Energia e Clima 3

SSST

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Outline

4. Externalities and energy (2 hours)

The concept of externality.

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

Local energy externalities: oil spills

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 (2 hours)

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.

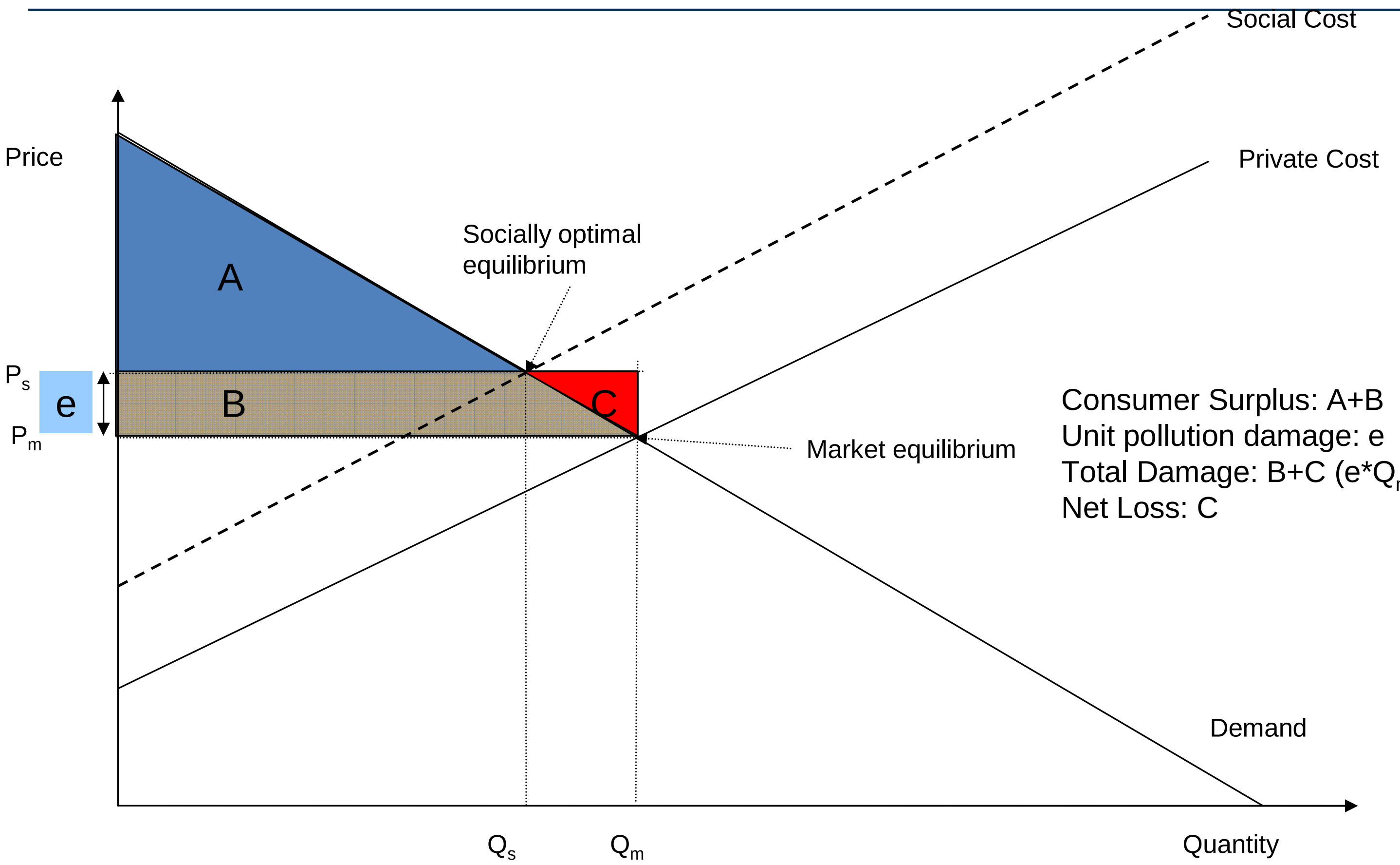
They include damage to the natural and built environment, such as effects of air pollution on health, buildings, crops, forests and global warming; occupational disease and accidents; and reduced amenity from visual intrusion of plant or emissions of noise."

