Centre for Climate Change Economics and Policy

Grantham Research Institute on Climate Change and the Environment

Economic growth, poverty reduction and managing climate change

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E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL | Living With Environmental Change | Munich RE | LSE The London School of Economics and Political Science | University of Leeds | The Grantham Foundation for the Protection of the Environment

Seven Part Structure

- **Part 1: Six years since the Stern Review**
- Part 2: Where we are going and why action is so slow
- Part 3: Describing the risks: the scientific models
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- Part 6: Policy for the low-carbon transition
- Part 7: Collaboration and understanding others

Six years since the Stern Review

- ***Stern Review underestimated the risks.***
- Emissions are at the top end or above projections (e.g. IPCC AR4, SRES A1) (Peters, et al. 2012).
- Some effects coming through more quickly or severely than anticipated: extent of Arctic Sea ice decline; ocean acidification and functioning of ocean systems.
- Interactions of climate, ecosystems, planetary boundaries (Rockström, et al. 2009) mostly omitted from models and look more worrying.
- Some feedbacks and tipping points such as thawing permafrost omitted from models look more serious.
- All this underlines further the potential for radical transformation in how and where people can live: migration and conflict omitted from models.
- And see further below on problems with modelling.
- ***Technical progress faster than anticipated then; political will more problematic.***

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Where we are going (I)

- Greenhouse gas concentrations or stocks have increased from around 285ppm CO_2e in the 1800s to around 445ppm today. BAU likely to take us over 750ppm by the end of the century or thereabouts (adding at a rate of over 2.5ppm per year).

- Could result in an eventual temperature increase (around 50-50 chance) of more than 5°C compared with the pre-industrial era. The planet has not seen such temperatures for around 30 million years. Have not seen 3°C for 3 million years: 450ppm gives around a 20% chance of greater than 3°C.

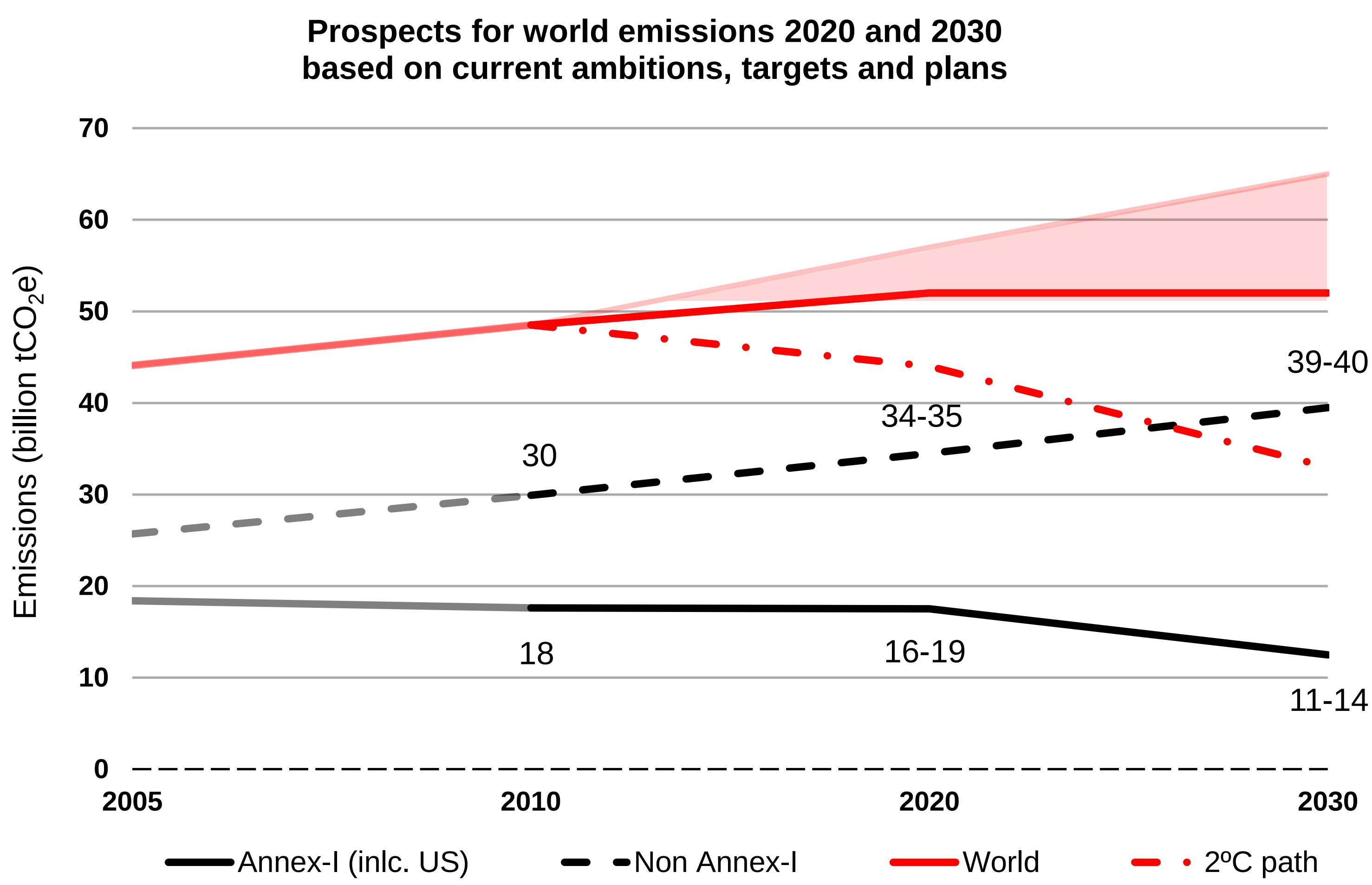
- High probability of extreme weather events.

