CAN Europe Workshop

The policy and environmental implications of CO2 capture and storage, hydrogen and fuel cell technologies

Policy options to drive technical innovation

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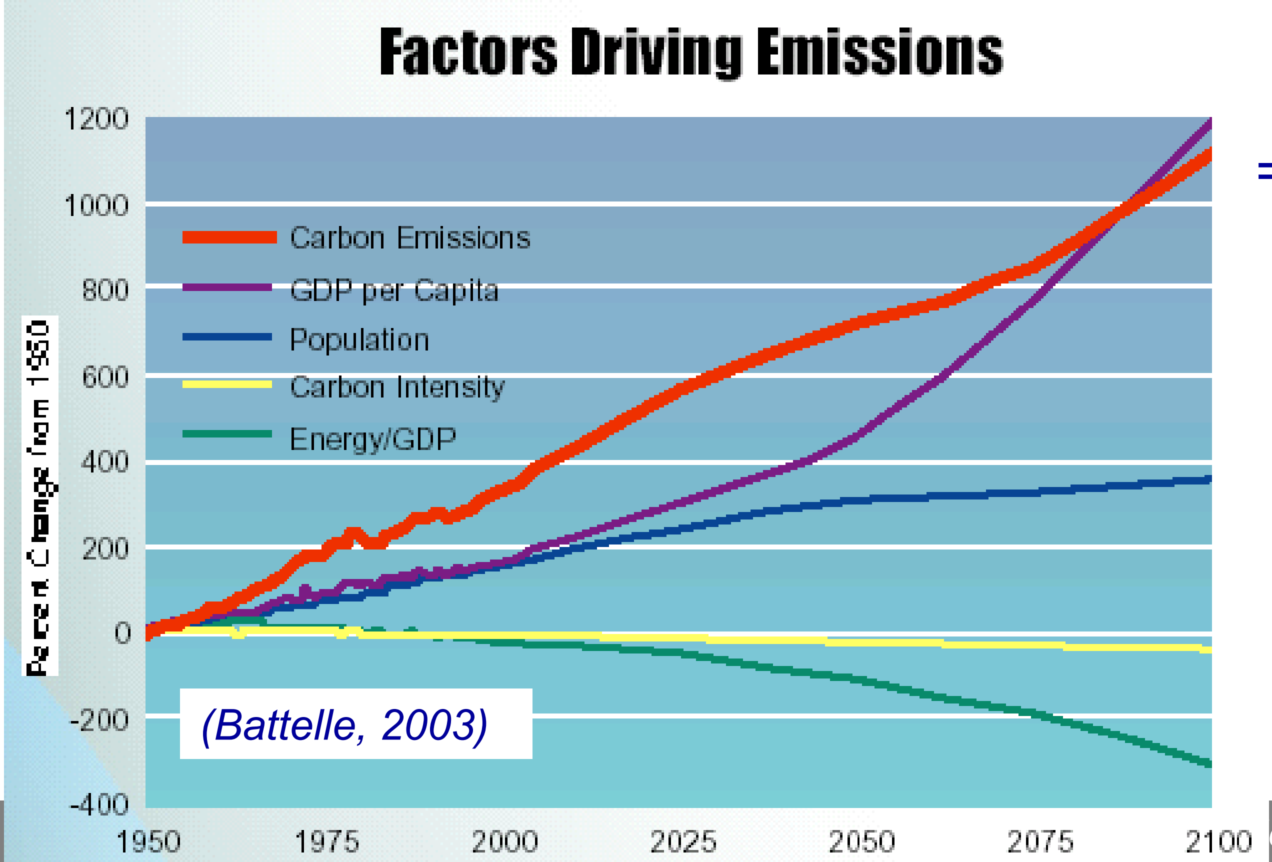
Presentation outline

- What do we know about technology, and technological change
- What seems required of technological change in our energy systems to protect the climate
- What do we know about induced technological change through government policy efforts
- What technology policy framework therefore seems required
- What might it all mean for CCS

Climate change and technology

- All technologies are energy technologies (end-use important too)
- Present technologies the major part of our climate problem
- Debatable whether current technological change helping or hindering

(Convery et al., 2003)



(Battelle, 2003)