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?

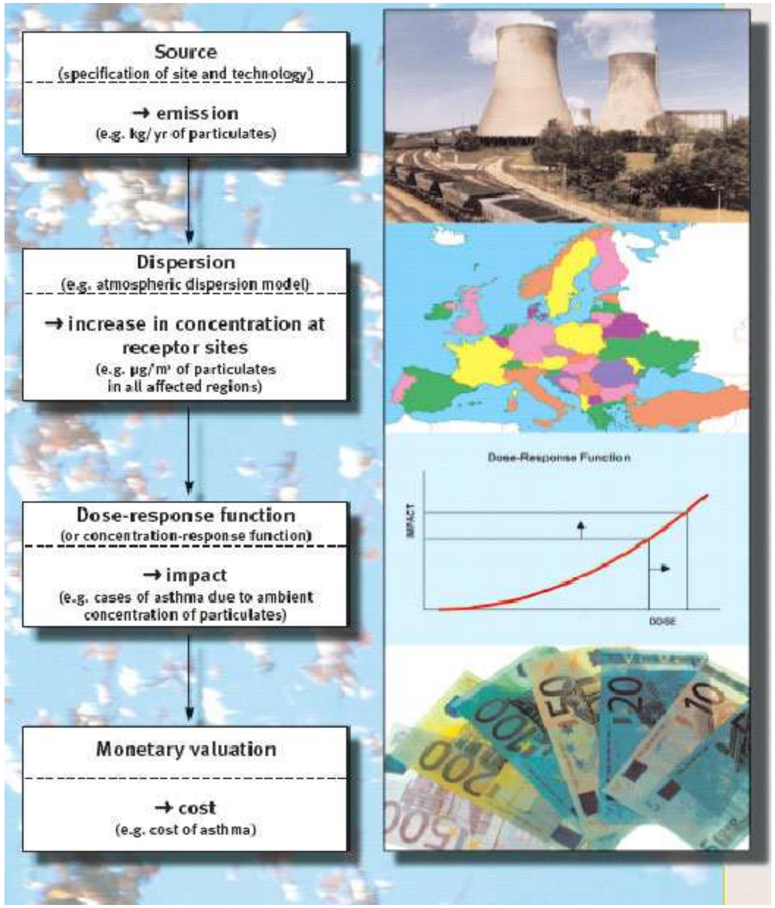
Because of C

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 evaluate externalities: the impact pathway approach



