel
- Early career on customer energy management with SSEB
- Worked on planning of future power plant mix with SSEB
- Worked in nuclear power sector (Hunterston and Torness)
- Led policy aspects of Longannet THERMIE Clean Coal Programme (won Queen's Award)
- Heavily involved in due diligence for coal and gas plant acquisitions.
- Hosted opening of Hare Hill Wind Farm

Spot the bias!

The evolution of environmental policy

- Science
- NGO and public pressure
- International Frameworks
- National Policy
- Detailed regime design
- Refinement and action



The evolution of public policy from science



Issue	Emerging Science	Agreed Science	International Framework	National Public Policy
Acid Rain	Various papers 1975-1990	Helsinki Protocol 1985	UN Long Range Transport Protocol 1989 (updated by subsequent Protocols – latest Gothenburg 1999	US Clean Air Act 1990 – various Rules and trading established therunder up to present day (including Clear Skies Proposal) EU Acidification Strategy 1997 – IPPC, LCPD (1987, 2003 current review)
Mercury	Various Papers 1986-1996	Bad Harzburg Workshop set levels for soils and water.	Aarhus Protocol on Heavy Metals (1998)	US – Mercury Rule due in 2005 for implementation by 2010 or so EU – Mercury Strategy under discussion for implementation via IPPC around 2012 onwards
Climate Change	International Panel on Climate Change (IPCC) established 1988	IPPC reports, 1990, 1995 (highly probable human impact on Climate), 2001, due 2007	United Nations Framework Convention on Climate Change 1992 Kyoto Protocol 1997 (yet to come into force)	US – CO2 intensity measures proposed under Clear Skies 2001 EU - Climate Change Programme 2002, Emissions Trading 2004

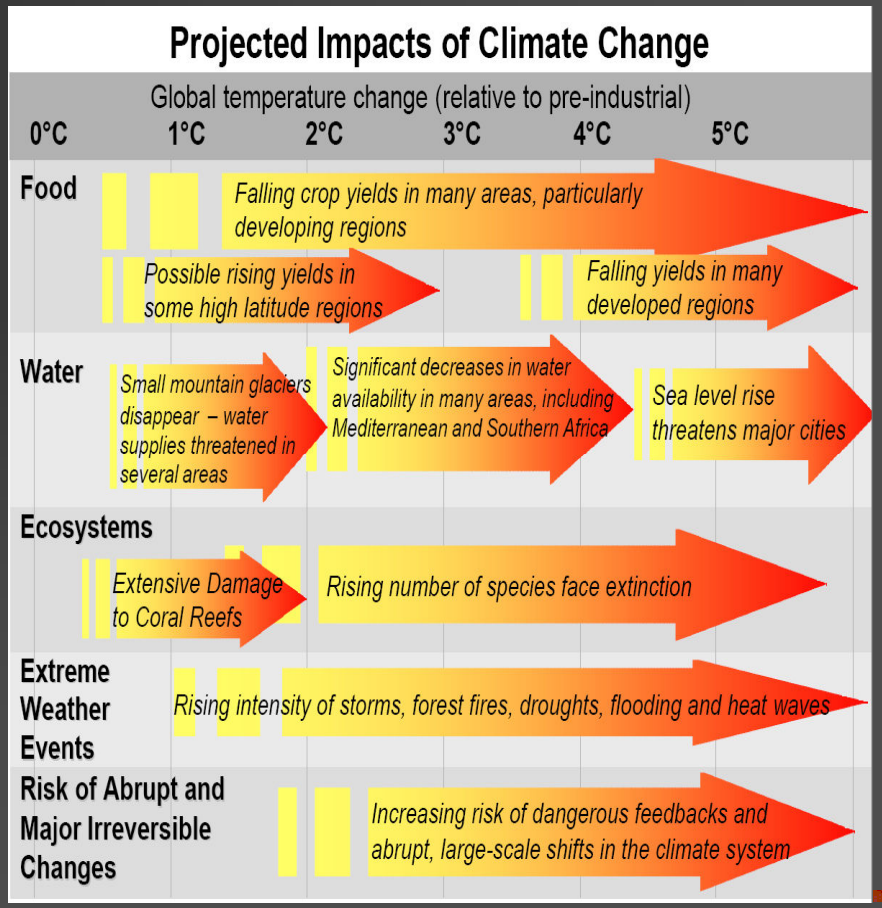
Business and industry responses

- Oppose/lobby
- Compliance
- Marketing
- Risk Management
- Business Strategy
- Just part of business



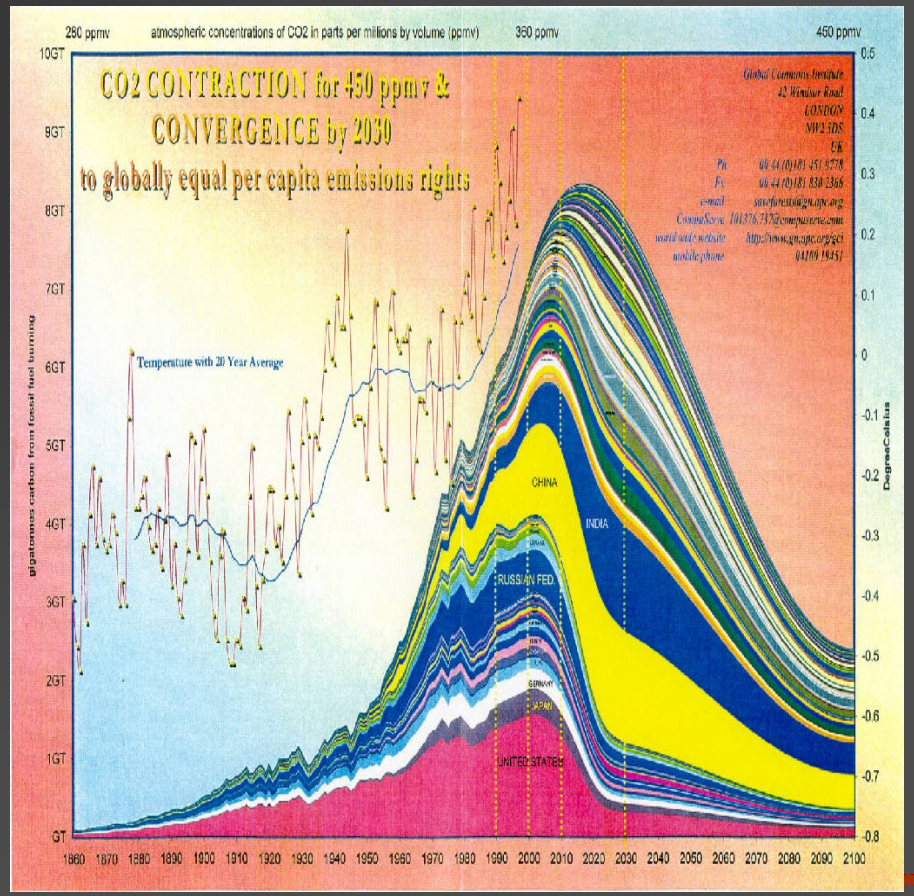
Climate Change Policy –where are we?

