Energia, clima e sostenibilità: risorse, popolazioni e sviluppo - Riserve di petrolio, di carbone, di minerali e loro evoluzione - 2

SSST

Torino, 6 Ottobre 2010

Sala Principi D’Acaja - Università di Torino

Andrea Bigano
Fondazione Eni Enrico Mattei

Outline

4. Externalities and energy

The concept of externality.

Local and global externalities. Supra-national policies and local issues

Global energy externalities of energy: climate change, greenhouse gas (GHG) emissions, human activities

Pigouvian taxes and the Coase Theorem

Tools for the correction of negative externalities: taxes, subsidies, standards, and tradable permits.

5. Energy, climate and sustainability

Energy use and emissions of greenhouse gases: the link between GDP and GHG emissions.

The main drivers of change.

Responses to climate change. Mitigation and adaptation

Model Scenarios: Business as usual and stabilization scenarios

The stabilization energy mix. Desirable goals and realistic objectives

Climate change mitigation policies and diplomacy: efficiency, equity and international agreements

Conclusions: energy security and sustainability: conflicts and synergies.

Resources and sustainability: Externalities

"An externality is present whenever the wellbeing of a consumer or the production possibilities of a firm are directly affected by the actions of another agent in the economy".

Mas-Colell et al. 1995

Negative externalities can be viewed as overexploitation by individuals of some common resource (air, water, climate, biodiversity etc.)

Negative externalities in energy fuel cycles

"Fuel cycle externalities are the costs imposed on society and the environment that are not accounted for by the producers and consumers of energy, i.e. that are not included in the market price.

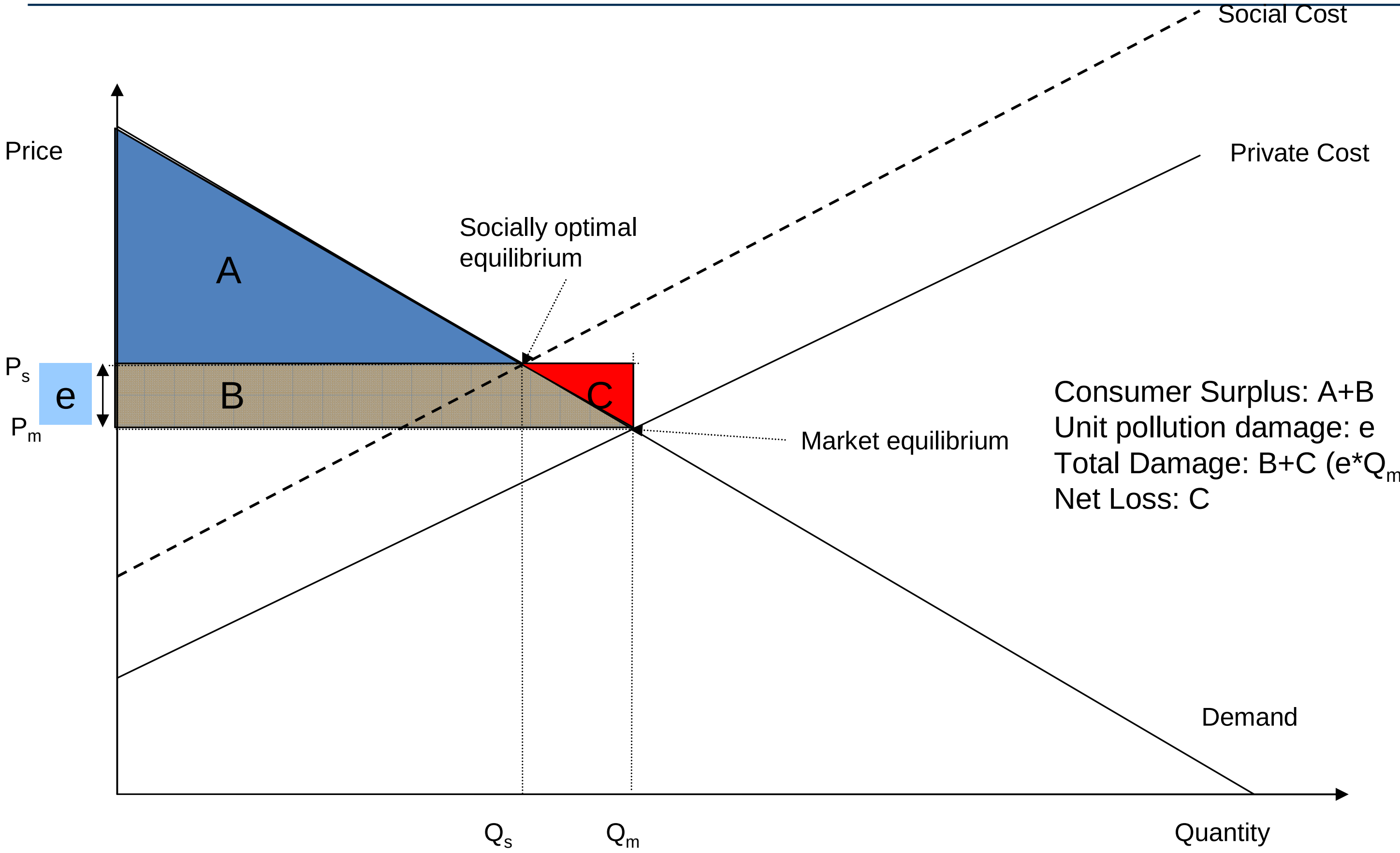
They include damage to the natural and built environment, such as effects of air pollution on health, buildings, crops, forests and global warming; occupational disease and accidents; and reduced amenity from visual intrusion of plant or emissions of noise."

ExternE, 1997

Negative Externalities in energy fuel cycles can be:

- local
- transboundary
- global

Negative externality (e.g. polluting emissions)



Consumer Surplus: A+B
Unit pollution damage: e
Total Damage: B+C (e^*Q_m)
Net Loss: C

Why are we interested in external costs?

Because of C

Cost benefit analysis

Guidance to policy

In case of global externality or high consequence local externalities, they may affect the future technological development or even the existence of the energy source.

How to correct externalities

Impose a standard: if emissions are $y=f(q)$, allow only $y^{*}= f^{-1}(q_s)$. But implies perfect knowledge and perfect enforcement

Internalize it: a tax equal to $p_s – p_m$ would restore optimality

➡ PIGUVIAN TAX.

- Implies perfect knowledge of external costs at the optimum. Above some unknown tresholds, damages may be irreversible.

Give property right on externality to either consumers or producers

➡ COASE THEOREM.

- Implies no transaction costs and distributional issues if property rights are given to the strongest agents.

An imperfect world: acceptable targets and policy tools

Optimality is not reachable in the real world, but authorities, on the basis of scintific evidence, may set “acceptable” levels of environmental quality. Which instruments may it use?

Exhortation, persuasion, information,

Promotion of voluntary agreements

Quantitative and qualitative controls on emissions,

Technology standards

Taxes on pollution inputs, eg. a tax on coal based on its carbon content,

Taxes on emissions,

Product taxes,

Subsidies on pollution reductions (subsides in aid of purchasing abatement equipment),

A system of tradable pollution permits,

A system of tradable input permits.

an imperfect world: problems with taxes

Taxes minimise abatment costs and promotenew technlogies, but:

It may be very difficult to determine an appropriate level of taxes,

Finding the by iteration might not work if producers get locked into inappropriate technologies.

Pollution may not be uniform. If local intensities of pollution are to be taken into account, then differential taxation may be called for, which could be impractical.

Policy makers must be able to commit to taxes

In case of uncertain damages, taxes might result in an unwanted pollution level (but give certainty of the cost) (Weitzman)

Tradeable Pollution permits

Dales (1968) showed that a cap-and-trade permit scheme has the same cost minimisation properties of an emission tax. However:

they give certainty about the target in an uncertain world

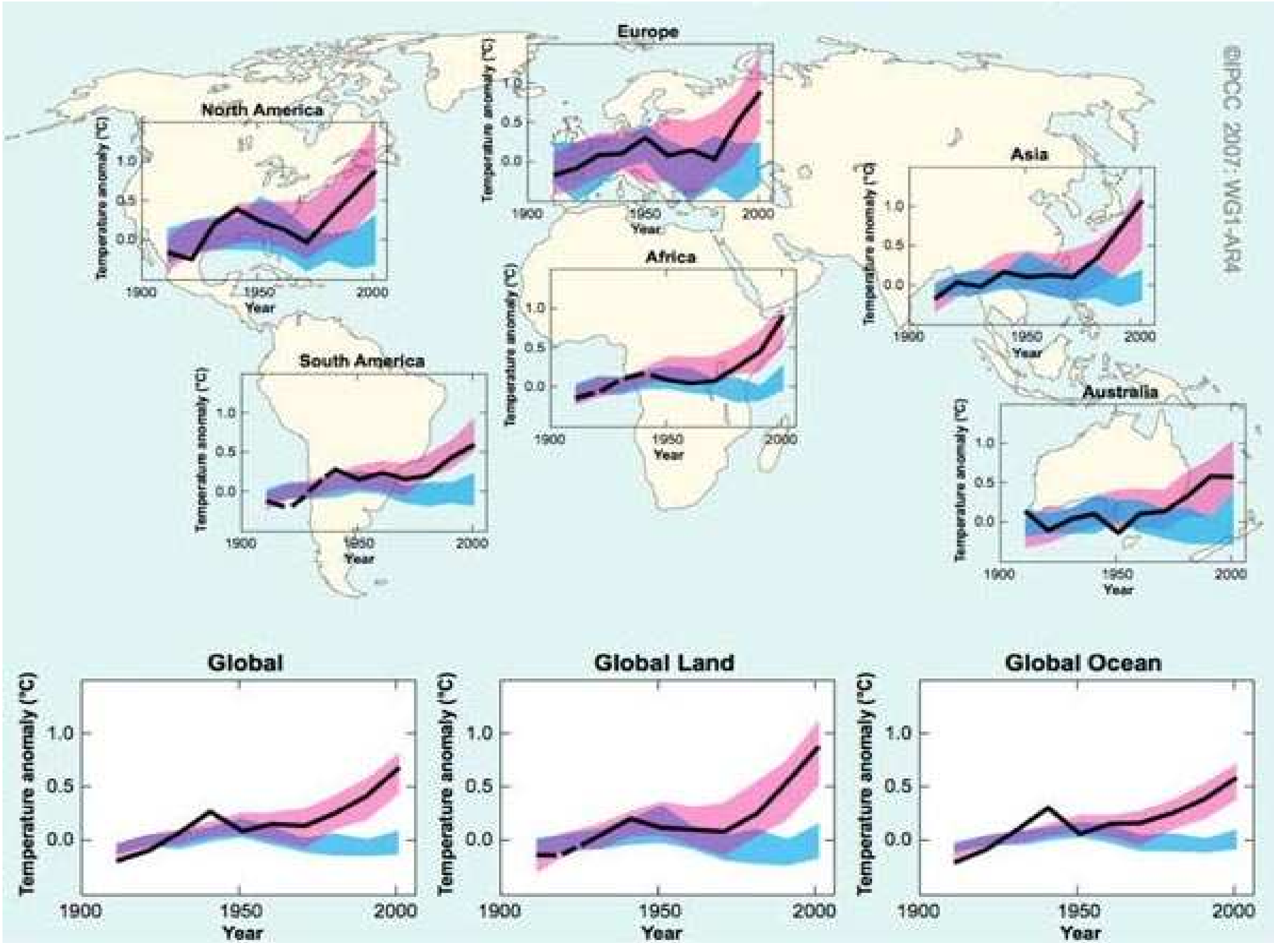
they do not require long term commitment from the policy makers