Source:
http://www.externe.info/externpr.pdf

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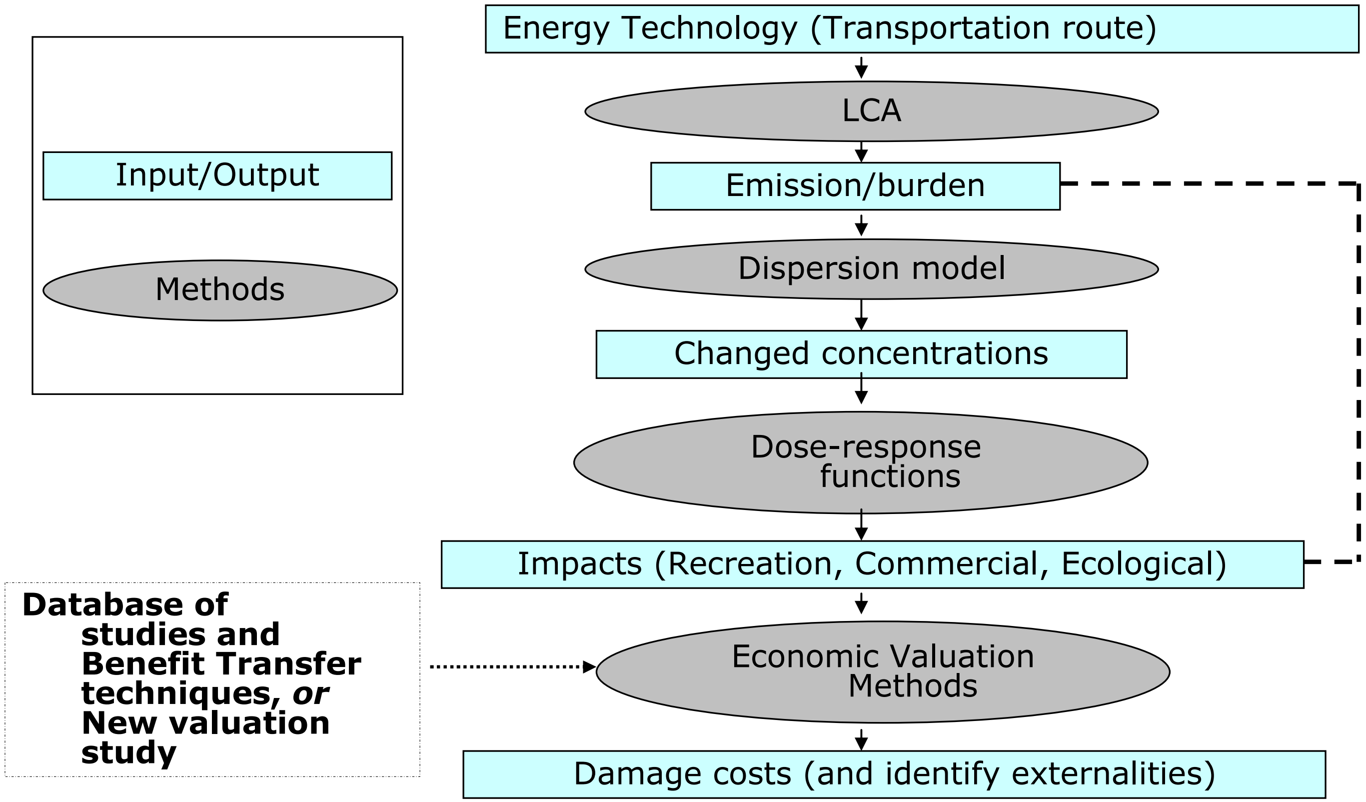
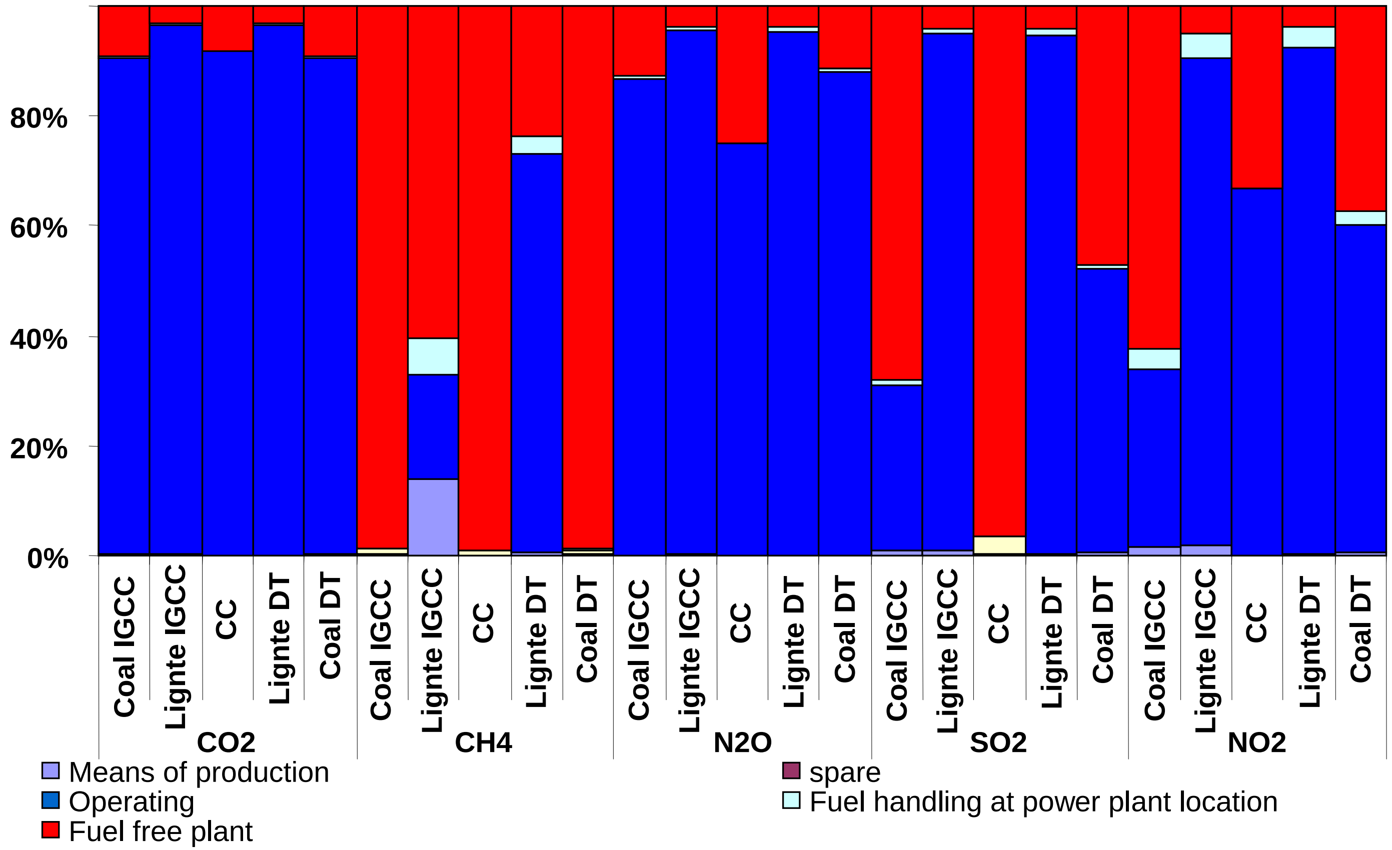
The impact pathway approach II