- Science
  - IPCC Fourth Assessment Report 2007
  - UKCIP 2008
- Economics
  - Stern (5-20% of GDP)
- Policy responses
  - Mitigation
    - Post Kyoto
    - EU Measures
    - Climate Change Bill etc.
  - Adaptation
    - Strategic Environmental Assessment
    - Planning Policy etc.



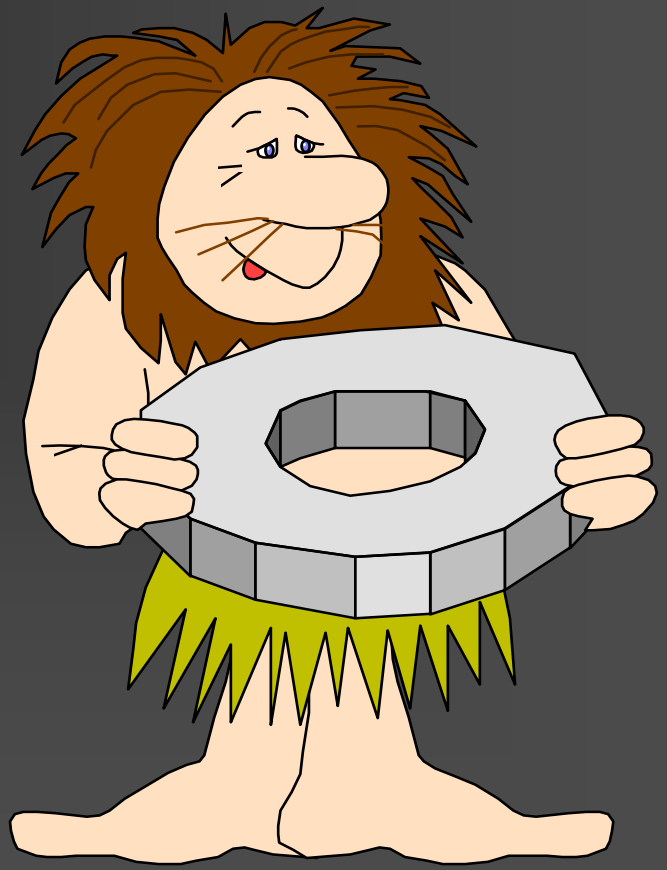
International Context

- UNFCC
  - Poznan
  - Copenhagen
- Key issues
  - Target
  - allocation
  - participation
  - Use of markets
  - Future of CDM/JI
- EU Commitments
  - (30% CO2 reduction by 2020)
  - 30% of energy from renewables by 2020
  - Future of EUETS (aviation etc.)



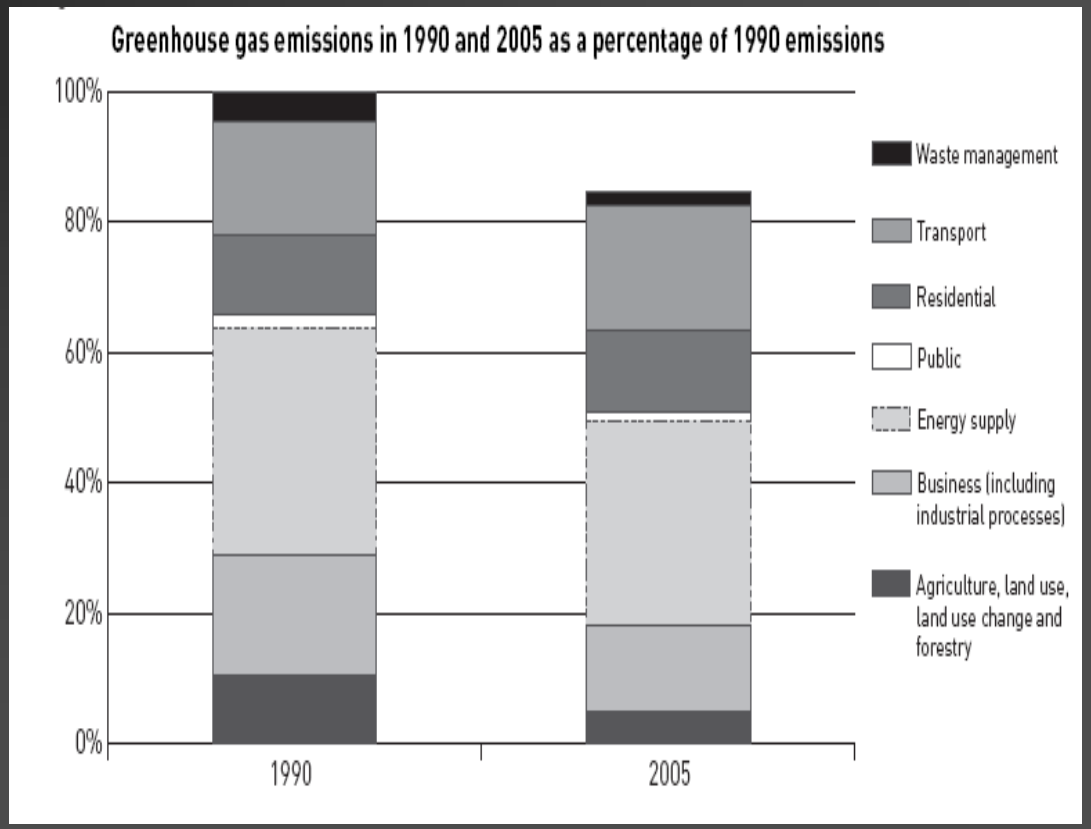
Scottish Climate Change Bill

- 80% reduction of all Greenhouse Gases (not just CO2)
- Inclusion of international shipping and aviation
- Year on year targets
- 50% by 2030 interim
- Sanctions?
- Limited use of international mechanisms (80% domestic)?
- Possible Scottish Committee on Climate Change
- Duties for Public Bodies
- Difficult (and unresolved) questions
  - Fit with Kyoto successor
  - Imports/exports
  - etc. etc.