they generate a constituency of vested interests that have strong motives to preserve the system in the future to protect their investment in permits. This requires banking or long term permits

Separates who undertakes abatement and who pays for it.

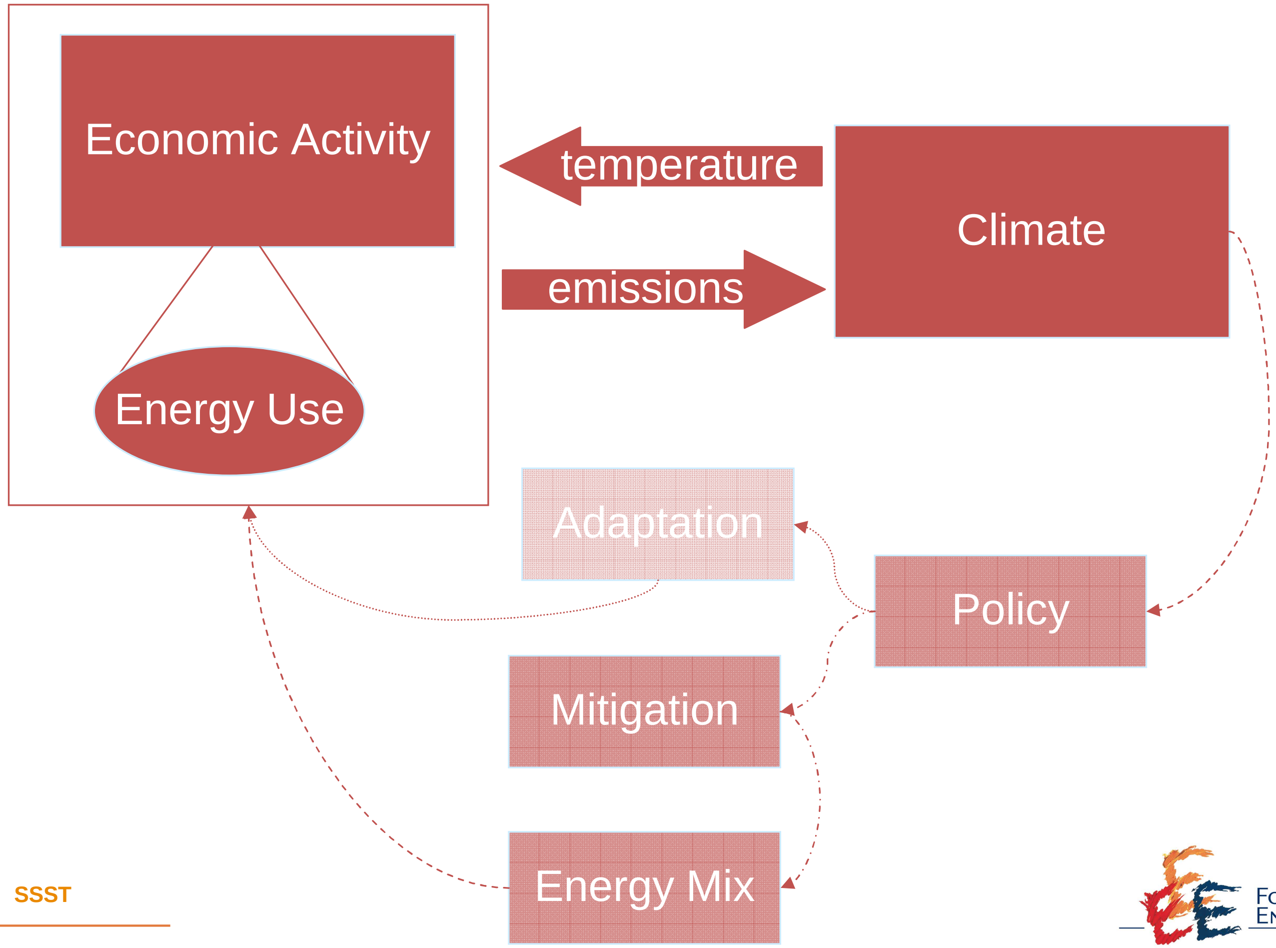
A tax generates revenue and thus allows lower other taxes and compensate negative consequences of environmental taxes on the economy. Under cap-and-trade, government revenues would also be increased if permits are distributed by means of an auction.

Climate change: historical data



Source: IPCC Climate Change 2007: The Physical Science Basis, Summary for Policymakers (2007), p11

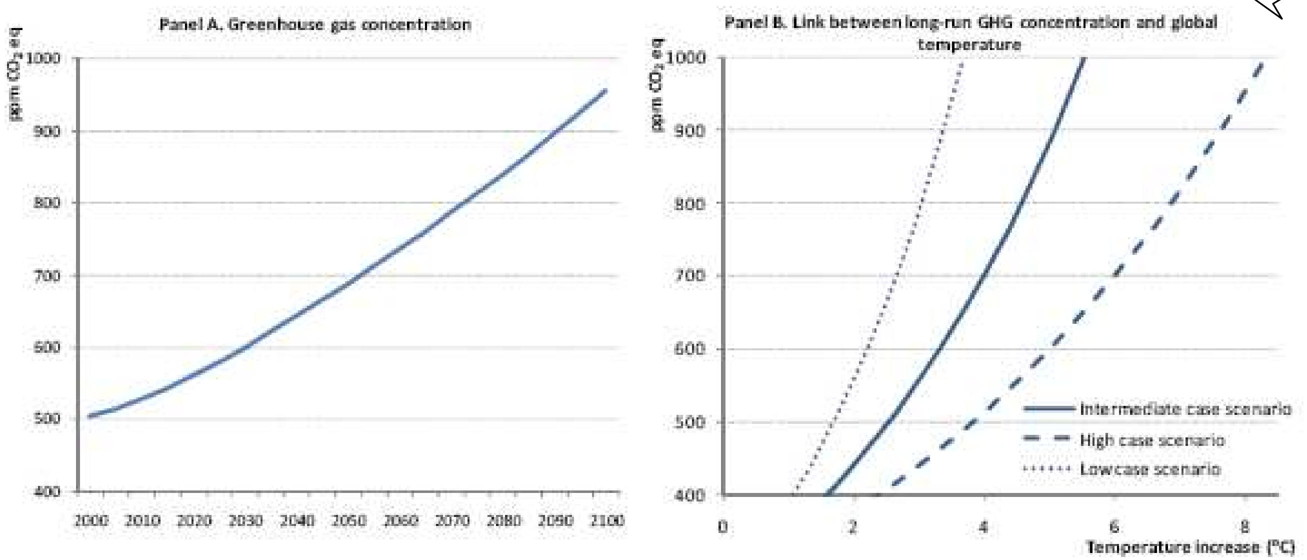
Energy and climate change: the issue



Energy and climate change: the issue

Greenhouse gas concentration (ppm CO_2-equivalent)	Most likely temperature increase	Very likely above (>90%)	Likely in the range (>66%)
350	1.0	0.5	0.6 - 1.4
450	**2.1**	**1.0**	**1.4 - 3.1**
550	2.9	1.5	1.9 - 4.4
650	3.6	1.8	2.4 - 5.5
750	4.3	2.1	2.8 - 6.4

Projected trends in greenhouse gas concentration and associated temperature increases in the absence of new climate change policies (source: OECD 2008)



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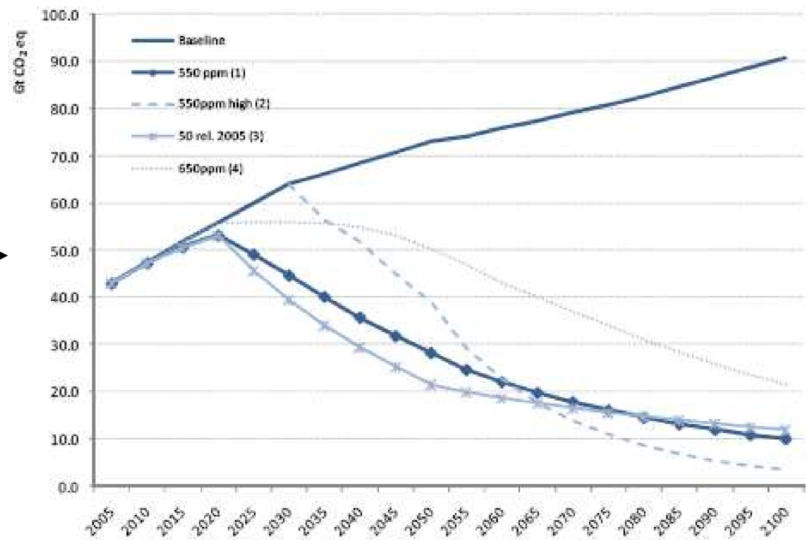
Energy and climate change: the issue

1. Stabilisation at 550ppm CO2 eq all gases included (corresponding to about 450ppm CO2 only) with modest overshooting.
2. Stabilisation at 550ppm CO2 eq all gases included (corresponding to about 450ppm CO2 only) with high overshooting.
3. 50% GHG emission cut in 2050 with respect to 2005 levels.
4. Stabilisation at 650ppm CO2 eq all gases included (corresponding to about 550ppm CO2 only) without overshooting.

