Institute for Environmental Studies

Carbon, vulnerability and energy systems

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Sketch

1. Energy systems and carbon emissions
2. Vulnerabilities to GHG emissions reductions from energy systems
   – Climate stabilisation
   – Costs of emissions reductions
3. Energy system vulnerability to climate change impacts
The disposition to suffer harm
  – Sensitivity to impacts of change
  – Resources to recover from impacts (coping range)
  – Capacity to adapt:
    ▪ Capacity to reduce risk of harm (exposure, sensitivity)
    ▪ Capacity to make adjustments to experienced or expected changes
    ▪ Capacity to take advantage of opportunities
Energy systems and carbon emissions

- Historic carbon emissions from energy systems of the order 300 GtC
- Resources/reserves of fossil carbon of the order 5000 GtC
- IPCC SRES scenarios (2001) predict a range of emissions scenarios to 2100 between 1000-2100 GtC
- Emissions budgets associated with current EU climate policy objectives in the range 600-1000 GtC
Fossil carbon and emissions scenarios

Source: IPCC TAR, 2001

Notes: - Reserve/resource and historic use data derived directly from section 3.8.1.
- Cumulative carbon emissions are from the IPCC Third Assessment Report WG-I.
- Unconventional resources do not include gas hydrates, which contain an estimated 12,000 GtC.
Building GHG emissions scenarios

- Emissions scenarios increasingly take account of a range of gases (GHG, ozone precursors, sulphur aerosols)
- Future emissions shaped by socio-economic conditions and assumptions about technological change (in energy producing and using systems)
- Each of the four IPCC SRES scenarios represents a different balance between mitigative and adaptive capacities
Future CO2 emissions scenarios

Source: IPCC/SRES
Future climate change scenarios

Source: IPCC TAR, 2001
Vulnerabilities to climate change mitigation

• Concept of ‘dangerous’ climate change embedded in FCCC
• Many interpretations possible – one benchmark is the 1996 commitment by the European Council to limit global average temperature increase to no more than 2degC above pre-industrial levels
• Achieving this will require significant global GHG emissions reductions in the period to 2050 (30-40% below 1990 levels by 2050)
• Making assumptions about landuse CO2 decreases significantly alters reductions of Kyoto gas emissions required (by about 15%)
Achieving the 2degC target

Source: Wigley and Raper, 2001
Stabilisation levels related to emission reductions

Source: Den Elzen and Meinshausen, 2005
Achieving emissions reductions

- Emissions reductions will need to be achieved through a combination of measures
  - Demand reduction (absolute reduction)
  - Technological and structural change (decarbonisation)
  - Carbon capture and storage
- A shorthand way of expressing vulnerability to mitigation is to define it in terms of aggregate costs and learning rates (capacity to innovate and absorb new technologies into the economy)
- Since the last oil crisis, energy intensity improvements of 1-2% per year have been achieved in industrialised countries (but with a corresponding growth of demand)
Achieving emissions reductions, 2

Source: Nakicenovic and Raihi, 2003
Many commentators now argue that deep GHG emissions reductions can be achieved with commercialised (or near-market) technologies – the key is widespread diffusion.

However, the costs of transition to ‘low-carbon economy’ are significant and primarily determined by assumptions about technological learning.

Early reductions reduce longer-term costs of meeting stabilisation targets.

Very rapid emissions reductions would have a more marked effect on economic growth rates and therefore on overall social welfare.
Costs of stabilisation scenarios

% Global GDP

Source: Den Elzen and Meinshausen, 2005
Effects of delayed emissions reduction

Source: Den Elzen and Meinshausen, 2005
Costs of policies to mitigate GHG emissions

Source: Tol, 2005
Energy system vulnerability to climate impacts

• Impacts on production and distribution infrastructures – extreme events (droughts and storms) and sea-level rise
• Impacts on energy demand (peak management)

• Possible adaptations: more resilient networks, re-siting of facilities