- Global sea-level peak 22m higher than present for the Pliocene interval (2.5-5.5 million years ago), which was 2-3°C warmer than today (Miller, et al. 2012).

- Deserts, coastlines, rivers, rainfall patterns, the reasons we live where we do, would be redrawn.

- Potential cause of migration of hundreds of millions, perhaps billions, of people around the world: likelihood of severe and sustained conflict (note that those such as CIA who worry about security also worry about climate change).

Where we are going (II)



Source: UNEP, 2012, The Emissions Gap Report, Appendix; own calculations.

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Why action is so slow

- Main obstacle to action is lack of political will. Due to:
  - A failure to understand the magnitude of the risks and the dangers of delay (ratchet effect of emission flows to concentrations, physical capital/infrastructure lock-in);
  - A failure to understand the attractiveness of the alternative paths and that these can combine growth, poverty reduction and climate responsibility; and
  - A failure to understand what others are doing and a presumption it is very little.
- Global economic challenges/crises have diverted attention:
  - Major macroeconomic structural imbalances; debts and deficits in rich countries; unfinished financial sector reform; fragile growth in many countries; radical changes in international division of labour and skills.
- We can do better on all these challenges, including climate change, if we tackle them together in a coherent and integrated way. But creation of political will requires deeper understanding of above issues.

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Describing the risks: the scientific models (I)

- Structure and calibration of scientific and economic models have broadly underestimated risks.
- Disconnect between planetary history of change at high temperatures and what modelling predicts.
- The scientific models mostly leave out dangerous feedbacks/tipping points. At 4-5-6°C (or below) the probability of passing some tipping points, such as melting of permafrost, may be high. If modellers cannot capture or model effects "sufficiently clearly" they are omitted. But best guess surely not zero.
- The models do not generally represent the lasting/dynamic impacts of extreme weather events.
  - Pakistan flooding 2007, "Development in large areas set back 20 years". If extreme events of similar magnitude happen more frequently, say every 10 years, development will go backwards.

Describing the risks: the scientific models (II)

- The models are not built in a way that help us describe the impacts on people:
  - At sea level (SL) 2m higher a few hundred million might have to move (Nicholls, et al., 2011);
  - At 3-4-5°C may see radical monsoon changes in India and substantial changes in flows of major rivers off the Himalayas (a billion plus people depend on them). Desertification of southern Europe?
- Models should focus on understanding probabilities of events with severe consequences for people rather than on those bits which (on narrow assumptions) seem more tractable, such as change in agricultural output, relative to those effects that can be modelled more easily. Need new generation of models.

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Economic modelling and discounting (I)

- Severe limitations in the economic modelling structures.

- Output generally modelled assuming underlying exogenous exponential growth and minor percentage GDP damages (around 5-20%) as multiplicative factors on production functions from temperature increases of 4-5-6°C and higher.

- "Current economic modelling of climate damages is not remotely consistent with the recent research on impacts" (Ackerman and Stanton, 2011).