Source: OECD ENV-Linkages model.



Time horizon	*Business As Usual (BAU)*	*450 ppm CO_2 (ca. 500-550 ppm CO_2 eq.)*	*dcrease % w.r.t. BAU*
2005	7.8	7.8	
2030	13.0	8.0	**38%**
2050	17.0	4.9	**71%**
2100	23.6	3.6	**85%**

Annual Carbon emissions from fossil fuels (GtC) in alternative scenarios

Source: Bosetti V., C. Carraro, M. Tavoni, FEEM, 2009

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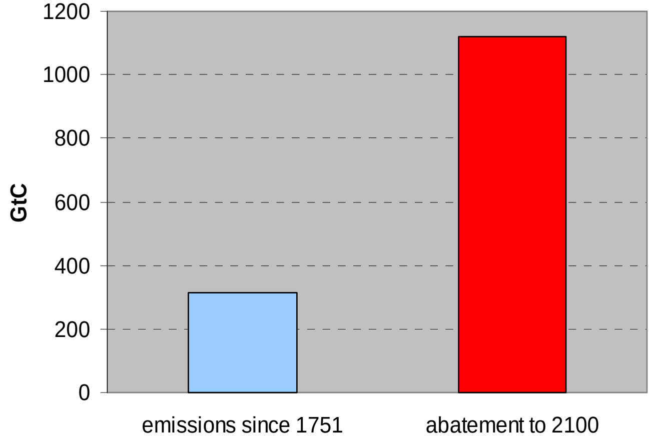
Stabilising the climate will ultimately require large emission cuts

Energy and climate change: the issue

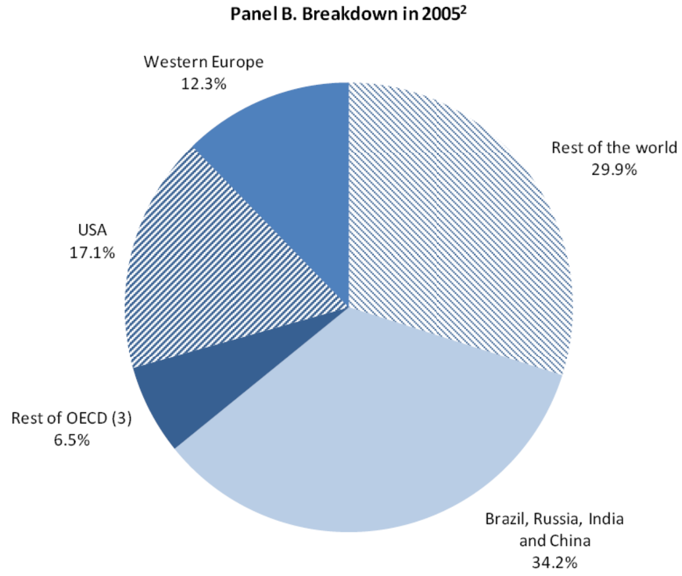
Mitigation effort needed for a 450 ppm di CO_2 stabilization scenario

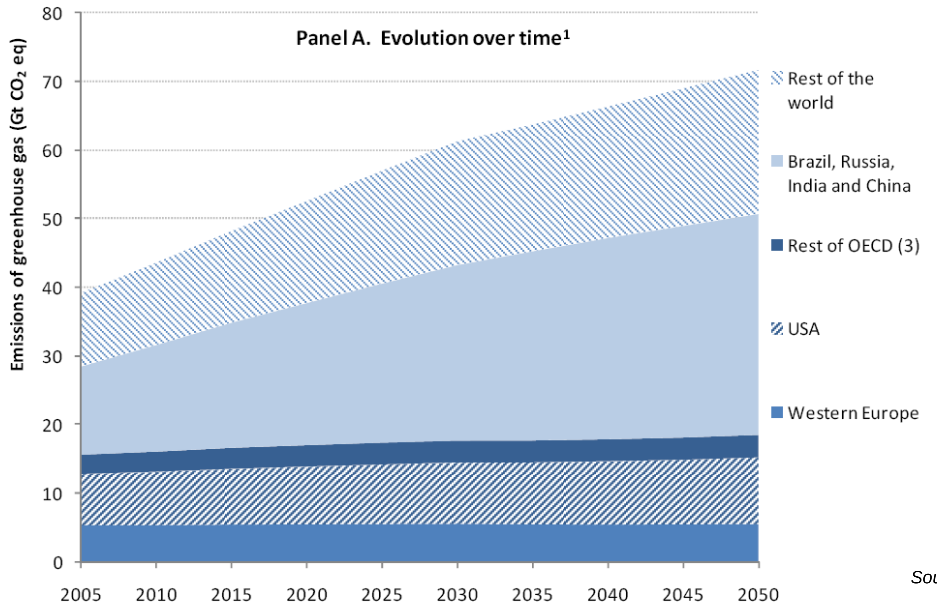


Fonte: Bosetti V., C. Carraro, M. Tavoni, 2009

- **The abatement effort needed to stabilise atmospheric CO_2 to 450 ppm is almost 4 times all greenhouse gases emissions from preindustral times to date.**
- **In per capita terms, global average emission must fall from 2 to 0.3 tC per capita per year.**
- **The way we produce and consume energy must change!**

Emission trends – regional breakdown (baseline)





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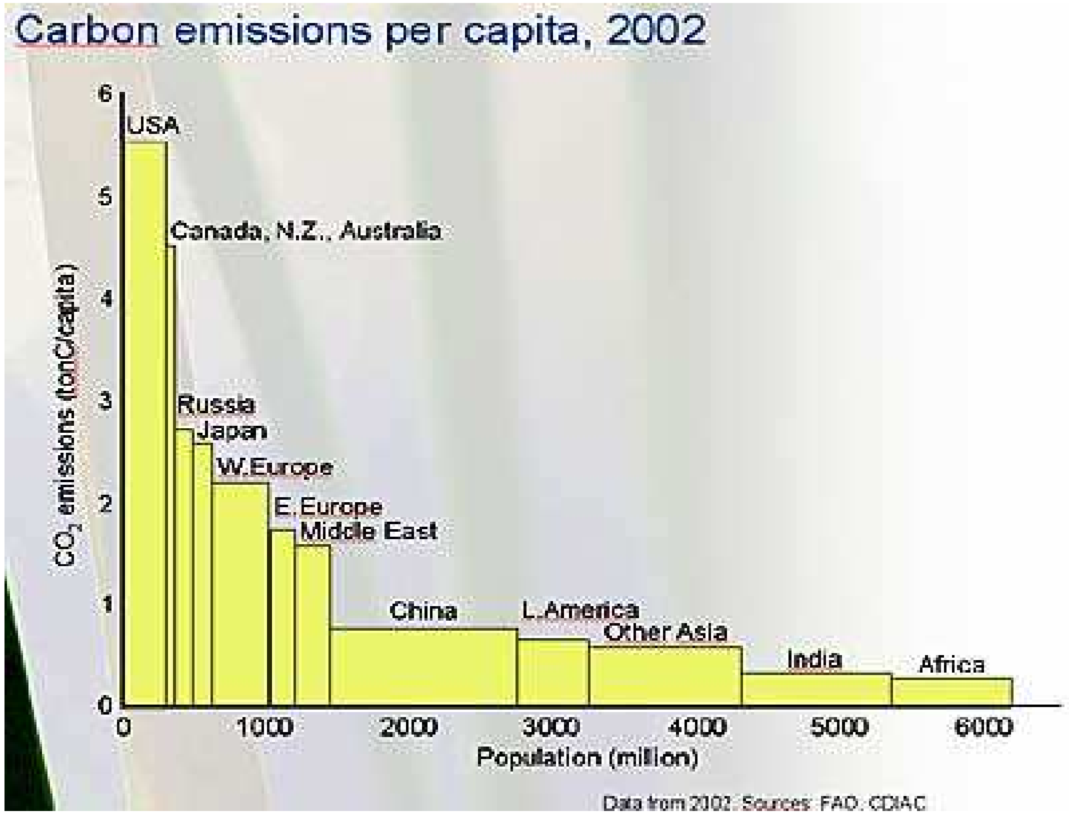
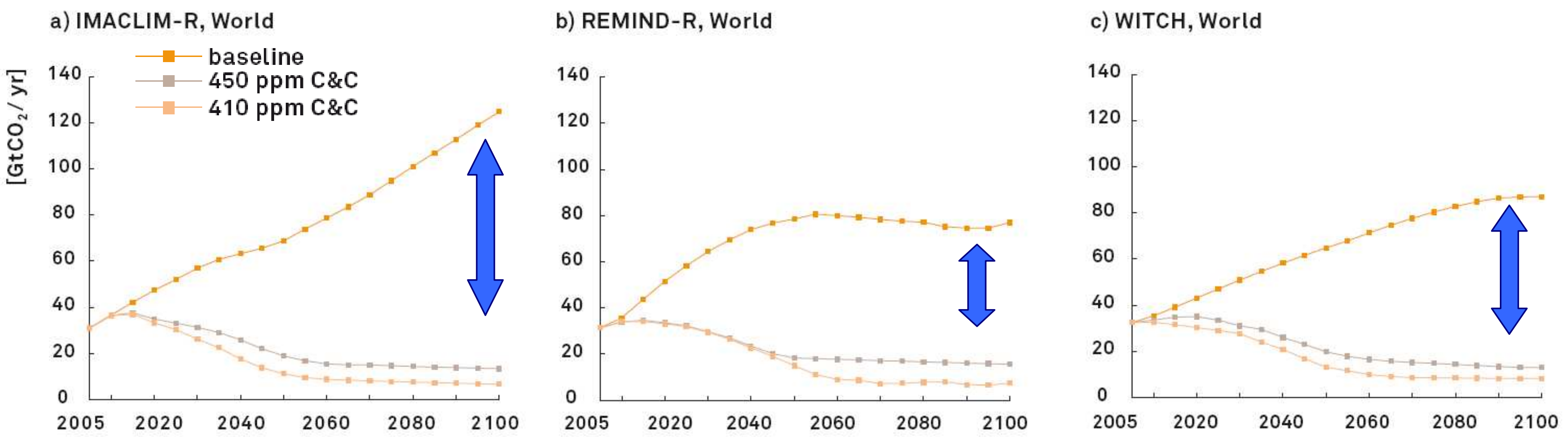
Source: *OECD Environmental Outlook to 2030* (2008) and OECD ENV-Linkages model