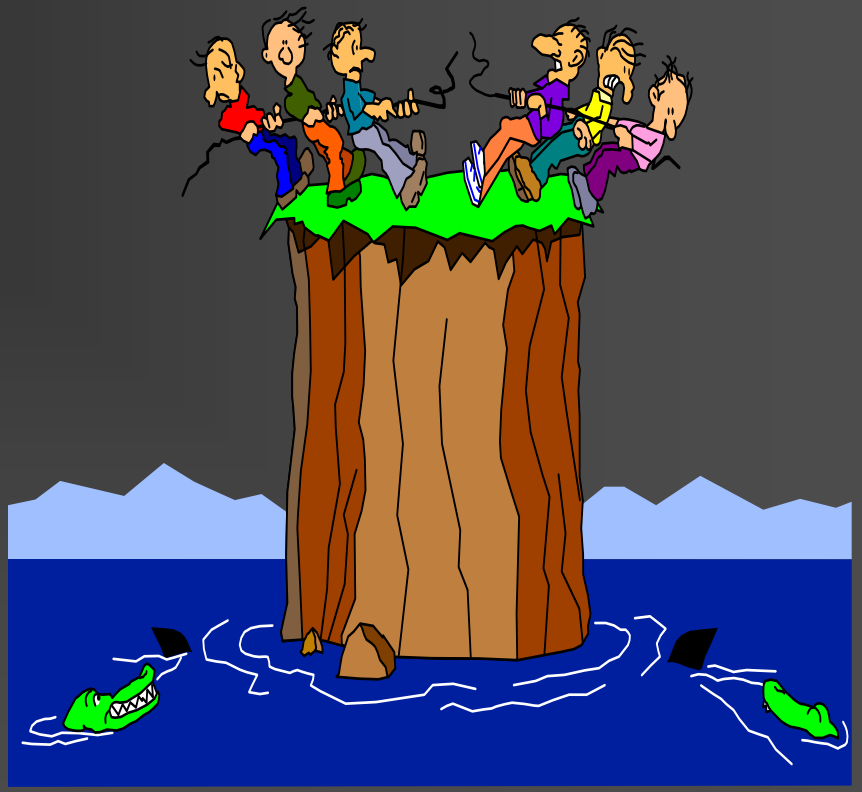
Principal sources of Greenhouse Gas Emissions in Scotland

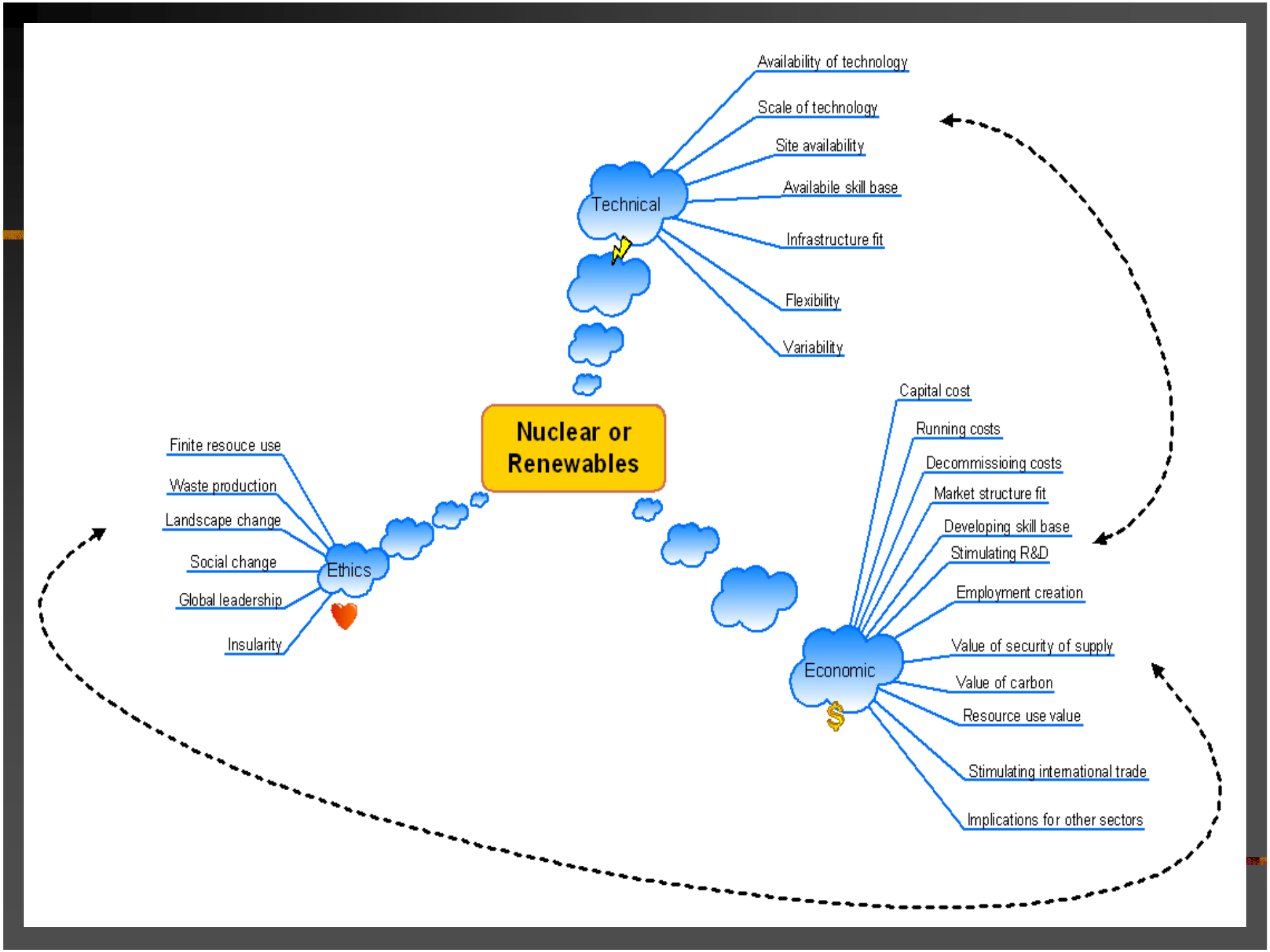
- Energy Supply
- Business
- Residential
- Transport
- Land Use



How should we do it?