Emissions and LCA



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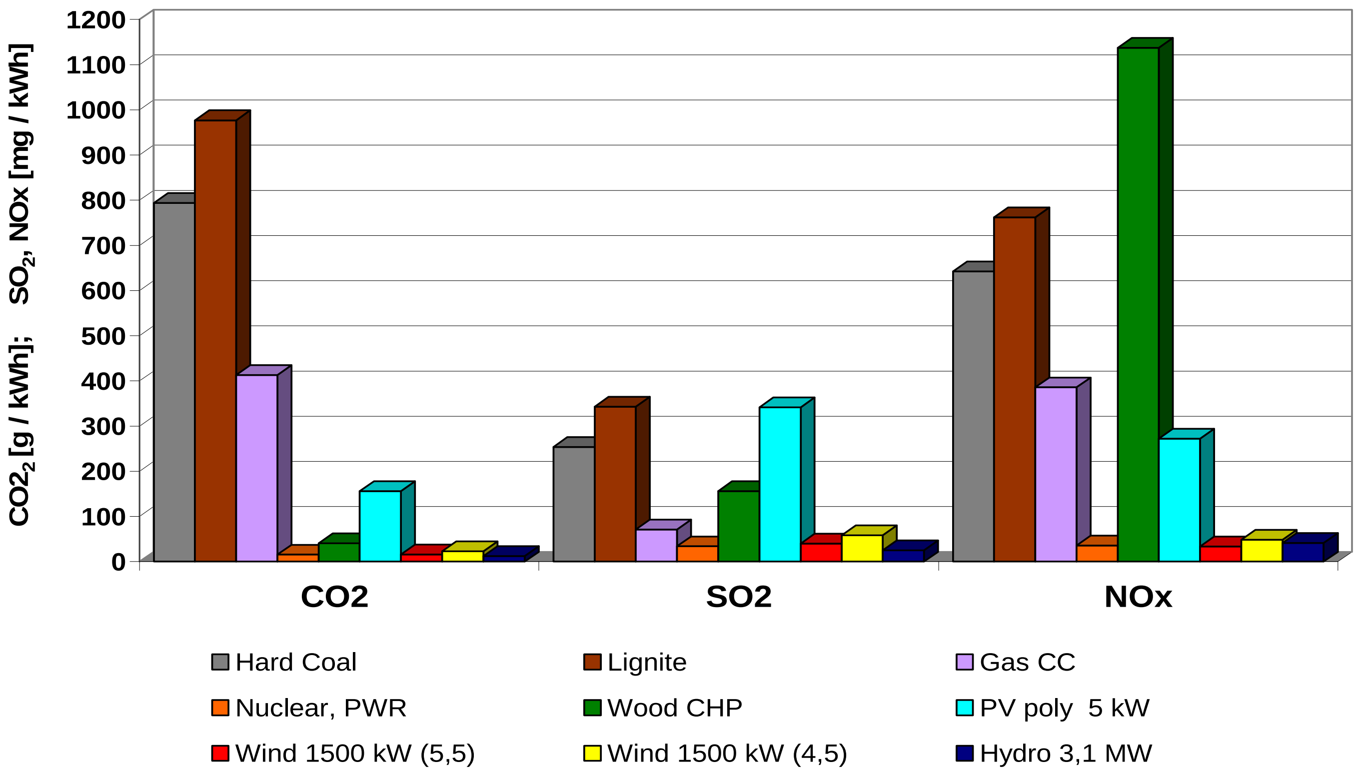
Emissions



source: IER 2005

Measuring damages in money terms

The monetary evaluation of the damages depends upon which aspects of human well being are affected.

•If the damage affects activities or assets for which a market exists, damage evaluation can be directly based on the market value of what has been lost. Examples: the value of the production which has been curtailed, the income lost because of illness, etc.

•If the damage affects activities or assets which

- •can be enjoyed freely and directly by people (that is, they have **use value**)
- •do not have a market a market, and
- •influence the value of goods for which a market exists,

their implicit price can be estimated indirectly. Example: pollution or visual intrusion can reduce the property value of houses.