Climate change: present emissions per capita



Source: IPCC Climate Change 2007: _ The Physical Science Basis, Summary for Policymakers (2007), p11

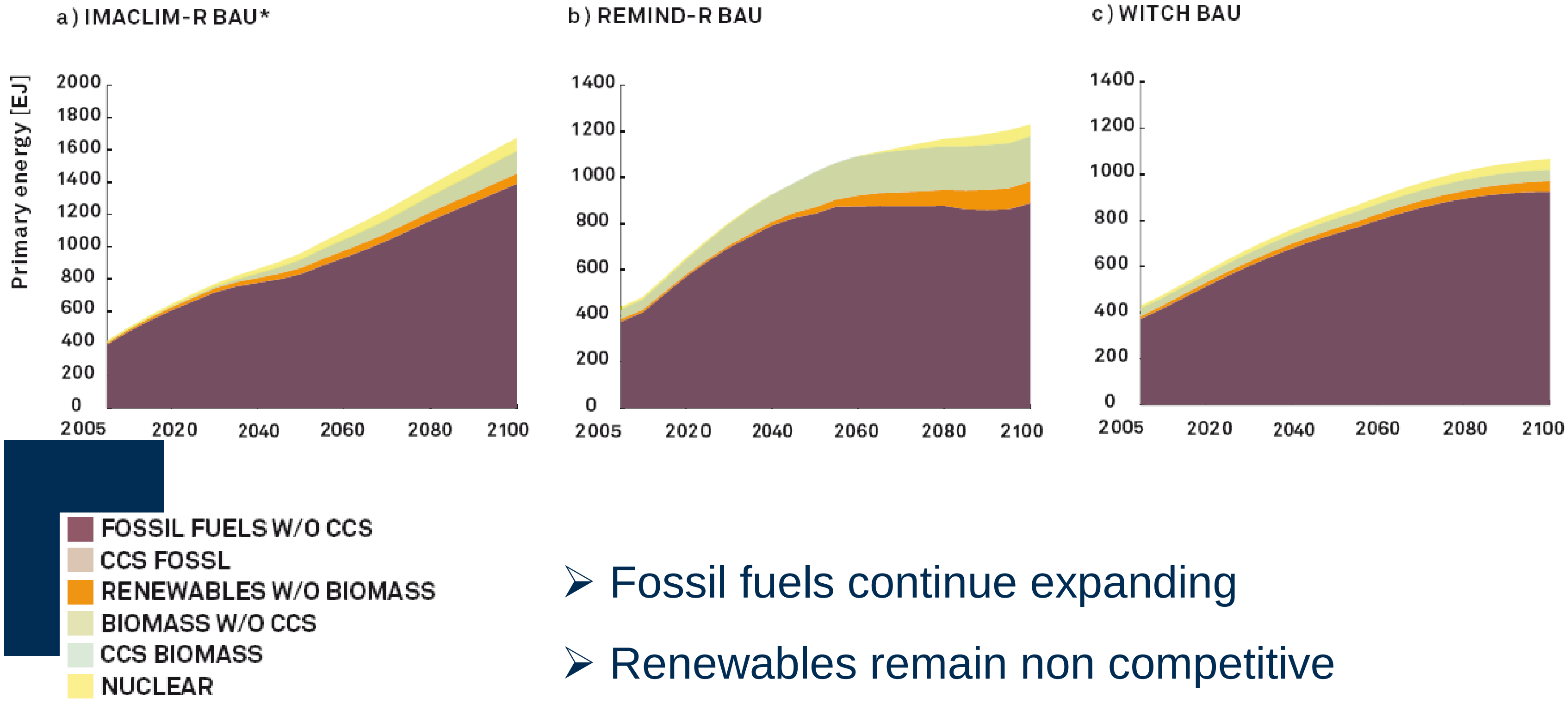
Global CO_2 emission and stabilisation scenarios



- global emissions increase for the whole century in absence of mitigation policy
- CO_2 at 730-840 ppm: probability of overshooting +2ºC is 94%-100%, expected temperature +3ºC / +7ºC
- At 450 ppm overshooting +2ºC probability is 51%-58%
- At 410 ppm overshooting +2ºC probability is 43%-50%

Source: RECIPE Project (2009)

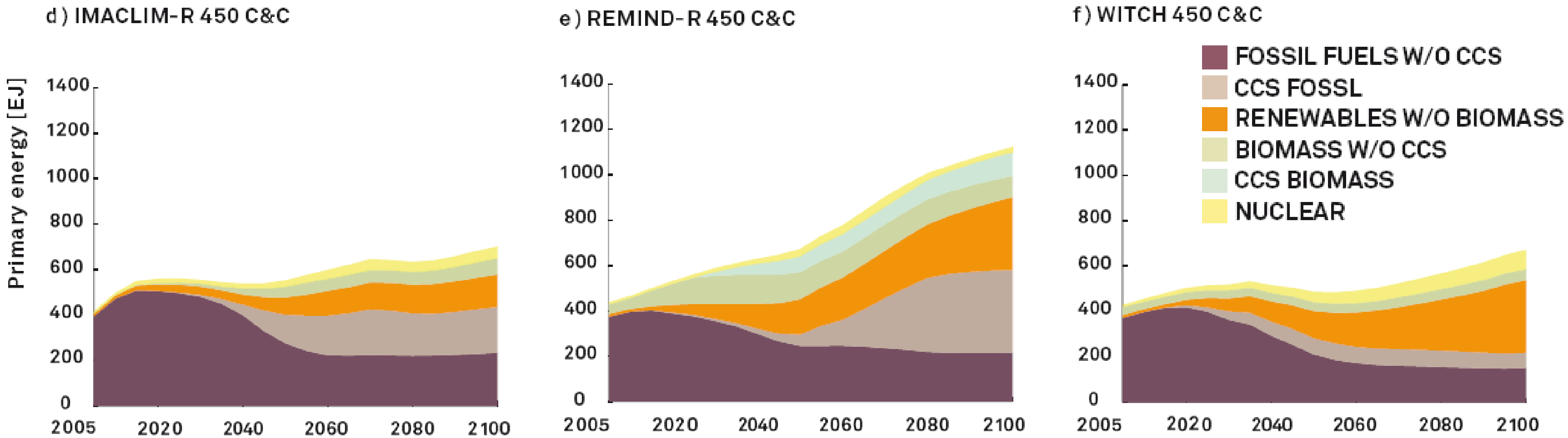
Energy use must change: BAU scenarios



- Fossil fuels continue expanding
- Renewables remain non competitive

Source: RECIPE Project (2009)

Energy use must change: stabilizing at 450 ppm CO_2

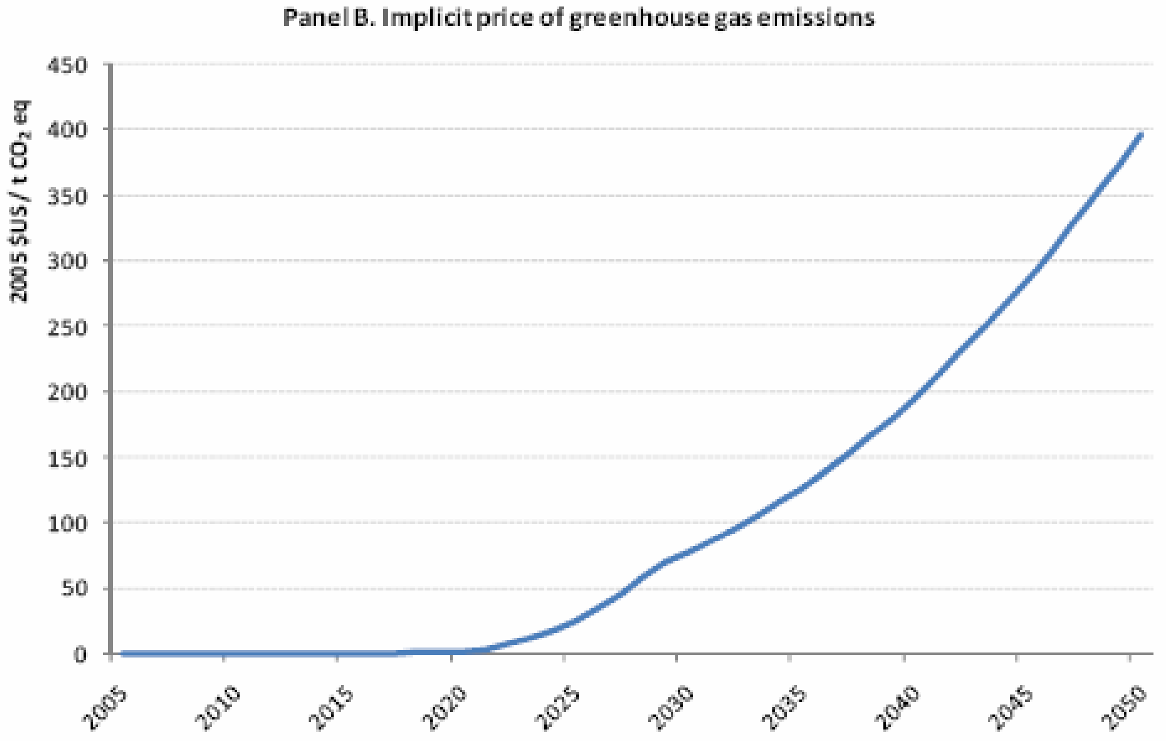


- Energy efficiency: very important in WITCH e IMACLIM-R
- Coal with CCS
- Substantial share for renewables