- DICE, a generic economic model, has 50% GDP loss for temperature increase of 19°C (Ackerman, et al. 2009). Population would likely have vanished long before that.

- Using models of this kind, the US Interagency Working Group in 2009 estimated social cost of carbon at around a modest $20/tCO_2$.

Economic modelling and discounting (II)

- An exogenous growth rate (say around 1-2%) overwhelms the damages in these models (e.g. over 100 years gives a factor of 2.5 to 7); even 50% damage would claim that we are still substantially better off. Possible scale of climate change could deeply damage growth possibilities and rates.

- In standard models the damage function impacts output only in the current period (other than through reducing saving). This is a key modelling error. Impacts such as loss of capital, labour and land will impact future periods.

- Absence in the models of migration, conflict, loss of life.

- Models flawed in both calibration and structure. (1) Some problems not too hard to fix within models. (2) But also a new generation of economic models is needed. (3) And broader perspectives for more profound effects such as conflict.

Economic modelling and discounting (III)

- Modelling failures compounded by ignoring key principles of discounting.
- Discount factor (discount rate is its rate of fall) depends on future development of the economy and on good chosen for accounting.
- Failure to recognise that future generations may be poorer than us; magnitude of possible effects could put growth into reverse and lead to large-scale loss of life. Thus discount rates could become negative.
- Pure-time discounting is discrimination by date of birth; a key asymmetry. Many or most structured ethical positions would indicate symmetry.
- Failure to understand that cannot ‘read-off’ the relevant discount rates from market interest rates or rates of return (different decision-makers and decisions, market failures….).
- In most models discount rates should be riskless because risk/uncertainty handled directly.
- Overall failure to understand discounting and modern public economics. (See Stern 2009, Ely Lecture, AER 2008).

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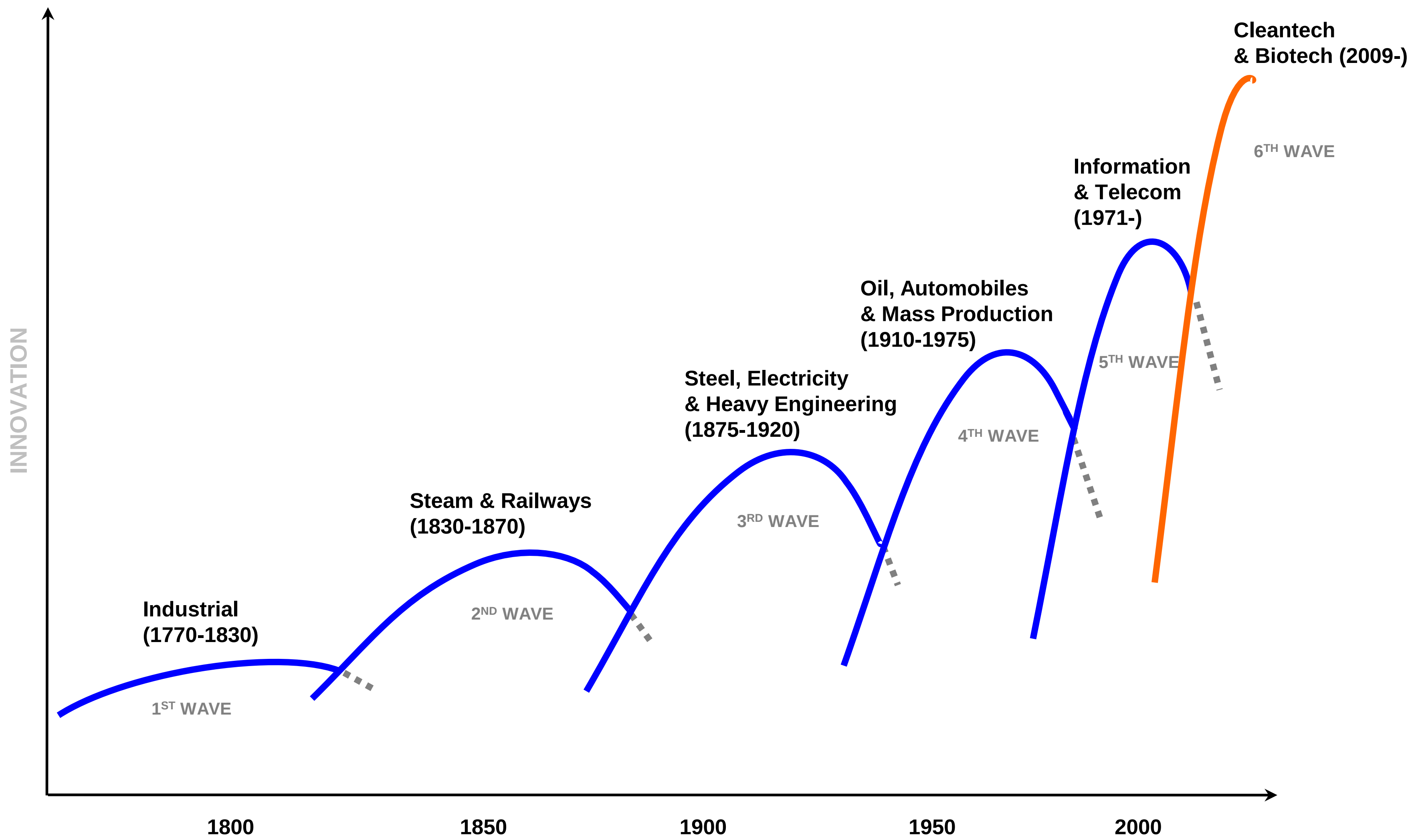
The new energy-industrial revolution (I)