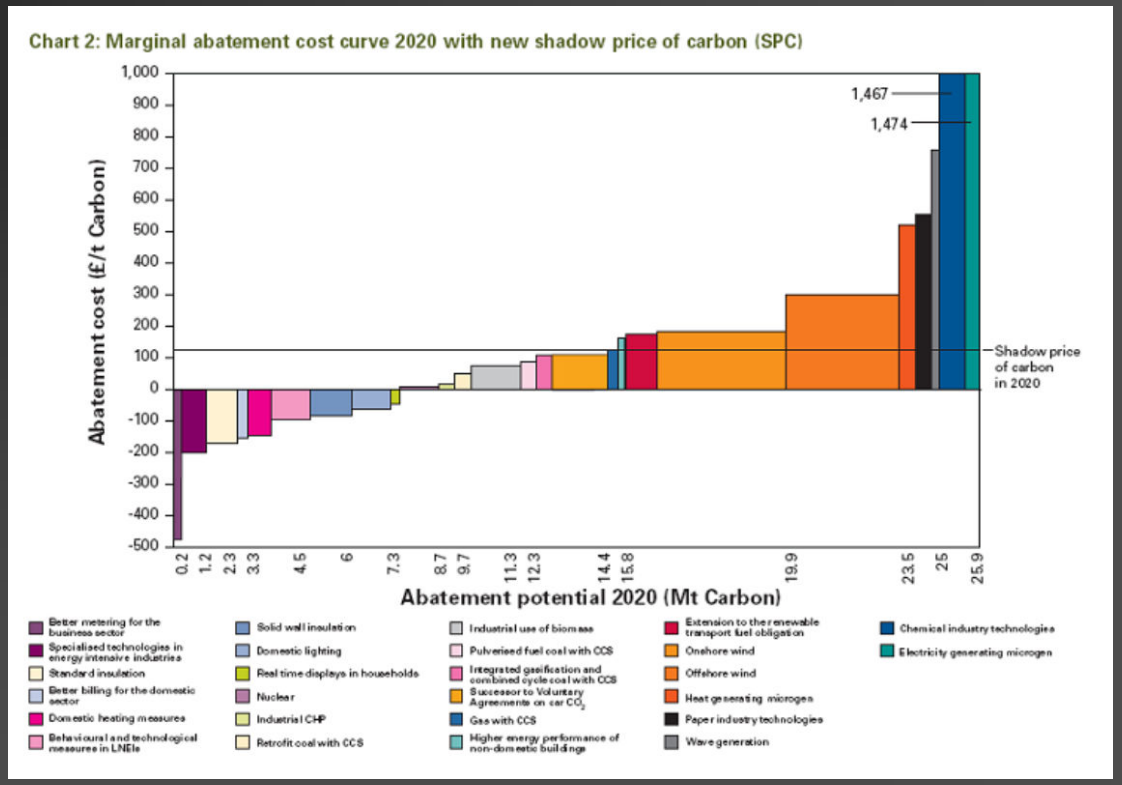
- Economics, markets and ethics?
- Technology
  - Engineering
  - Bioscience
- Lifestyle change
  - Reduced travel
  - Reduced consumption
  - ‘One planet living’
- Impact sector by sector




Nuclear or Renewables
Technical
Availability of technology
Scale of technology
Site availability
Availabile skill base
Infrastructure fit
Flexibility
Variability
Economic
Capital cost
Running costs
Decommissioing costs
Market structure fit
Developing skill base
Stimulating R&D
Employment creation
Value of security of supply
Value of carbon
Resource use value
Stimulating international trade
Implications for other sectors
Ethics
Finite resouce use
Waste production
Landscape change
Social change
Global leadership
Insularity