Source: RECIPE Project (2009)

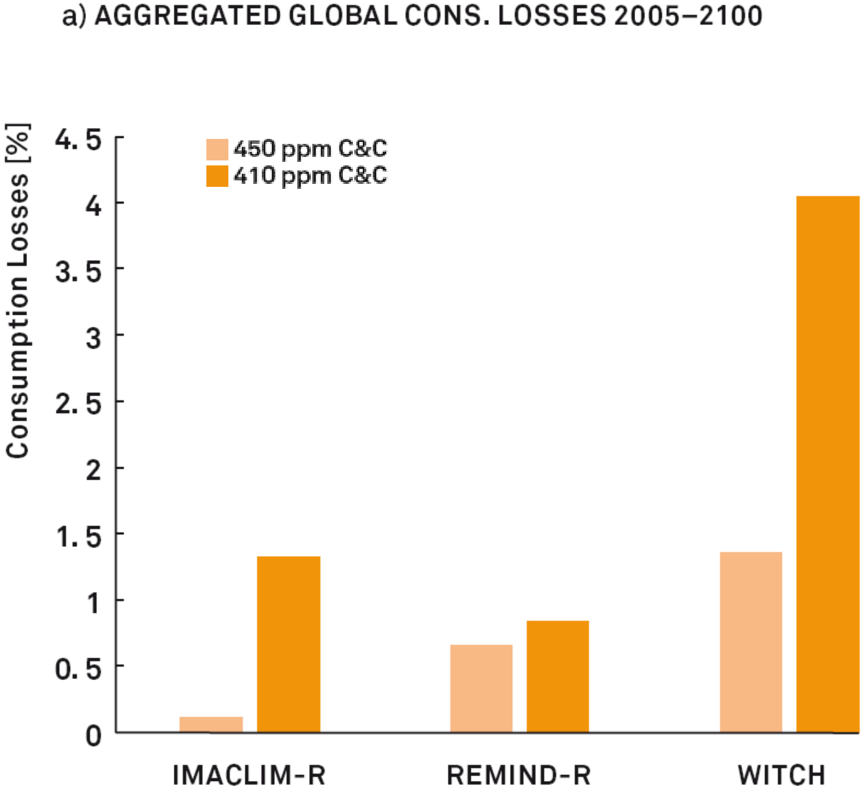
Energy use must change: is it expensive?

"Cost-effective mitigation action would imply only limited costs in the first decades"



Source: OECD (2008)

Energy use must change: is it expensive?

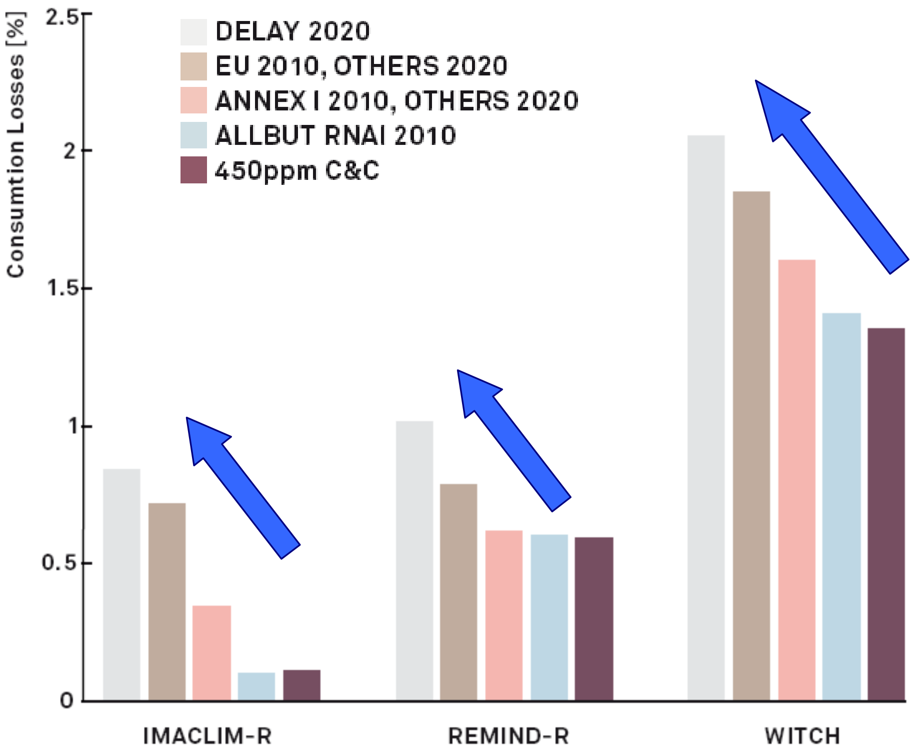


- The 450 ppm CO_2 target is not expensive.
- Bringing concentration further down to a 410 ppm CO_2 brings up costs considerably.

Source: RECIPE Project (2009)

Note: Costs in terms of foregone consumption. 3% discount rate

However…



Source: RECIPE Project (2009) : alternative assumptions on international cooperation, 450ppm scenarios

- Previous projections are based on optimistic assumptions on international cooperation, swiftness of action and availability of technologies
- In case of delays or uncoordinated actions costs soar
- Delaying action to 2030 may make it impossible to reach 450 ppm CO_2

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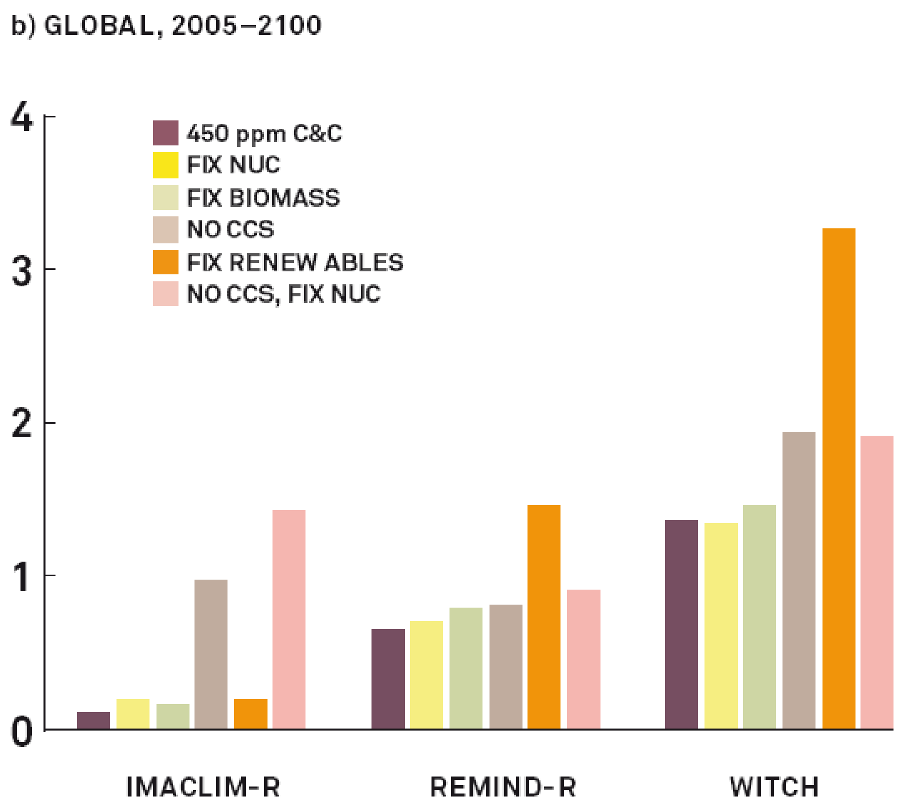
However (continued)…



- **Problems in renewable energy technologies diffusions…**
- …or in CCS deployment…
- … can result in soaring costs!