- Transition to low-carbon growth / new industrial revolution gives more than a fundamental reduction in climate risks.
- Likely to be a dynamic period full of innovation, investment, creativity, opportunity and growth, with large and growing markets for the pioneers (see, for example, Perez 2002 and 2010).
- With strong technical progress and breakthroughs, the growth effects may be similar, or larger, to the railways, or electricity in earlier eras, inter alia, because more widely spread, more rapid, and complementary with other technical changes and urbanisation.
- When achieved, low-carbon growth will be more energy-efficient, more energy secure, more community based and inclusive, safer, quieter, cleaner and more bio-diverse.
- Potential to achieve growth, overcome poverty and be climate responsible.
- An attempt at high-carbon growth likely to self-destruct.

Waves of innovation



Source: DONG Energy (2009); diagram based on Perez (2002) drawing on report by Merrill Lynch (2008) (schematic not precise quantitative vertical axis).

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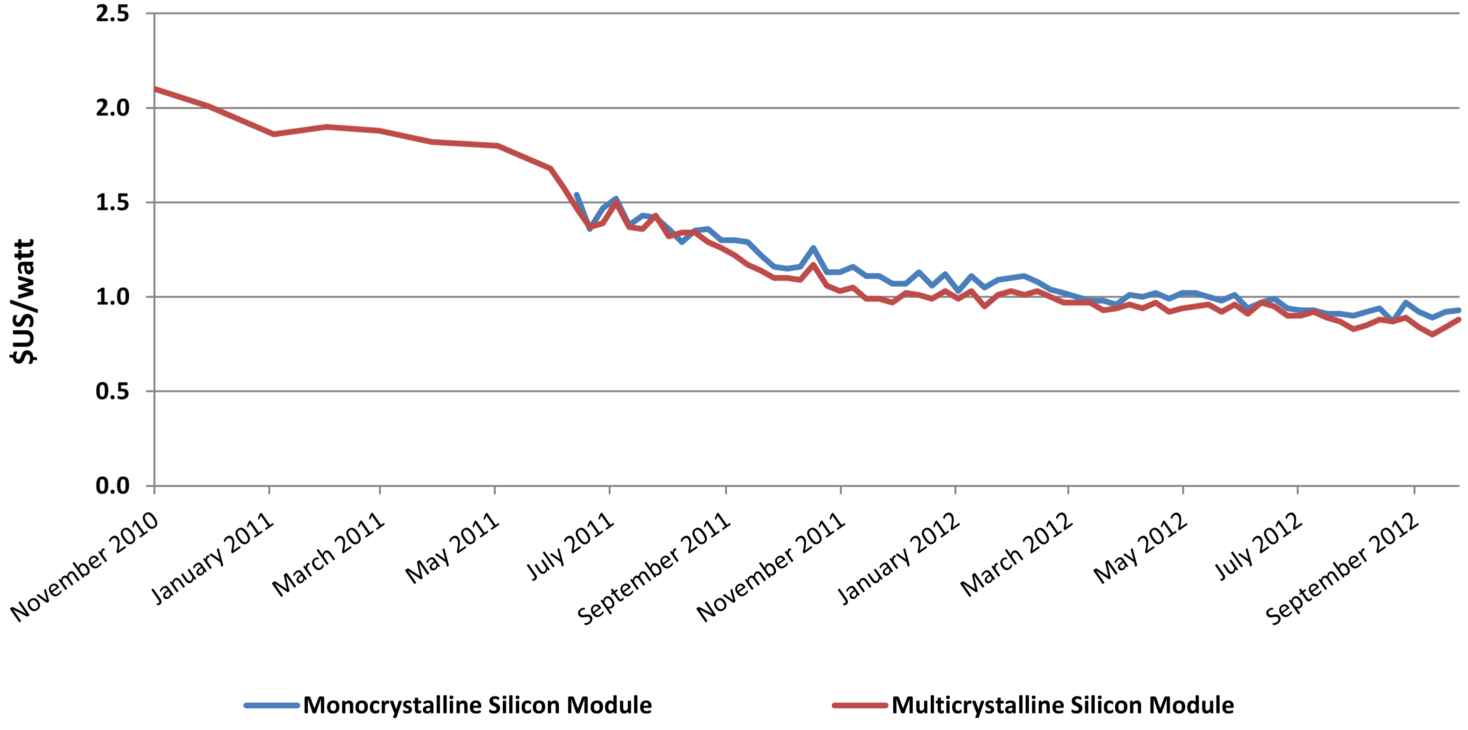
Technical progress - solar

