Climate change and technology: innovation policy gaps

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Structure of this presentation

- What kind of socio-economic problem do we face with climate change?
- What kinds of innovation are needed to address that problem?
- What current policy instruments do we have, and how do they relate to the central problem
- What role(s) do government(s) have in sponsoring energy innovation?
- What new modes of governance and policy collaboration are needed?

The innovation background

Environmental problems derive from long-term innovation in a dominant energy regime.

The world wants continued large-scale access to energy (falling energy coefficients are outweighed by global growth)

If we do not wish to reduce overall energy consumption, then we will need energy innovation if current climate problems are to be resolved.

The problem for policymakers

Stern Review:

- Climate change results from an externality associated with emissions
- Impacts are global, long term and persistent
- Uncertainties and risks in impacts are pervasive

The climate change problem

- High probability of significant warming, with small but definite probability of large temperature increases
- This is a problem of radical uncertainty: an event which has small probability of occurring, but very large and irreversible losses if it does.

The innovation issue

- We need technological options for zero or low emission energy technologies
- Policy question: will our current economic organisation and policy system generate these alternatives?
- If not, do we have currently available instruments?

The Four Elements of Abatement Strategies

- Fuel efficiency gains (i.e. replace coal power with extra 2 million windmills plus 7GW more nuclear)
- Reduce demand for emissions-intensive goods and services (via carbon pricing)
- Low-carbon power, heat and transport technologies (cut carbon emissions by 25% in buildings, raise car fuel efficiency from 30 to 60 mpg)
- Reducing non-fossil fuel emissions (reduce deforestation)

Policy methods:

Basic instruments are economic:

- Taxes: carbon price is established that reflects full social cost. Then market decides how much carbon is emitted.
- Tradable quotas: government caps quantities, then lets emitters trade. The market decides price of emissions.
- R&D programs, with commercialisation measures
- Subsidies such as feed-in tariffs, based on learning effects
- Regulation instruments

The big question …

Will these policy measures generate the right kind of innovation efforts and outcomes?

A framework for analysing the innovation issues

Technologies are not things, but complex socio-technical systems.

A "technological regime" refers to the whole complex of scientific knowledge, engineering practices, process technologies, infrastructures, product characteristics, skills and procedures that make up the totality of a technology.

Technological regimes link up with social organisation and modes of life

Three modes of innovation in technological regimes

- Incremental change (upgrading and improvement within a technological regime - such as improvements on the fuel economy of engines)

- ‘Disruptive change’ - new functionality within a technological regime (for example, fluorescent lights replacing incandescent lights)

- Radical change (full-scale change in the technological regime - for example, mechanisation, the shift to electrification, the hydrocarbon energy system)

The current policy problems…

- We need instruments to change the current energy regime
- Existing policy measures for raising carbon fuel costs are likely to produce incremental innovation (such as fuel economy technologies)
- ‘Disruptive’ innovations such as carbon sequestration or climate engineering will reduce the impact of warming, but keep the hydrocarbon system intact
- Policies for renewable are constrained: existing renewables are limited in functionality and still far from economically viable; feed-in tariffs and R&D will not change this

How to shift a technological regime?

Policy problem:

A regime shift is not a market failure problem but a more fundamental coordination problem involving large-scale ‘lock-in’.

That is, it cannot be solved solely by the creation of markets, the assignment of property rights, taxes and subsidies etc.

It requires mission-oriented policy: the creation, survival and growth of comprehensive technological alternatives.

Characteristics of historical ‘regime change’

- Very long time horizons (steam power - ca 250 years, mobile telephony 50 years)
- Inferiority of new technologies at early stages
- Big risk and uncertainty - multiple search paths (hence multiple options), many failures (uncertainty about whether technology will work, and about how it will be used)
- Patronage of early-stage technologies; in the modern era, big role of government
- Institutional changes (in property rights, regulation, management and organisation, role of governments, cooperation mechanisms, consumption patterns) etc
- Systemic approaches and ‘mission oriented’ search programs

Roles of public sector in modern regime shifts

Significant public-sector roles (of different types) in regime-changing technologies:

- Computing and networking
- Digital telecommunications
- Nuclear
- Lasers
- GSM mobile telecoms
- GPS
- Biotechnology
- High speed rail

Why have there been significant public-sector roles in regime-changing innovations?

- Public has capability to bear risks and uncertainties
- Government can ‘shelter’ inferior technologies and support dynamic improvements
- The need to create multiple options
- Collective invention and hence appropriability issues
- Scale of financial commitment,
- Infrastructure requirements,
- Long development times (long time horizons)

Energy innovations: what is necessary?

- Government-backed mission-oriented programs to develop major energy alternatives
- Because of uncertainty we can’t use a cost-benefit approach to weight alternative actions; we need something like a real options approach.
- Options might include fusion, energy storage, new transport infrastructures, high-input solar, changes in city design, sustainable hydrogen, new-generation nuclear

Governance and organisation

- Because climate change is both a global externality (and hence there are global benefits to solutions), and because of the scale of the problem this cannot be done by national governments. (But all governments are equally affected - its nothing to do with size)
- So we need multilateral collective action in identification, finance, development and adoption
- This would have to involve a specific global treaty and possibly G7 leadership
- Creation of time-limited cross-functional agencies, led by global organisation

Functions of a global climate change agency

- Identification of scientific possibilities
- Assessment of paths
- Programme design and testing (technology platforms/FRAMEWORK equivalent)
- Implementation supervision
- Multilateral agreements on cost/benefit sharing

Conclusion

- We face a complex challenge requiring radical innovation in energy carriers
- Radical innovation requires major government intervention
- Such intervention must rest on multilateral cooperation of hitherto unprecedented scale and complexity
- The first step is the creation of a time-limited organisation to identify and scope the technological options