Source: RECIPE Project (2009) : alternative assumptions on tecnology availiability, 450ppm scenarios

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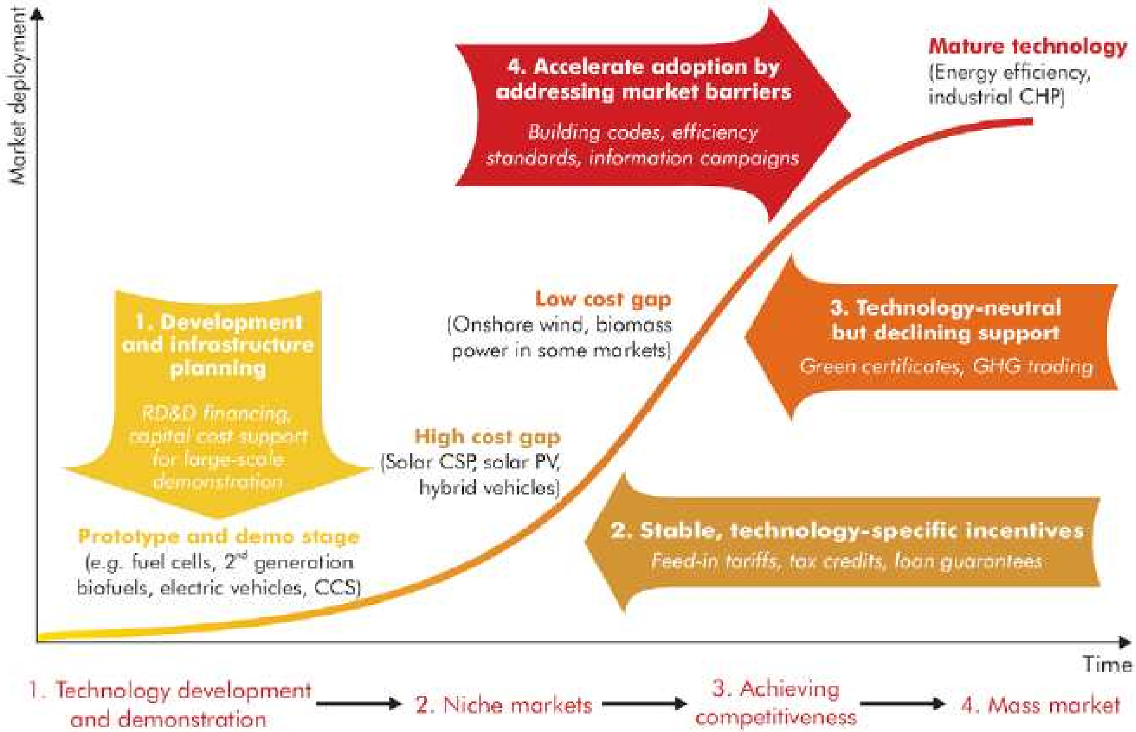
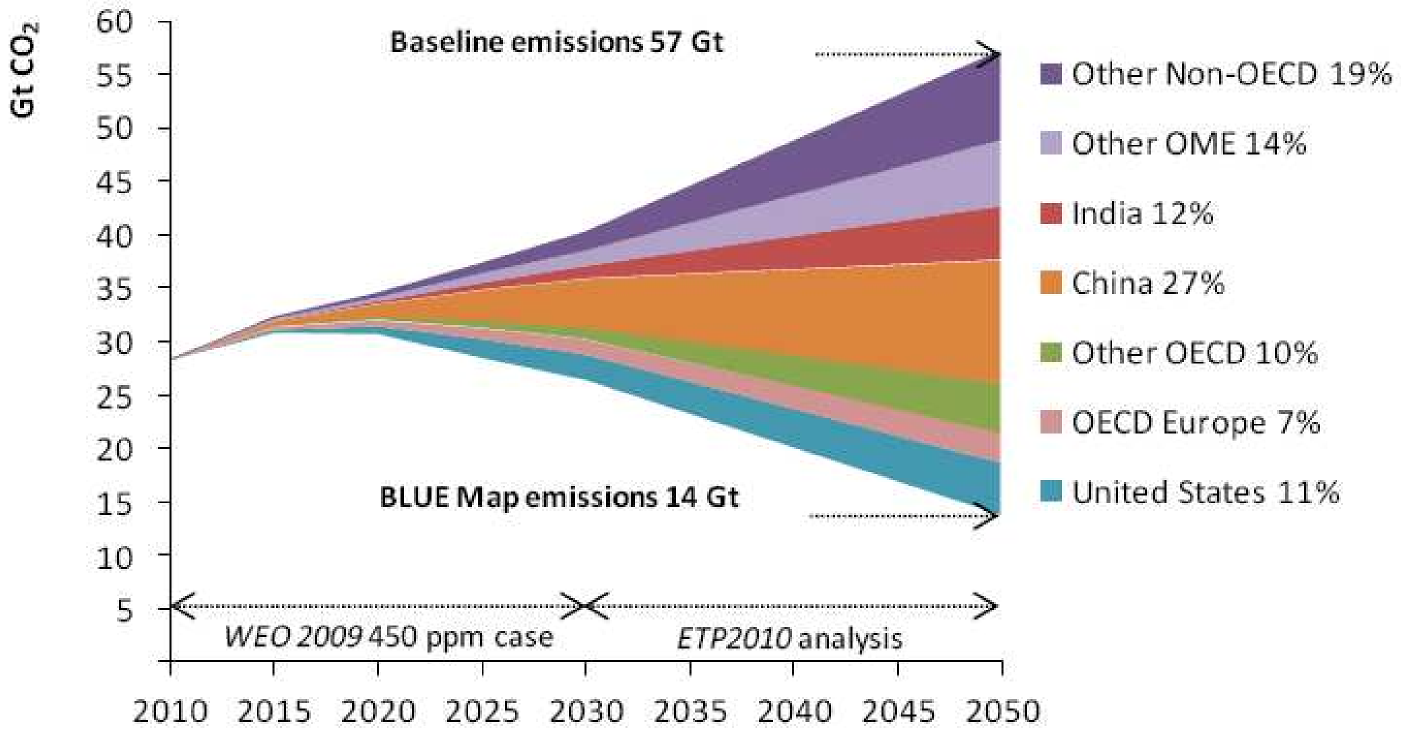
However (continued)…



Source: IEA, Energy Technology Perspectives, 2009

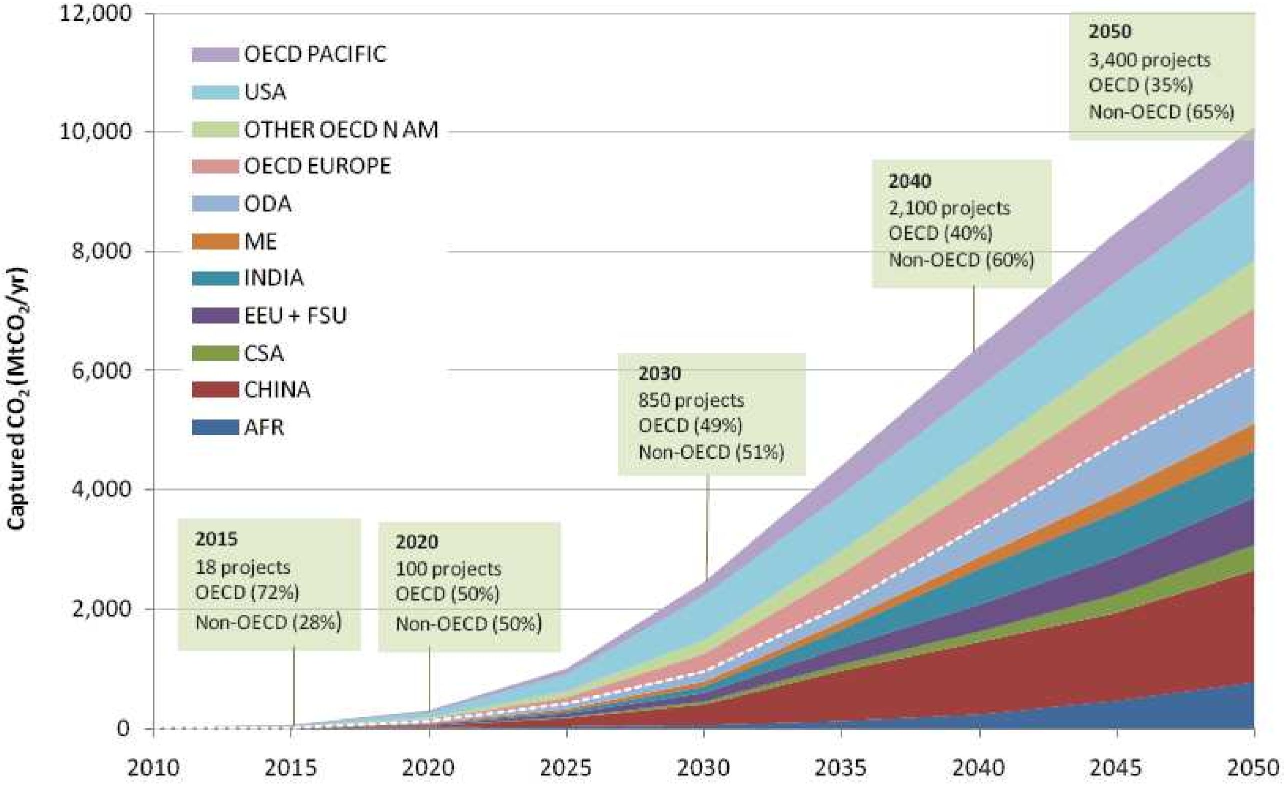
technology development and deployment requires policy support!