=> Solving our climate problem requires we change present process of technological change, as well as technologies themselves

What technological change is required

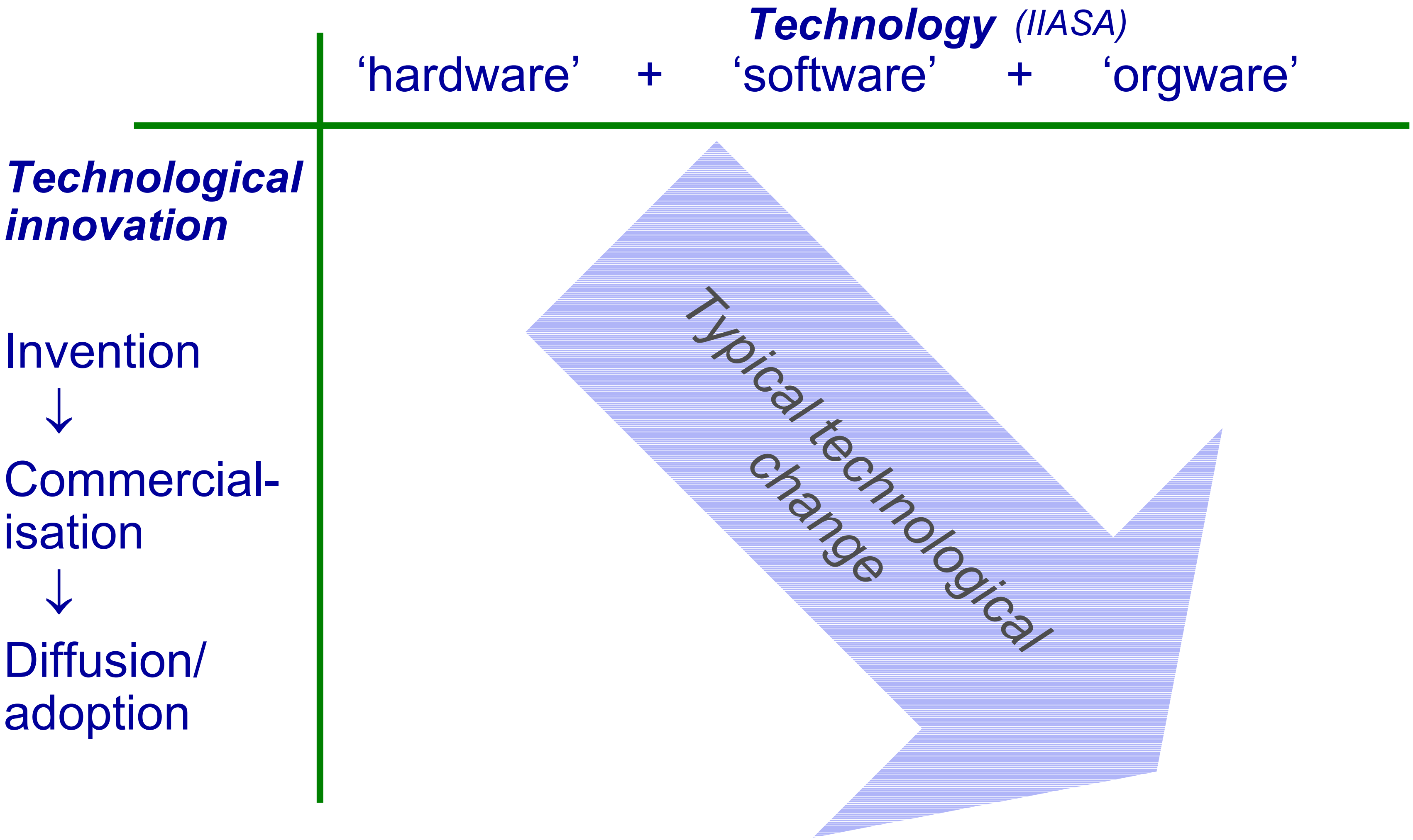
- **Effectively** solving our climate problem seems likely to require
  major (60 to 80% from present levels)
  rapid (emissions peaking within around 30 years) and *(IPCC, 2001)*
  then sustained (centuries or more)
  reduction in global GHG emissions from our energy technologies..