Measuring damages in money terms II

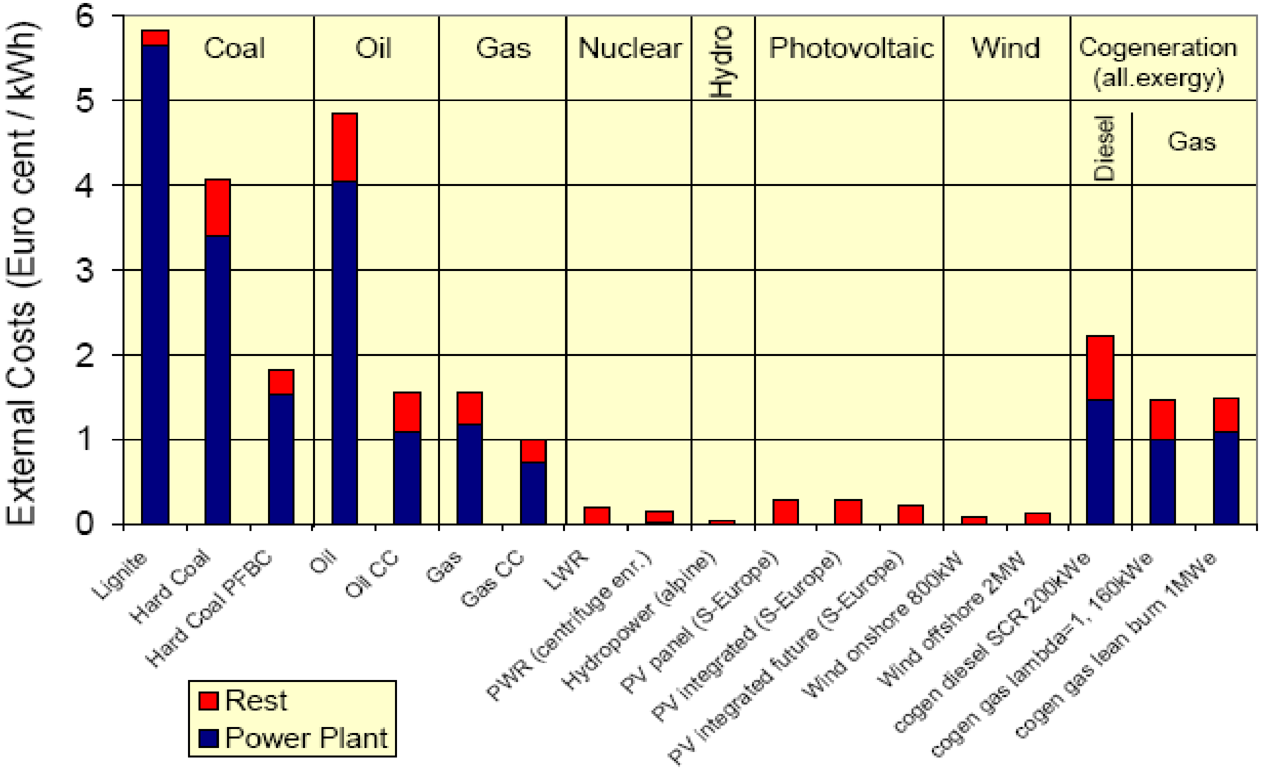
•If the damaged good can be enjoyed freely and directly by people (it has **use value**), but it requires costly activities in order to be enjoyed, the cost of these activities can provide an indication of people's **willingness to pay** to enjoy that good. Example: pollution in a lake with recreation possibilities to which tourists travel

•The affected good may not have a direct use, but we might be happy to know that it is there because we might use it one day (**option value**) or because we think it makes the world is a better place (**existence value).** In these case, we can ask people directly their **willingness to pay** to preserve that good.

Measuring damages in money terms III-methods

Use Value			Non-use value
Actual Payment	Willingness to Pay		Willingness to Pay
-	Indirect	Direct	Direct
-Health Costs -Reduced productivity due to illness Value of Statistical Life	Travel Cost Hedonic Prices	Contingent Valuation; Choice Experiments	Contingent Valuation

ExternE-Pol [€-Cent per kWh] — current and advanced tech. (CENTREL), applying average EU15 costs



Externality evaluation: summing up

Evaluation of external costs allows better informed policy decisions and Cost Benefit analyses. There has been substantial improvement in the last 10 years both in methodology and coverage

However uncertainties remain because of:

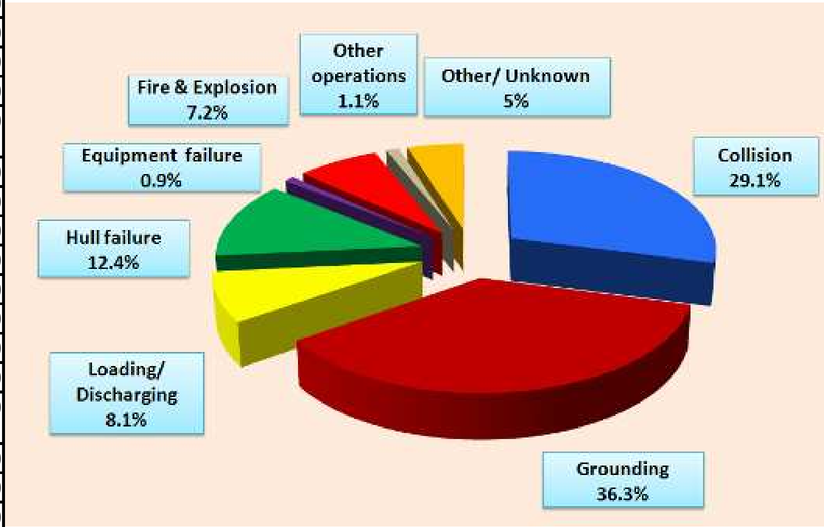
- Technology specification
- Technical change
- Nonlinearities in damage functions
- Methodological doubts about money metric measures
- Local specificities
- Climate change impacts