Differentiated efforts: abatement effort



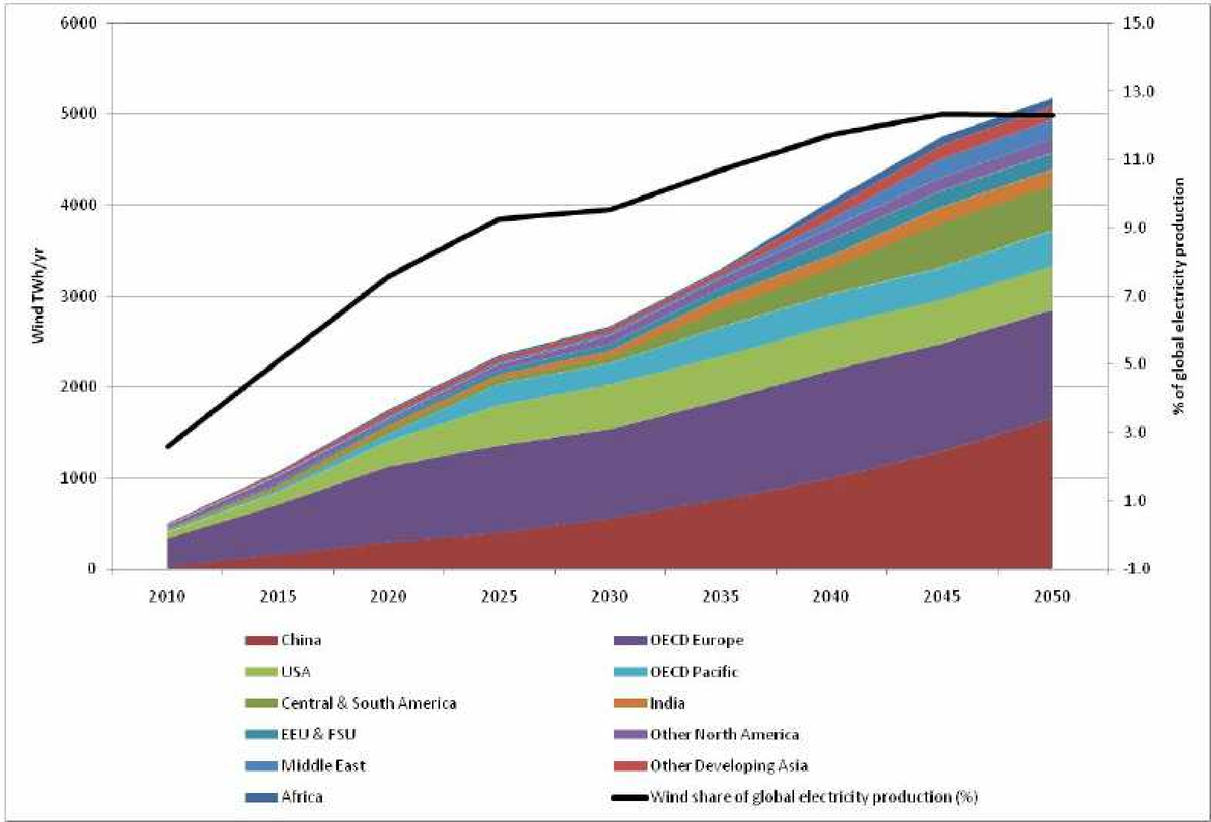
Source: IEA, Energy Technology Perspectives, 2009

Differentiated efforts: CCS



Source: IEA, Energy Technology Perspectives, 2009

Differentiated efforts: Wind



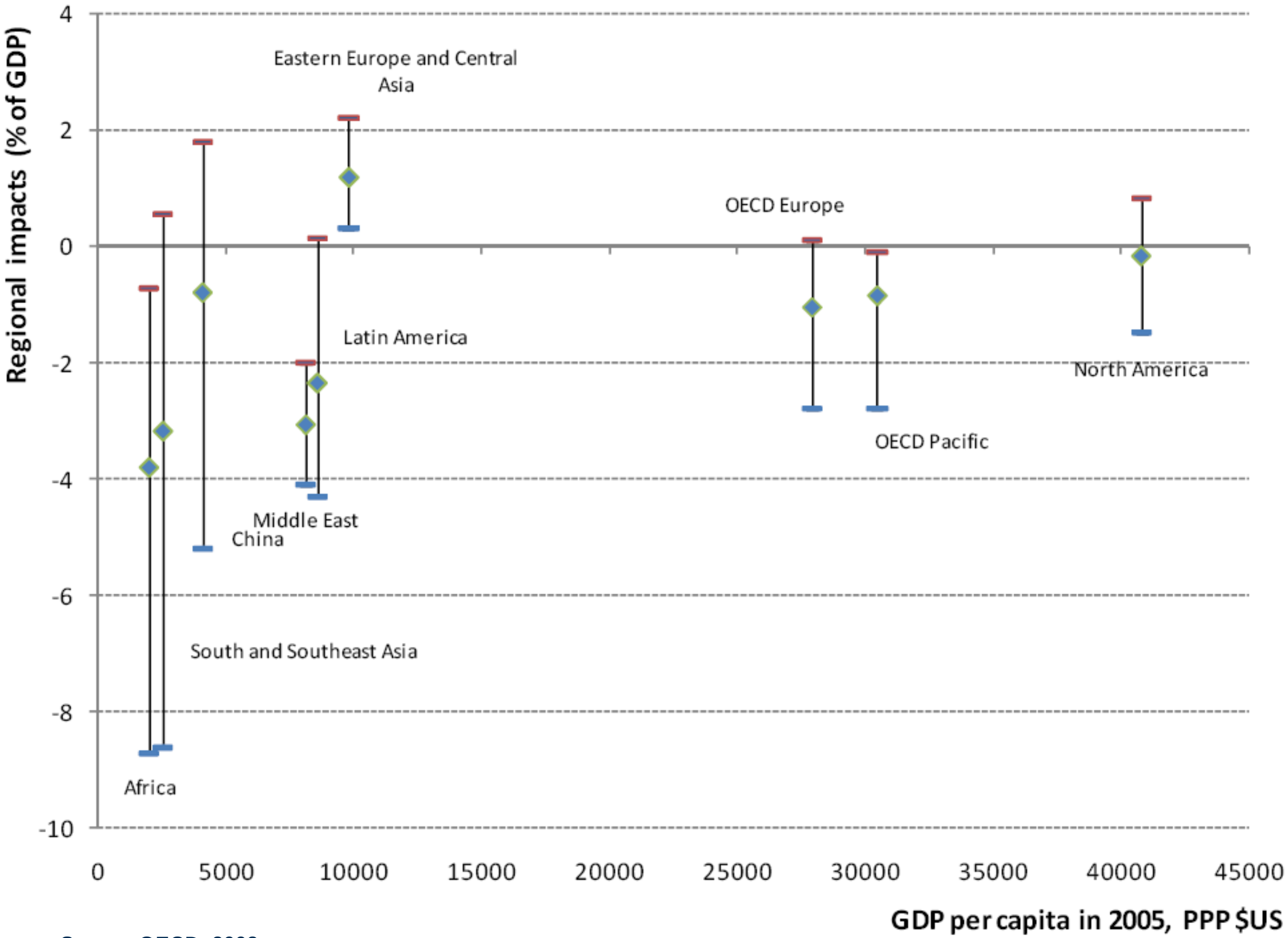
Source: IEA, Energy Technology Perspectives, 2009

Why to join? cobenefits of GHG–free technologies

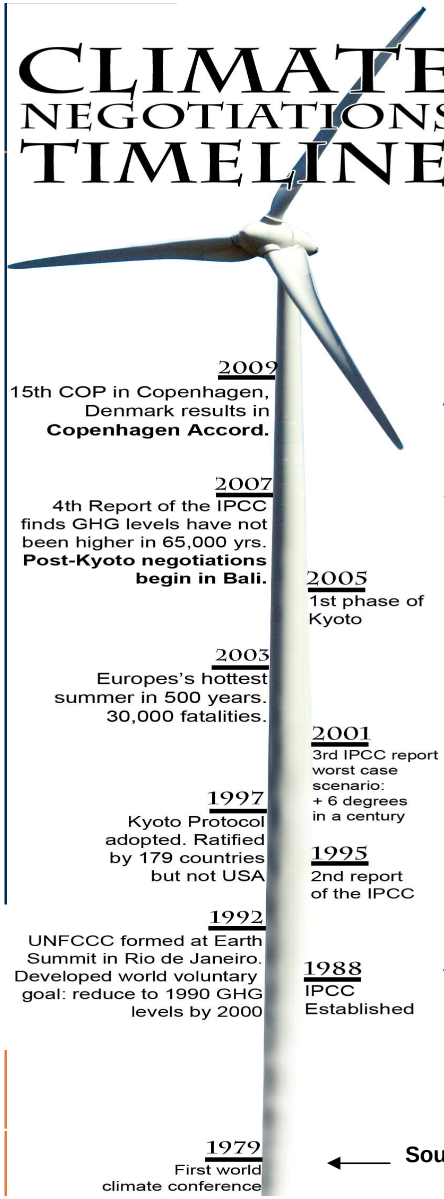
Energy Technologies	Life Cycle Impacts (Pre- and Post-Generation)			Power Generation Impacts			CO_2 Emissions *t/MWh*
	Air	Water	Land	Air	Water	Land	
Coal - USC	*Baseline Technology for Relative Assessments Below*						0.777
Coal - Biomass	Positive	Positive	Variable / Uncertain	Variable / Uncertain	Minimal	Minimal	0.622
Coal - CCS	Negative	Negative	Negative	Variable / Uncertain	Negative	Minimal	0.142
Coal - IGCC	Minimal	Variable / Uncertain	Minimal	Positive	Positive	Minimal	0.708
NGCC	Positive	Positive	Positive	Positive	Positive	Positive	0.403
Nuclear	Positive	Variable / Uncertain	Variable / Uncertain	Positive	Negative	Positive	0.005
Solar - CSP	Positive	Positive	Positive	Positive	Negative	Minimal	0.017
Solar - PV	Positive	Positive	Positive	Positive	Positive	Minimal	0.009
Wind	Positive	Positive	Positive	Positive	Positive	Variable / Uncertain	0.002

SSST Source: IEA, Energy Technology Perspectives, 2009

Why to join? distribution of global warming impacts



Source: OECD, 2008



Source: blogs.dickinson.edu/cop15/

Climate negotiations: what happened so far

Mid '70s: climate change (CC) emerges a scientific issue

1979: first world climate conference in Geneva

Supranational institutions on CC established in **1988** (IPCC) and **1992** (UNFCCC)

After initial commitment to emission reduction of Bush (1990) and Clinton (1993) administrations, CC mitigation drops from US agenda, priority given to knowledge advancement

Since 1995, annual Conferences Of Parties (COP) for CC negotiations

December 1997: More than 150 countries sign the Kyoto Protocol, which binds 38 industrialized countries (called Annex 1 countries) to reduce greenhouse gas emissions by an average of 5.2% below 1990 levels for the period of 2008-2012. To become law, at least 55 countries must ratify the Protocol and 55% of Annex 1 emissions must be covered.