  ..within context of other societal needs and aspirations, now and future

  ..and given
  present energy systems (options, scale of different technologies), and
  possible technological change of these systems (scale, speed and longer-term sustainability required)

- ***Efficiently*** solving our climate problem achieves above at lowest cost/ max. benefit possible – valuable, but less important than effectiveness
  Saving the climate at slightly higher cost than might have been possible with another approach would still be worth it.

Some dimensions of technological change



Technology *(IIASA)*

‘hardware’ + ‘software’ + ‘orgware’

Technological innovation

Invention
↓
Commercial-isation
↓
Diffusion/ adoption

What drives technological change

- Technical change driven by
  - Markets, and their competitive pressures *(market pull)*
  - Government policy efforts *(make markets reflect societal choices, 'niche' market pull and R&D push)*
  - Technology 'champions' *(largely R&D push)*

- However, successful technology change arises from societal preference (+ what it therefore rewards)

  => its really about *social choice*

The need for innovation policy

- Technological change is too important to leave to:
  - *Imperfect markets*: currently have severe climate *externality* failings, generally under-deliver R&D, more systemic problems too..
  - *Technology 'champions'*: dangers of undue techno-optimism + unaccountable technical elites
- Government policy roles in:
  - *Invention*: support R&D into promising socially beneficial yet unproven technologies
  - *Commercialisation*: support demonstration and initial deployment of promising, technically proven, technologies
  - *Diffusion/Adoption:* ensure markets reflect societal preferences

=> However, many challenges for policy makers…

Government support for R&D + commercialisation

- Govt role because private firms likely to underinvest:
  - Public good spill-overs that aren't captured by firms undertaking R&D
  - Collective insurance
  - Some markets don't reflect externalities (but is there better way to fix this?)
- Risk + return
  - R&D relatively low cost but high risk, potentially v. high returns
  - Provides 'learning by searching' + 'learning by doing'
  - Demonstration generally higher cost with lower risk
    Demonstration is not deployment – results necessarily experimental since trying new approaches *(Watson et al., 2001)*
  - Public funding necessarily directed – who and how is assessment done?
- Current energy related R&D
  - Low + falling public $ - $2-3b/yr; Energy Industry R&D < 10% Ind. average
  - Total (public + private) R&D spend ~$7.5b/year (cf. Daimler/Chrysler R&D budget of $8.4b/yr) *(EPRI, 2003)*
  - 1974-2002 – IEA country R&D budgets for fusion, fossil + fusion >4 X that for renews + EE (almost 50X more on fission than wind) *(IEA, 2004)*

Government support for diffusion/adoption

- Govt role b/c many markets don’t reflect societal prefs:
  - Externalities + adverse subsidies (Foxon, 2003)
  - Systemic challenges – infrastructure, technological/institutional lock-in

  => Governments can create niche markets, transform existing markets
- Risk + return
  - Major deployment involves large $ investments (public or induced private)
  - Some potential to avoid making choices in technology focus (eg. economy wide carbon price) *however* limits because niche markets are designed (eg. should renewables compete against tree planting?) *Problem is that effective markets rely on fungible products*
  - Technical risks (hopefully) low, however, large $$ may be involved
  - Vital role for ‘orgware’ innovation – a key NGO role
- Current energy related deployment programs
  - Energy very different from key areas where major innovation has been market driven (eg. IT + Telecoms) – driven by concern, not opportunity
  - Examples include Emissions Trading, Green certificates, PV programs
  - Difficult to measure, but far larger amounts of money than R&D involved

Guidance for policy makers

- Uncertainties in innovation mean risks in *picking winners*
  - Governments often pick losers (eg. Fast Breeder Reactors)
  - Even if chosen technology eventually succeeds to some extent, support may have been far better spent elsewhere (eg. nuclear?)
- *Yet*, limited public resources require some focus

⇒ A valuable formal risk management strategy is diversification – a portfolio approach

However, priorities still have to be established (its not enough to say everything should be supported)

=> important role for **risk-based technology assessments**

Technology assessment for GHG abatement options

- A range of abatement options, of varied status + promise
  - *Improved end-use energy efficiency*: arguably greater diversity of energy techs on demand than supply-side => more opportunities for innovation
  - *Lower emission fossil fuel technologies* – eg. CCGT, CHP: probably the greatest contribution to emissions reductions in energy sector to date
  - *Renewable technologies:* ‘new’ renews showing great promise
  - *Ecological sequestration:* low cost, but limits to scale + maybe temporary
  - **Lower emission fossil fuel techs through *CO2 capture and storage***