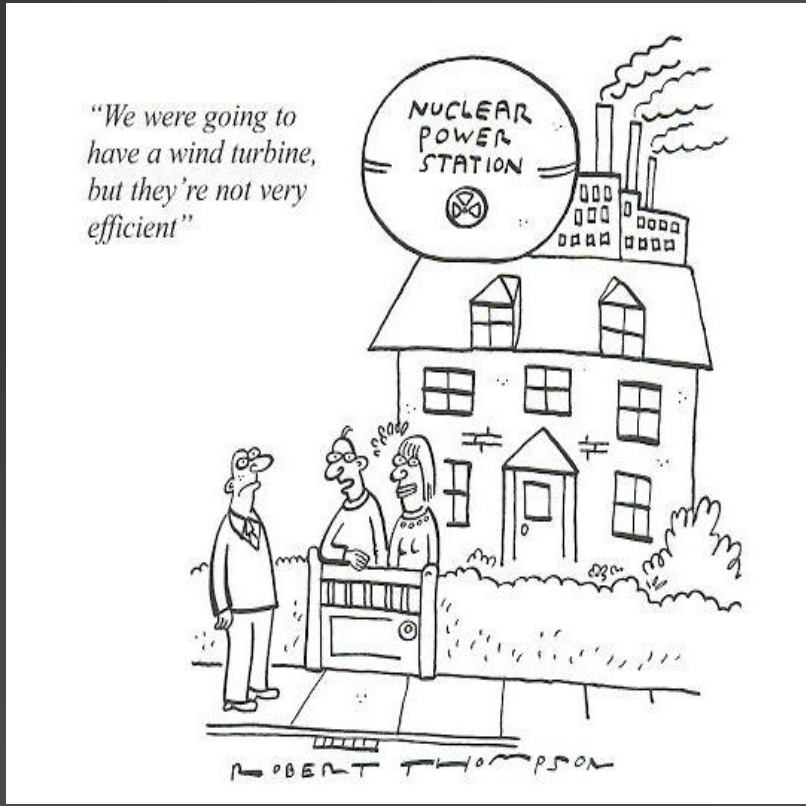
Abatement Options

- Electricity
- Heating
- Transport
- Road
- Rail
- Shipping
- Aviation

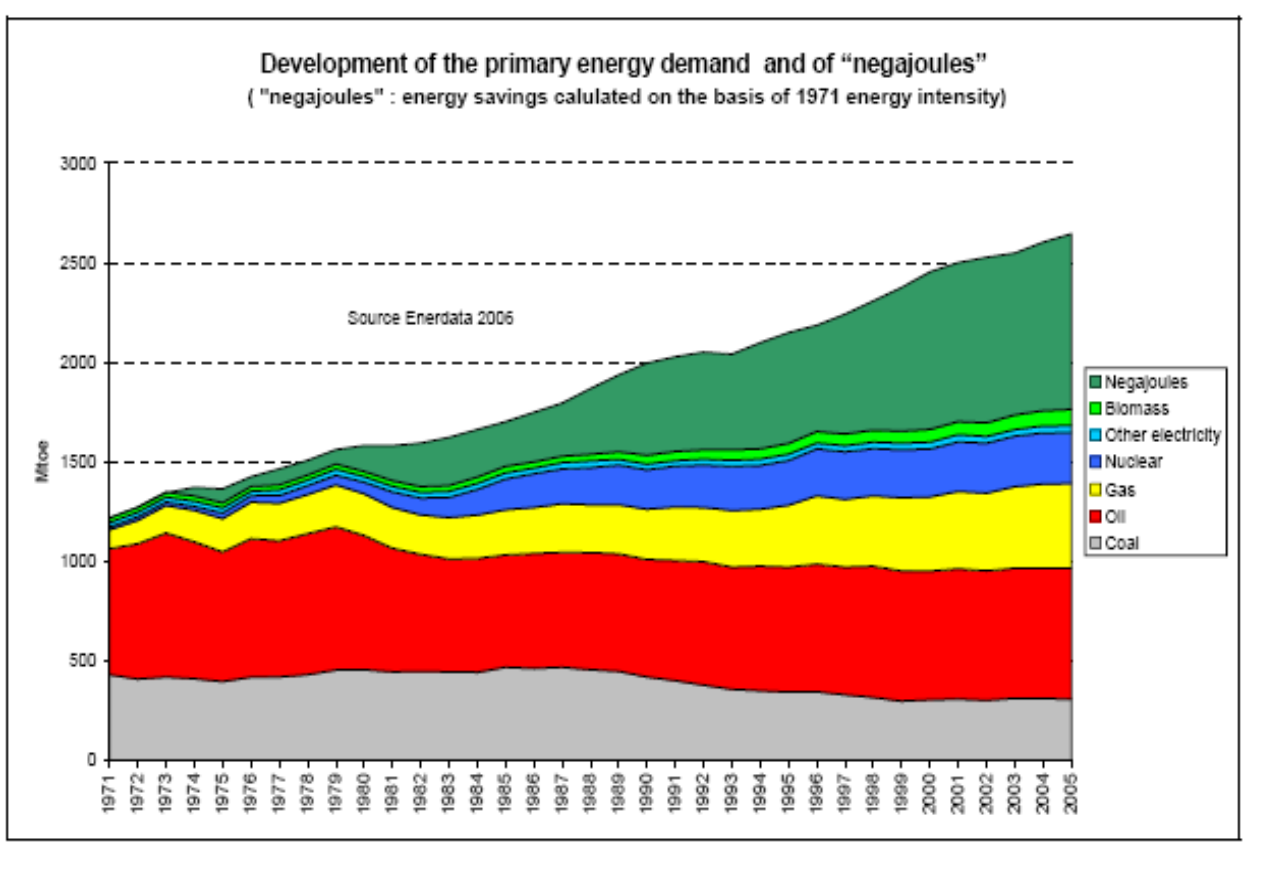


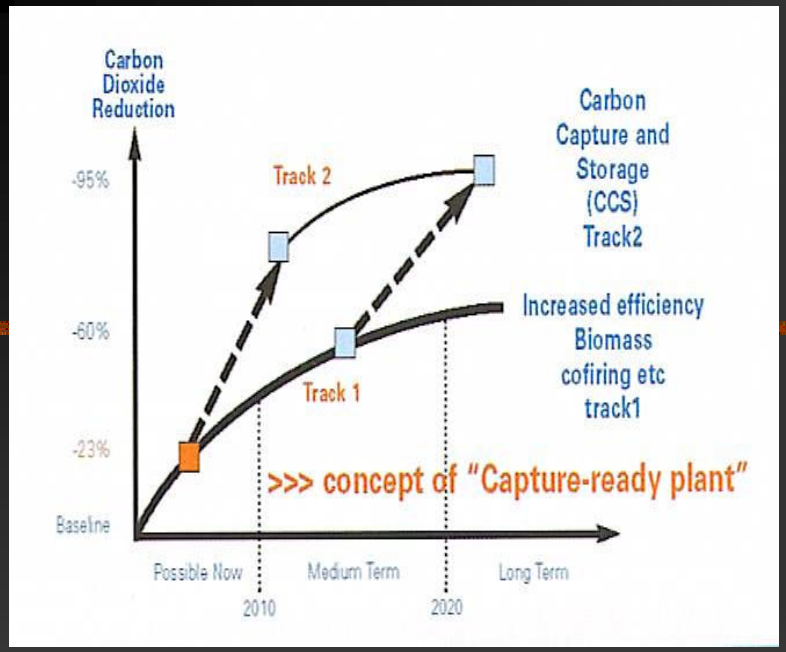
Electricity

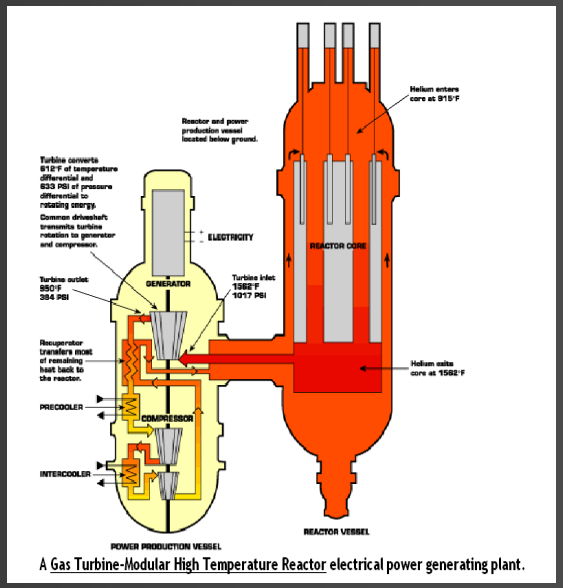
- Energy Efficiency
- Renewable Energy
- Fossil Fuels with Carbon Capture and Storage
- Nuclear



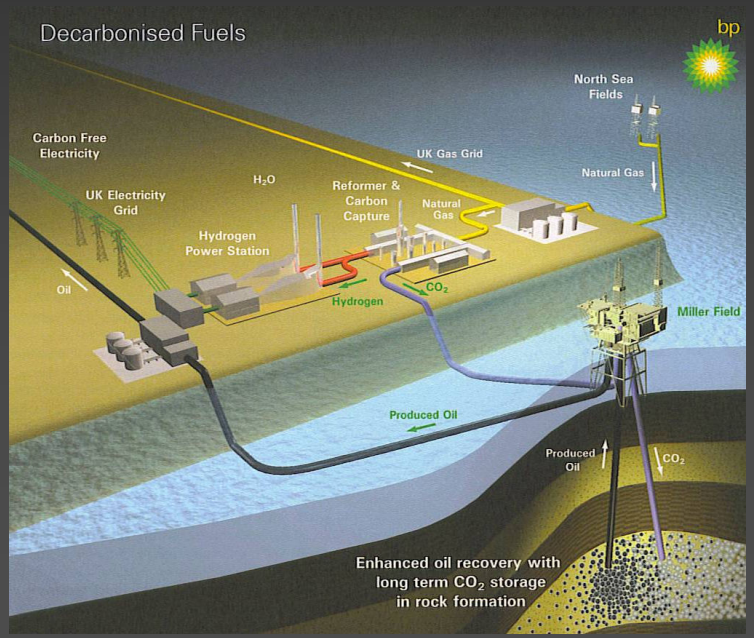
Value of ‘Negajoules’