March 2001: Two months after his inauguration, U.S. President George W. Bush announces his country's withdrawal from the Kyoto Protocol.

February 16, 2005: The Kyoto Protocol becomes international law after Russian ratification pushes the emissions of ratified Annex 1 countries over the 55% mark.

July 2009: G8 countries agree that 2°C of average global warming is a limit which should not be exceeded. GHG emissions should be reduced by at least 50% by 2050 and emissions from developed countries should be reduced by 80% or more.

December 2009: The COP15 in Copenhagen was the deadline for a fair, ambitious, and binding global agreement on climate change. Unfortunately no binding agreement was reached.

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The Japan Times

Conference adopts Kyoto Protocol

Greenhouse gas emissions to be cut by average of 5.2%

The Kyoto Protocol

"The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. […] It sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions .These amount to an average of 5% against 1990 levels over the five-year period 2008-2012.

Countries must meet their targets primarily through national measures. However, the Kyoto Protocol offers them an additional means of meeting their targets by way of three market-based mechanisms […] :

Emissions trading

Clean development mechanism (CDM)

Joint implementation (JI).

Monitoring emission targets

Under the Protocol, countries' actual emissions have to be monitored and precise records have to be kept of the trades carried out.

Registry systems track and record transactions by Parties under the mechanisms. […]

Reporting is done by Parties by way of submitting annual emission inventories and national reports under the Protocol at regular intervals.

A compliance system ensures that Parties are meeting their commitments and helps them to meet their commitments if they have problems doing so."

Source: UNFCCC website (http://unfccc.int/kyoto_protocol/items/2830.php)

Kyoto Protocol: pros and cons (Aldy and Stavins, 2010)

Pros

- provides for market based mechanisms, enhancing cost efficiency (Art. 17 on emission trading)
- nations are free to meet their targets in any way they like (sovereignty)
- appearance of fairness: most effort on richer countries "Annex I"
- Politically viable, given the 180 signatories

Cons

- world's major emitters are not constrained
- Few active countries: carbon leakage
- fairness declining as word changes
- countries are not cost minimisers
- CDM flawed
- short term horizon: ends in 2012
- measurement issues

Market based instruments might not be enough…

Taxes and tradeable permits have some useful properties, however supporting policies and measures might be needed for GHG mitigation because:

some markets may not respond well to price signals due to

- market power
- firms not always pursuing cost minimization
- information asymmetries

“While emissions monitoring is improving, there will always remain areas where such measurement is difficult, reducing the effectiveness of price based instruments” (OECD 2008).

International transport (ships and planes) are very difficult to involve in a cap-and-trade scheme

While promoting the adotion of most effcient technologies, they do not guarantee enough the property rights of the developers of new technologies. In the case of climate change, this is very important because:

- developing countries want to start their mitigation policies leapfrogging to the most advanced technology available
- “the value of R&D in climate change is essentially dependent on the credibility of the abatement policies that have been instituted”.

If additional measures are introduced however, it is important that the implicit carbon abatement costs are monitored and take into account in order not to introduce distortions and keep the abatement costs as low as possible.

The trouble with carbon leakage

"If only some countries participate in ambitious climate policies, then energy-intensive industries in participating countries would be at a disadvantage *vis-à-vis* competitors in nonparticipating countries.

At the same time global emissions would not fall by as much as expected due to "carbon leakage", where emission reduction in participating countries may be offset by higher emissions in others.

It operates through two distinct channels: a competitiveness effect, and an energy-intensity effect.

The **energy-intensive effect** would come because abatement in participating countries would reduce demand for fossil fuels worldwide, pushing their price down. This may lead non-participating countries to produce and consume more energy-intensive products than they otherwise would as these become cheaper." (OECD, 2008)

The **competitiveness effect** would come because energy intensive industries in non participating countries would have a cost advantage on international markets. This reduces further the incentive to commit to emission reductions.

"If certain industries, and their workers, feel threatened by abatement strategies that weaken their competitiveness, the leakage argument has considerable weight in sectoral terms. There is a very real risk that opposition by these industries could undermine the willingness of particular regions to continue to make progress in putting in place a comprehensive global mitigation approach."

Remedies:

Border taxes? Clashes with WTO and introduces inefficiencies.

carbon leakage effects can be important if the group of countries that constrain emissions is small; but these diminish rapidly as this group grows

co-operative approaches on sectoral action in the most carbon intensive sectors.

Source: OECD, 2008

After 2012: Post Kyoto policy architectures (Aldy and Stavins, 2007, 2010)

COP 13 in Bali, 2007 set up a RoadMap for post 2012 negotiations. Proposed measures included combating deforestation in poor countries, scaling up investment in green technology, and enhancing funding for adaptation measures. Details on future emissions targets for a post-Kyoto period were not included.

COP 15 failed to reach a binding agreement, but political, and unilateral commitment was offered by major players.

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So how will future CC policy architectures may look like?

targets and timetables

Top-down, Kyoto-like, international agreements

but based on formulas rather than absolute levels (e.g. targets based on GDP: wealthier countries cut more emissions)

“graduation” criteria

climate clubs

international fund for low carbon technologies

harmonized national policies

international agreement on similar national policies

uniform carbon taxes

effectiveness - equity tradeoff

coordinated and unilateral national policies

bottom-up approach

coordination around a common goal, but reliance on domestic policies to set incentives for compliance

examples: regional and national ETS, Chinese energy intensity standards,

Key Principles for a New International Agreement (Aldy and Stavins, 2010)

Climate change is a global commons problem

- Countries must cooperate (UNFCCC, G20, or bilateral negotiations)
- Sovereignity implies that treaties must foresee incentives for participation and compliance
- all countries must move to less carbon intensive growth paths.

Equity is crucial for credibility

- Industrialized nations should accept responsibility for historic emissions
- Policies should promote both mitigation and adaptation without penalizing development, but
- Key rapidly growing, developing countries will need to take on increasingly meaningful roles
- Scope of attention and action should include all GHG, not only Carbon from fossil sources

A credible agreement must be cost-effective

- Technological change & transfer must be promoted
- Consistency with international trade regime

A credible agreement must be practical and realistic

- Build on existing institutions and practices, whenever possible, to minimise institutional costs


2009 Two important pieces of EU regulation adopted
Worse recession after the great depression
Worse Gas Crisis in European history
EU2009.CZ
3rd Energy Market Package (sept. 2007):
THE EU ELECTRICITY & GAS MARKETS
Competitiveness "LISBON"
3rd package: agreed May 09
Green package: agreed April 09
SER-2: under discussion
2nd Strategic Energy Review, november 2008
Securing our Energy Future
Sustainable Development "KYOTO"
Security of Supply "MOSCOW"
Green Package (jan. 2008):
Climate Action
Energy for a Changing World
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EU Stimulus package

Financial crisis + worse recession after the great depression

Worse Gas Crisis in European history

EU Stimulus package for the energy sector 3.98 B€

- **Gas and Electricity interconnections** (2.29 B€)
  - Baltic interconnection
  - Southern Gas Corridor
  - LNG
  - Mediterranean
  - Central and Southeast Europe
  - North See offshore grid
- **Offshore Wind Programme** (315 M€): Baltic and North Sea
- **Carbon Capture and Storage (CCS)**: 1.05 B€

More than half of the EU stimulus package for the energy sector goes to EU gas and electricity interconnections to increase the physical functionning of the internal market and thus improve security of supply.

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Energy Policy in the EU (2/2)

Security of supply, sustainability and competitiveness are not independent objectives;

Need to have a consensus view about the current situation and a (long-run) policy to deal with it.

The Green Paper (2006) “A European strategy for sustainable, competitive and secure energy” [COM(2006) 105 final]:

- Identifies priority areas and lists proposals to meet and fine-tune three core objectives:
  1. Increasing **security** of supply;
  2. ensuring the **competitiveness** of European economies and the availability of affordable energy, and;
  3. promoting environmental **sustainability** and combating climate change.

The “20-20-20” objectives : By 2020

- 20% reduction in CO_2 emissions
- 20% increase in renewable source share in TPES
- 20% increase in energy efficiency

EU policies promoting energy saving and efficiency

Energy efficiency is identified as a key ingredient to improve self-sufficiency and reducing GHG emissions.

GP on "Energy Efficiency or doing more with less" (2005):

- to cut energy consumption by 20% by 2020.
  - ⇒ to reduce the dependency on imported oil and gas
  - ⇒ to reduce the energy bill by an estimated 100 billion euro every year.

The EU has proposed directives and regulations concerned with areas where there is potential for energy savings:

- End-use Efficiency & Energy Services;
- Energy Efficiency in Buildings;
- Eco-design of Energy-Using Products;
- Energy Labeling of Domestic Appliances;
- Combined Heat and Power (Cogeneration).

Conclusions

Most of the energy used today comes from finite sources; there are many non exhaustible sources, but we still have to learn how to use them efficiently. This is crucial for the challenges ahead.

The two main challenges in finding the wisest way of using energy may lead to conflicting solutions in the short-medium run.

In particular coping with climate change may help towards a more secure energy supply; however in the next 10-20 years the easiest ways to securing energy supply may make harder the task of mitigating climate change.

10-20 years is also all the time we have left to enforce a credible climate change policy architecture, least we'll miss our only chance to attain GHG emissions stabilization compatible with a manageable temperature increase

In this time frame we must find a way to commit China, India, USA and later, developing countries to emissions reduction without prejudice for their right to reach our level of welfare

An uncontroversial price for carbon is crucial both for long term sustainability and to dispel uncertainty around energy security.

It is thus crucial to place the right items on the political agenda, with the right timing and with the support of the best available scientific knowledge.

Grazie!

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