- Solar PV module prices were $5-6/watt in 1990, around $5/watt in 1995, $3-4/watt in 2005 and around $2/watt in 2010 (EIA, 2012). They have fallen around 50% since 2010: currently well below $1/watt (BNEF, 2012).

Price for immediate delivery of silicon modules, November 2010 – September 2012 ($/W)



Source: BNEF (2012)

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Investment for the transition

- Expenditure involved in making the transition to a low-carbon economy should be analysed as an *investment*, rather than only a net cost (many co-benefits outside climate change). Most is not a direct cost to the public purse, largely private (Romani, et al., 2011).

- This is about both the *dynamics* of innovation and learning and the creation of benefits beyond narrow GDP; *not simply static* shift to higher input-output/coefficients and lower growth.

- Stern Review (2007) - incremental global investment for transition in the range of 1-2% of GDP per year. Lower figure was for target of stabilising below 550ppm CO_2e. Other estimates in similar range, e.g.: den Elzen et al. (2007); Knopf, et al. (2009); Edenhofer et al. (2009); WB (2010).

- IEA (2011) - 450ppm requires incremental world investments in energy sector around US$ 1 trillion p.a. to 2030, around 2% of current world GDP.

- Uncertainty around these estimates, but could be *lower* than 2% of GDP with energy and resource efficiency gains (see work on efficiency by McKinsey 2011 and also WEF 2012), and technological change. Other co-benefits are also potentially substantial and could deliver material benefits in the short run. *Higher,* if policy bad.

- Reduce emissions from stopping deforestation. Negative emissions from reforestation and restoration of degraded forests, or biofuel with CCS.

Hydrocarbons: rising prices/stranded assets? (I)