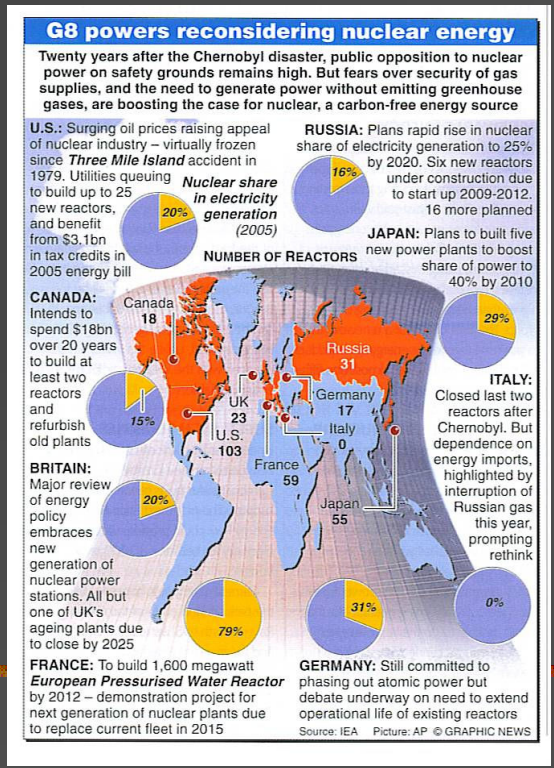






A Gas Turbine-Modular High Temperature Reactor electrical power generating plant.





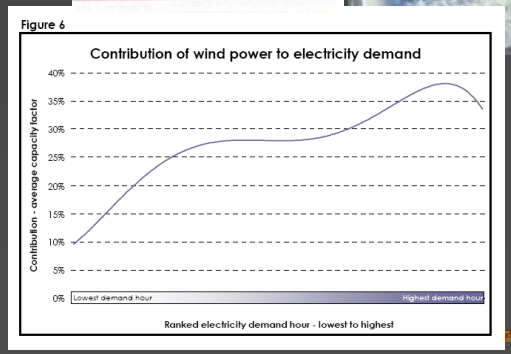
Scotland's renewable potential

Technology	Constrained Capacity (GW)
Offshore Wind	2.5
Wave Energy	3
Onshore Wind	3
Tidal stream	0.4
Agriculture	0.4
Small hydro	0.3
Energy Crops	0.14
Forestry Residues	0.09
Landfill Gas	0.07
Municipal Solid Waste	0.1
Total	**10**

Garrad Hassan and Partners data

ΦΡΕΔΣ Ρεπορτ 6ΓΩ βψ 2020

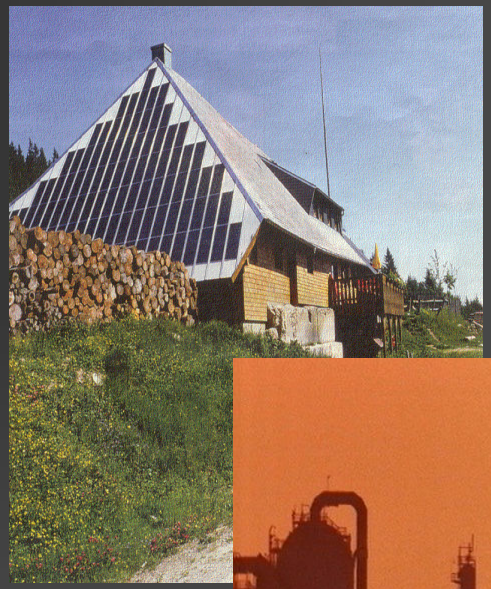




Source Oxford University Environmental Change Institute 2005

Heat – Domestic and Industrial

- Conservation
- Building design
- Fuel source switch (biomass)
- Renewable heat vs waste heat
- Location
- CHP
- Microgeneration





Transport

- Road
  - EU Efficiency measures
  - Future vehicle designs – hybrid/electric
  - Hydrogen
- Rail
  - Efficiency
  - Electric traction
- Shipping
  - Sail?
  - Hydrogen
- Aviation
  - Efficiency
  - Hydrogen??



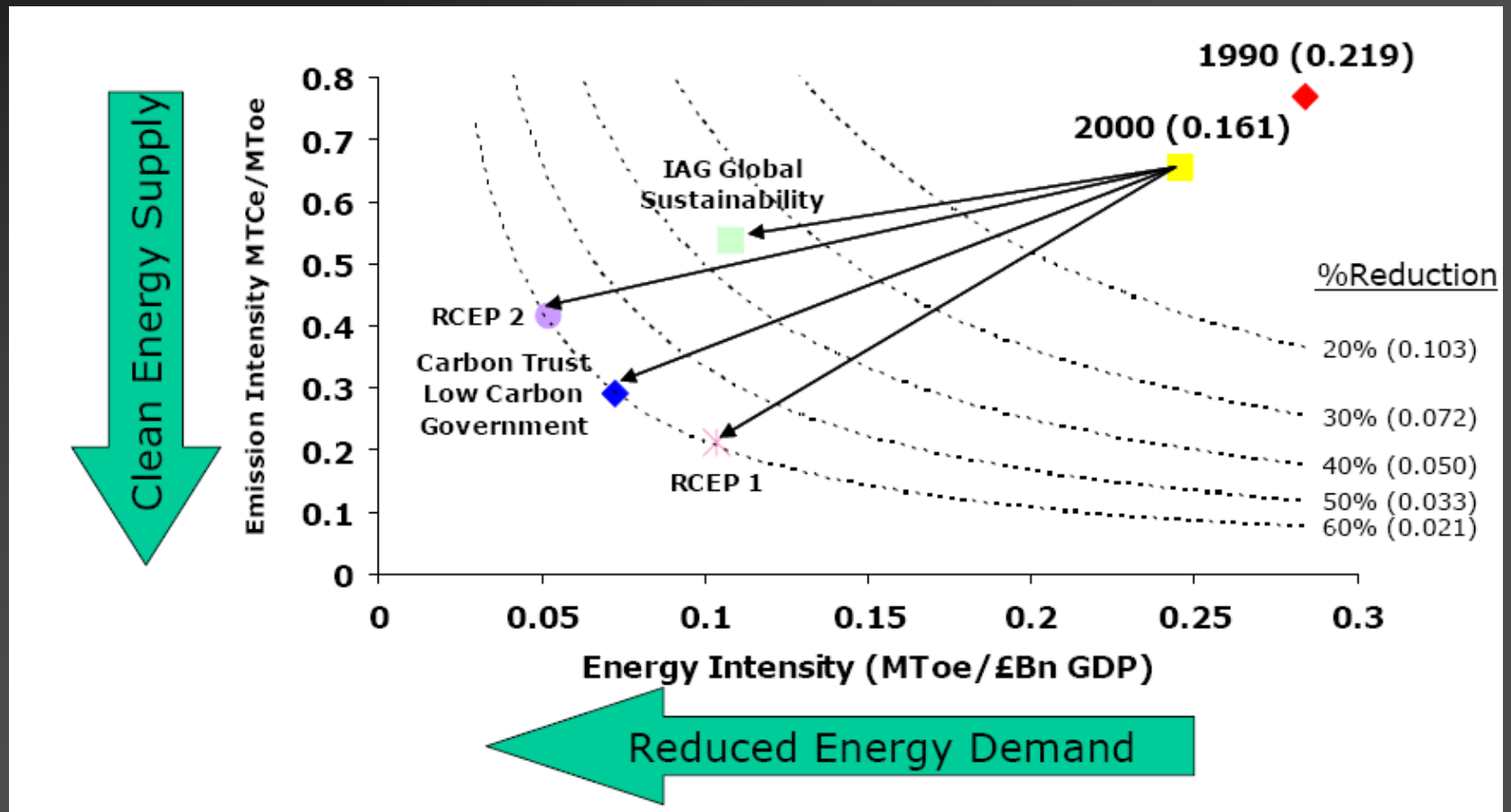
Can it be done?