=> A possible risk-based technology assessment framework

- *Technical status* – unproven => mature, emerging => widespread
- *Delivered services and benefits* – **GHG emission reductions**, others… eg. dispatchability, network requirements
- *Present costs* where known, and possible future costs
- *Potential scale of abatement*
- *Potential speed of deployment*
- *Other possible societal outcomes* – eg. env. impacts, energy security

(MacGill, 2003)

The context for a technical assessment for CCS

- For climate protection, is large scale deployment of CCS
  necessary? => hopefully not given its present uncertainties
  sufficient? => almost certainly not

  …or *a valuable contributor* to the abatement challenge?

  => **our view** - we don't know yet, and we need a way to find out that minimises our risks and maximises our opportunities for GHG abatement of the scale, speed and longer-term sustainability required to protect the climate

A possible technical assessment for CCS

- Technical status
  - *CO2 capture*: well established in oil + chem. Industries, challenges for coal-fired power: – likely requires 'advanced' gen techs that aren't yet commercial
  - *Transportation*: seems relatively straightforward
  - *CO2 storage* – not yet demonstrated, although some injection underway, with experience in EOR, very limited exp. with ECBM + saline aquifers (Proving *injection* = *storage* may take considerable time – decades or more)
  - **COMPARISON WITH OTHER OPTIONS: Reasonably mature EE, renewable, CCGT, DG options available, and potential for many of these to be improved**
- Delivered services/benefits
  - Possible value-adding through EOR + ECBM (an abatement option that increases fossil fuel production!)
  - Coal-fired generation with GHG emissions perhaps ~150kgCO2/MWh (but note that still ~40% of off-shelf gas-fired CCGT)
  - Good fit with existing centralised infrastructure
  - **COMPARISON WITH OTHER OPTIONS: EE + Renews offer very secure CO2 storage as fossil fuels (the safest form of sequestration we know), some other options offer distributed benefits, intermittency issues for some renews**

A possible technical assessment for CCS (cont.)

- Costs now, + into the future
  - Considerable uncertainty + variability depending on application
  - Future costs dominated by present uncertainties *(Gielen, 2003)*
  - **COMPARISON WITH OTHER OPTIONS: Some EE options offer very low costs, but CCS may be competitive with others. All may benefit from 'learning'**
- Potential scale of abatement
  - CCS may be large c.f other options. EE potential large but inherently limited
- Potential speed of deployment
  - A major challenge for the power sector: technologies exist but scale, application and integration reqd. R&D has uncertain time frames, meaningful demo. programs may take decades ***and we are already ½ way from 1990 to 2020***
  - Turnover of long-lived capital intensive energy infrastructure is slow (eg. oil took 100 years to get from 1% to 46% of global energy supply and is the closest thing we've yet seen to technological magic in energy)
  - Deployment can draw upon existing + large expertise and workforce
  - **COMPARISON WITH OTHER OPTIONS: Mature options offer faster deployment, some EE options offer faster capital turnover opportunities (but some slower)**

GHG abatement policy needs

- Need a coherent technology strategy that:
  - Establishes priorities subject to scale, speed + long-term sustainability that appears required to protect climate
  - Doesn’t rely on technological magic
  - Uses technology push + market pull in tandem: *either type of policy alone is far less effective than when combined* *(IEA, 2003)*
  - Focuses particularly on market-pull to drive rapid deployment of established technologies: *our quickest possible emissions reductions*
  - Doesn’t permit delay (delay is victory for incumbents)
  - Fosters competition between options and innovators where appropriate
  - Works to reduce information asymmetry and enhance societal decision making roles: *NGOs have key role here*
  - Works to counter present institutional/technological lock-in with fossil fuels
  - **For CCS:** focuses R&D & Demo programs on key questions of storage uncertainty + site specificity, capture: *ie. reduces present unknowns* (don’t treat injection as fungible with proven abatement until shown to be)
- all embedded within wider, coherent, climate policy framework

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