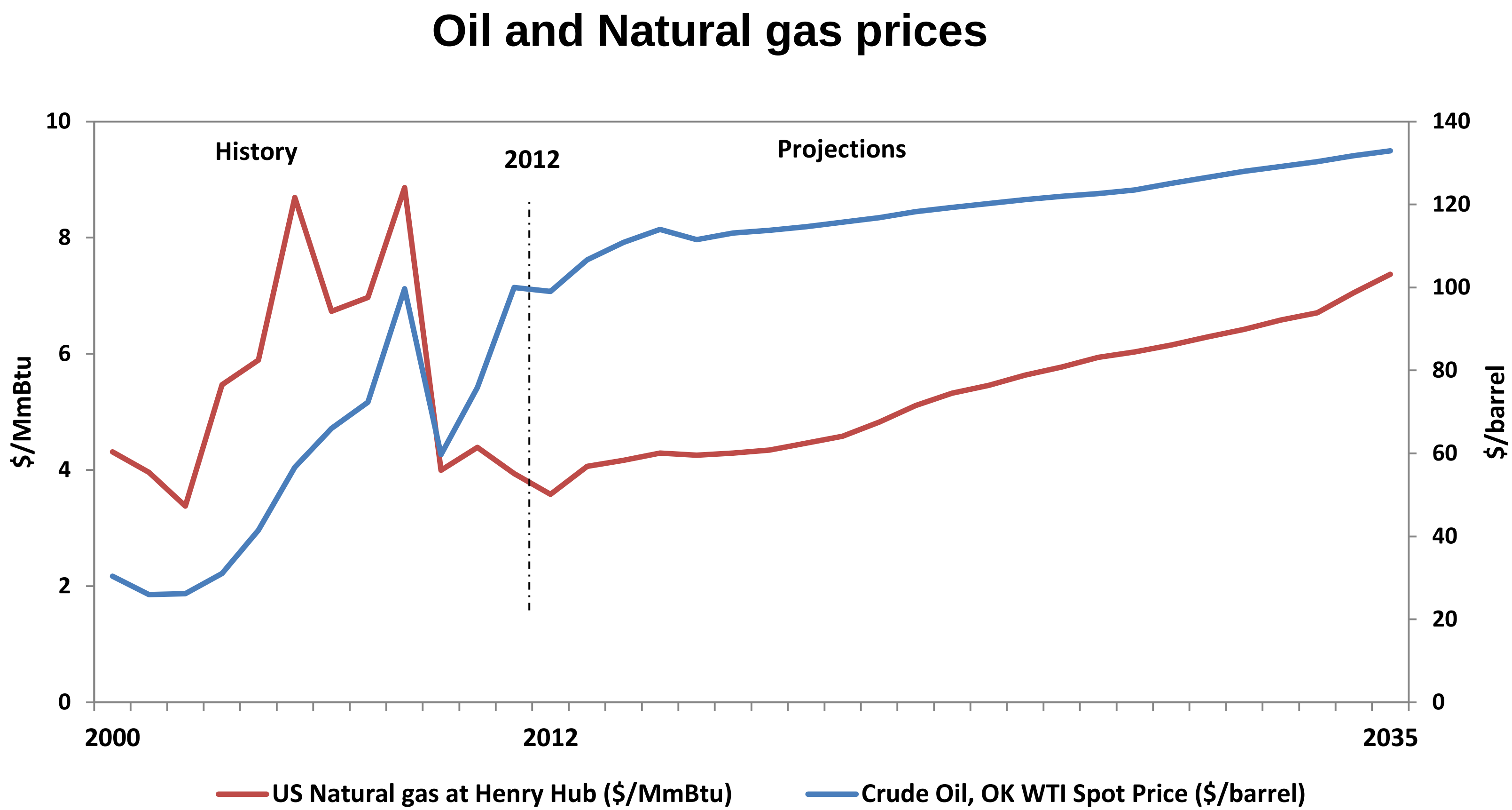
- Hydrocarbon prices rising (see next slide).

- And most are "unburnable uncaptured". Only around 30 per cent of global proved fossil fuel reserves can be burnt "uncaptured" between 2012 and 2050 for a 2ºC path (IEA WEO, 2012).

- Therefore, either the development and deployment of CCS on scale must be very rapid or 70 per cent of these resources must stay in the ground or the 2ºC target will be greatly exceeded. Fundamental contradiction between current valuation methods and declared world climate policy.

- Risks of stranded assets a major issue.

Hydrocarbons: rising prices/stranded assets? (I)



Source: EIA, Annual Energy Outlook 2012, Reference Case.

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Hydrocarbons - Gas

- Potential role for hydrocarbons in the transition, e.g. gas as a "bridge technology".
- Global trends appear to suggest a shift over the coming decades to gas; emissions benefits widely stated in the region of 50% of coal (divided gas escapes limited).
- Much technical progress in hydrocarbons. Horizontal drilling and "fracking" has enabled "unconventional" gas resources to be exploited economically (tight gas, shale gas and coal bed methane). US wholesale gas prices have fallen sharply; will rise with greater world market integration.
- If a role for gas as a "bridge technology", how to substitute 'gas for coal' and not 'gas for renewables'? Renewable investment has continued to rise over recent years, but could be threatened as shale boom changes perceptions. Need clarity now on future regulation/carbon prices.
- The development of Carbon Capture and Storage is crucial if we are to continue to use hydrocarbons in the future. Slow progress. Cross-country collaboration can accelerate technological development?