- RCEP
  - 60% reduction
  - Electricity only
  - 4 scenarios
  - Proven or near proven technologies
- Tyndall Centre
  - 60% reduction
  - CO2
  - All sectors
  - Backcasting approach
- Other studies
  - FREDS
  - Low Energy House
  - WWF
  - Etc.





Pathways to a low carbon economy



Note: Figures in brackets show UK Carbon Intensity (MtCe/£Bn), Scenarios show 2050 projections
Source: RCEP 1998, DTI EP68 GDP growth forecasts, IAG "Long-term Reductions in GHG in the UK", Feb 2002

The RCEP Scenarios –making the choice clear?

Number of generating plants required in 2050 under the four scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Large onshore wind farms (100 turbines each)	50	25	2	25
Small onshore wind farms (10 turbines each)	510	250	16	252
Large offshore wind farms (100 turbines each)	180	177	180	88
Photovoltaic roof installations (average peak output 4kW)	15 million	7.5 million	0.75 million	0.75 million
Wave power units (1MW capacity)	7,500	7,500	7,500	7,500
Tidal stream turbines (1MW capacity)	500	500	500	500
Tidal barrage	1	1	1	1
New small scale hydro	4,500	4,500	4,500	2,200
CHP plants fuelled by energy crops (capacity 1-10 MW)	290-2,900	290-2,900	42-420	42-420
CHP plants fuelled by agricultural and forestry wastes (capacity 0.5-10 MW)	53-1,050	53-1,050	53-1,050	34-688
CHP plants fuelled by municipal	3-20	3-20	0	0
Baseload plants:either nuclear or fossil fuel with carbon dioxide recovery and disposal (capacity 1,200 MW)	46	0	19	0
Domestic (micro) CHP units using gas (2kW)	0	1.7 million	1.8 million	2.4 million
Fossil fuel plants to back up intermittent renewables (capacity 40MW)	1,000	760	475	460
Fossil fuel plants for meeting peak electricity demand (capacity 400 MW)	120	70	65	55

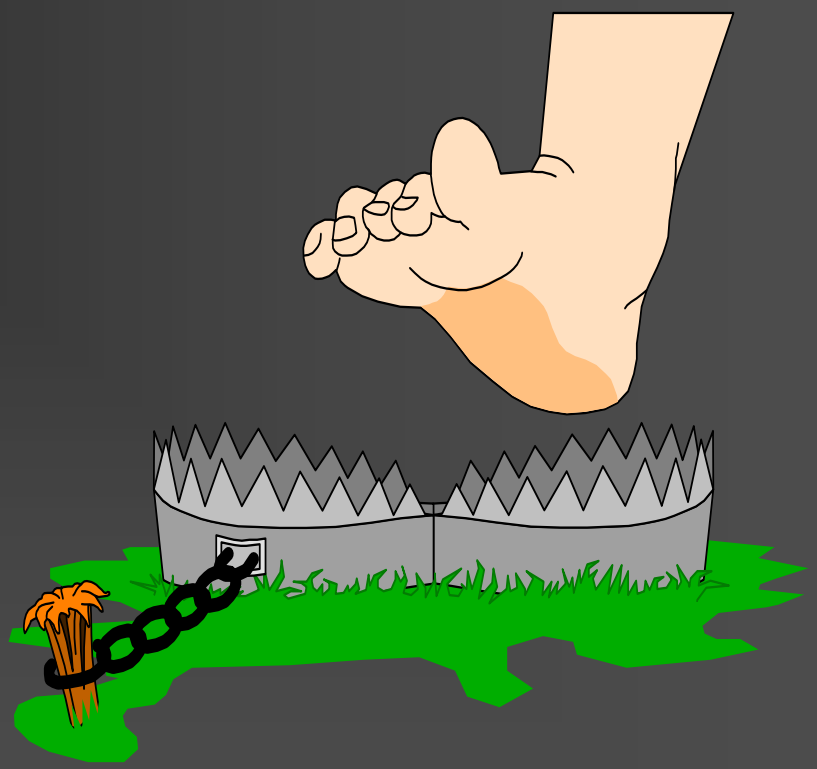
Description of the Five Scenarios

Table A

	Red	Blue	Turquoise	Purple	Pink
Growth in UK GDP (per year)	3.3%	1.6 %	2.6%	3.9%	3.9%
Dominant economic sectors	commercial	commercial public admin non-intensive industry	commercial construction public admin	commercial non-intensive industry	commercial non-intensive industry
Energy consumption (Mtoe)	90	130	200	330	330
Number of households (million)	27.5	25	30	27.5	27.5
Energy use per household	large reduction	very large reduction	small reduction	similar to current	similar to current
Supply mix	coal (with and without CCS) renewables H_2 biofuels	coal (with CCS) nuclear CHP biofuels	gas (with and without CCS) biofuels nuclear H_2 renewables	nuclear renewables H_2 biofuels	nuclear CCS (coal and gas) renewables biofuels
Decarbonisation policies	innovation and technology driven	collectivist approaches to demand-side policy	similar to today with focus on supply	strongly market- focused government	strongly market-focused government
Transport	low growth in aviation reduction in car use very large increase in public transport	medium growth in aviation low growth in car use large increase in public transport	large growth in aviation no growth in car use small increase in public transport	very large growth in aviation large growth in car use large growth in public transport	very large growth in aviation large growth in car use large growth in public transport
Transport fuels	oil electricity H_2	oil electricity H_2	oil biofuels electricity H_2	oil biofuels electricity H_2	oil biofuels electricity
Hydrogen	stationary and transport uses production from gasification with CCS and renewables no pipelines	transport uses production from gasification with CCS, nuclear and renewables no pipelines	all sectors including aviation production from gasification with CCS, nuclear and renewables pipelines and H_2 by wire	stationary and transport uses production from renewables and nuclear extensive pipeline system	no hydrogen