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Policy for the low-carbon transition – medium-term structures

- Good policy needed to drive this industrial revolution – different from past revolutions.

- Six key **market failures**. Different failures point to different instruments, but the collection is mutually reinforcing:

  - ***Greenhouse gases*****:** carbon taxes / cap-and-trade / regulation;
  - ***R,D&D*** (research, development and deployment): tax breaks, feed-in tariffs (FIT) for deployment, publicly funded research;
  - ***Imperfection in risk/capital markets*****:** risk sharing/reduction through guarantees, equity, feed-in tariffs, floors on carbon prices. FIT straddles first 3 imperfections. Green/infrastructure development bank: reduces policy risk, provides leverage, longer-term horizon, power of example;
  - ***Networks*****:** electricity grids, public transport, broadband, recycling, community-based insulation schemes. Government frameworks needed;
  - ***Information*****:** for consumers labelling and information requirements on cars, domestic appliances, products more generally; awareness of options. Similar issues for producers.
  - ***Co-benefits*****:** valuing ecosystems and biodiversity, valuing energy security, regulation of dirty and more dangerous technologies.

- Should not see these in terms only of static re-allocations or corrections: policy concerns the dynamics of change and learning. Fostering a transition – experience of EBRD.

Development, mitigation and adaptation are intertwined

- For example:
  - **Food:** low-till techniques for rice save inputs, including water and energy, and provide more resilience, reduce methane, reduce soil disturbance and emissions.
  - **Energy:** low-carbon energy, e.g. decentralised solar, reduces emissions, brings electricity and clean cooking facilities to poor people (around 1.3 billion people in the world without access to electricity and 2.7 billion without access to clean cooking facilities (WEO, 2011)), is less vulnerable than grids, and is more inclusive, e.g. enables women and children to study at night, reduces time spent collecting and transporting biomass, and enables women to open businesses such as solar charging stations. Less susceptible to corruption than grids.
  - **Public transport:** reduces congestion and pollution, increases the mobility and opportunities of people, if well designed is more resilient.
- Analytical and practical mistake to separate out the three issues into silos or, to portray as in conflict or tension.

Policy for the low-carbon transition – shorter-term issues

- Now is the time to invest for (low-carbon) growth: in many developed countries private sector sitting on record levels of savings and long-term real interest rates low.

- Good (clear and credible) public policy to correct market failures can restore confidence and leverage large private investment opportunities with little threat of crowding out.

- Will require government instruments that help manage risk. Mostly private investment and finance.

- Government is key source of policy risk. Policy uncertainty risks damaging short-run investment and hindering long-run structural change. Greater clarity can unlock private investment for a sound path for medium-term growth (Zenghelis, 2011 and LSE Growth Commission 2013).

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Collaboration and understanding others

- It is possible to move forward without full agreement, and we are seeing examples including China, Indonesia, Colombia, Mexico, etc.

- *Equitable access to sustainable development* (language of UNFCCC Cancun 2010) is an attractive way of framing the issues that may help bridge the gap between developed and developing countries and accelerate action.

  – Countries come together in a *dynamic partnership* where the *choice* of their sustainable development path is determined by the people of developing countries and that path is supported by rich countries (providing *strong example* and *access* to know-how, technology and finance).

  – Contrast with "burden-sharing", "others should pay incremental cost", zero-sum games.

Leadership from international institutions

- Collectively, their **mandates** are poverty reduction, growth, development, sustainability and stability.
- They can **integrate across the key problems** of our decade: economic crises, climate crises, medium-term growth, changing international division of labour.
- They can provide **finance** with a **longer-term** perspective for longer-term issues.
- They can bring nations together in an equitable way, in part **by showing what others are doing,** around what must be an **internationa**l and **collaborative** endeavour.

Conclusion

- *Six years since the Stern Review*: Risks bigger, technological change promising.
- *Where are we going and why action is slow:* To a dangerous place; need political will.
- *Describing the risks - the scientific and economic models*: Both scientific and economic models badly under-estimate potential impacts; new generation of models needed.
- *Sustainable growth and development*: Transition to low-carbon economy likely to be full of innovation and benefits beyond reduction of climate risks.
- *Policy for the low-carbon transition*: Policy to overcome six major market failures is key to fostering the recovery of economies and the dynamic transition to a low-carbon growth and economy.
- *Collaboration and understanding others*: International institutions are key to addressing economic and climate crises together and building international cooperation.

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