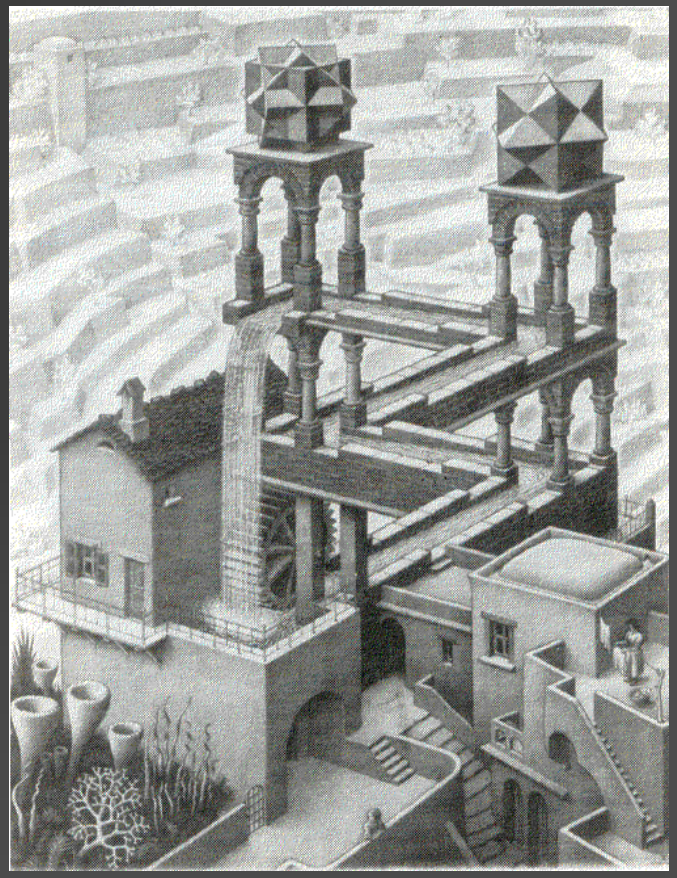
What policy measures?

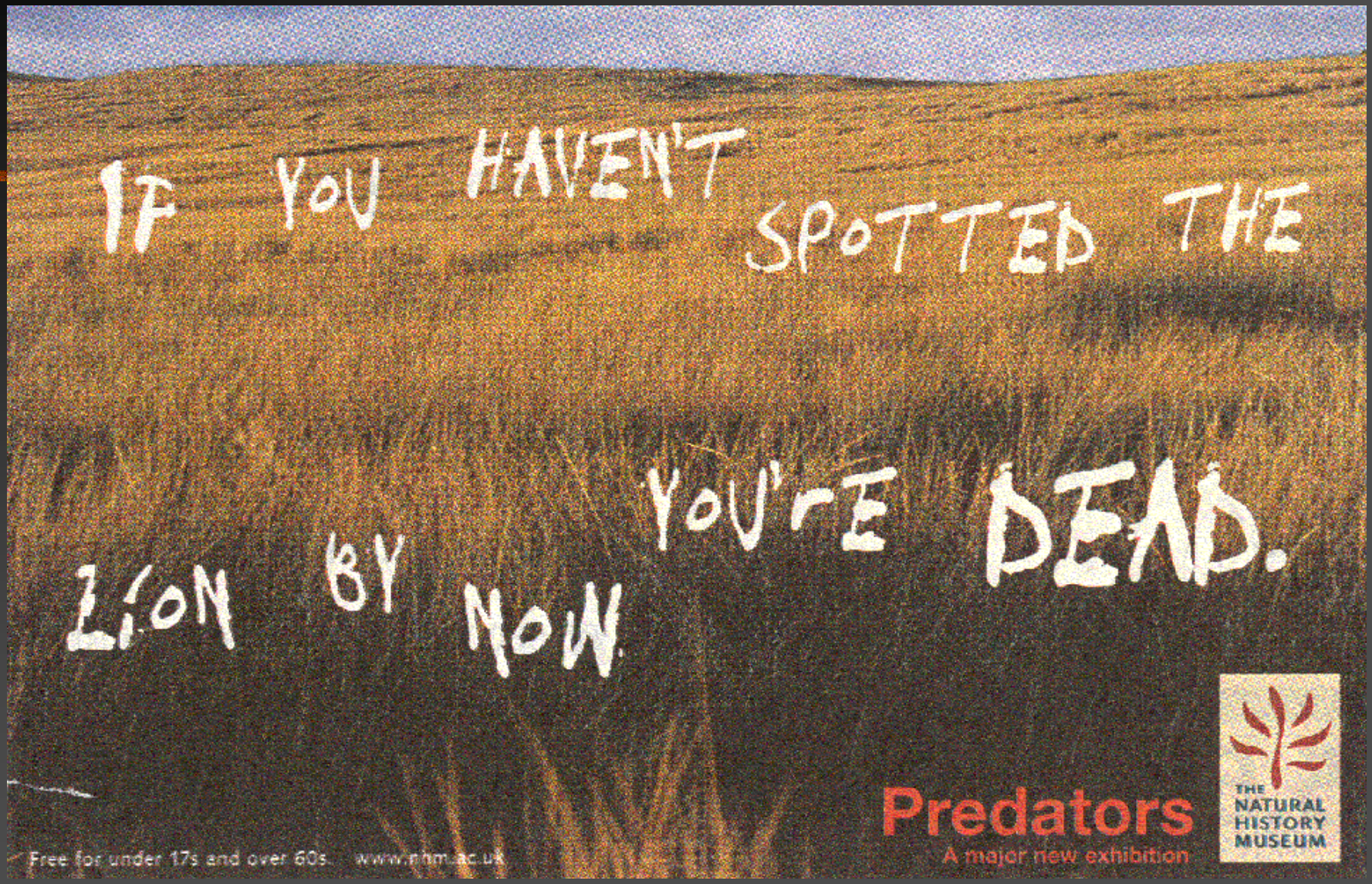
- Direct Regulation
  - Planning System
  - Building Regulations
- Taxation
  - Fuel Duty
  - Airport charges
- Market Instruments
  - Emissions Trading
  - Renewables Obligation



Conclusions?

- Can it be done?
- Are the policy measures sufficient?
- Are Government committed?
- Do the public really understand?




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