Are these numbers better than no number? The European Union has acknowledged the importance of the external costs in the production of electricity and has required that measures be undertaken to take these costs into account. EU guidelines on state aid for environmental protection explicitly foresee that EU member states may grant operating aid, calculated on the basis of the external costs avoided, to new plants producing renewable energy (European Commission, 2003).

Local Sustainability: Oil spills

Position	Shipname	Year	Location	Spill Size (tonnes)
1	Atlantic Empress	1979	Off Tobago, West Indies	287,000
2	ABT Summer	1991	700 nautical miles off Angola	260,000
3	Castillo de Bellver	1983	Off Saldanha Bay, South Africa	252,000
4	Amoco Cadiz	1978	Off Brittany, France	223,000
5	Haven	1991	Genoa, Italy	144,000
6	Odyssey	1988	700 nautical miles off Nova Scotia, Canada	132,000
7	Torrey Canyon	1967	Scilly Isles, UK	119,000
8	Sea Star	1972	Gulf of Oman	115,000
9	Irenes Serenade	1980	Navarino Bay, Greece	100,000
10	Urquiola	1976	La Coruna, Spain	100,000
11	Hawaiian Patriot	1977	300 nautical miles off Honolulu	95,000
12	Independenta	1979	Bosphorus, Turkey	95,000
13	Jakob Maersk	1975	Oporto, Portugal	88,000
14	Braer	1993	Shetland Islands, UK	85,000
15	Khark 5	1989	120 nautical miles off Atlantic coast of Morocco	80,000
16	Aegean Sea	1992	La Coruna, Spain	74,000
17	Sea Empress	1996	Milford Haven, UK	72,000
18	Nova	1985	Off Kharg Island, Gulf of Iran	70,000
19	Katina P	1992	Off Maputo, Mozambique	66,700
20	Prestige	2002	Off Galicia, Spain	63,000
35	Exxon Valdez	1989	Prince William Sound, Alaska, USA	37,000

source:ITOPF



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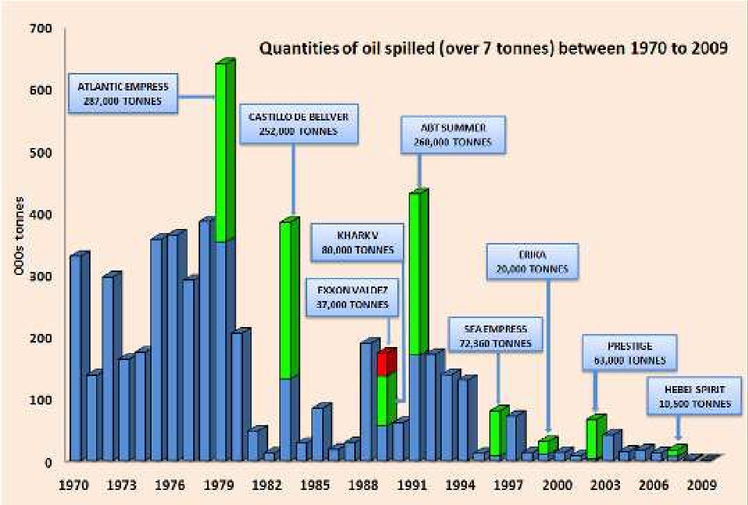
Local Sustainability: Oil spills

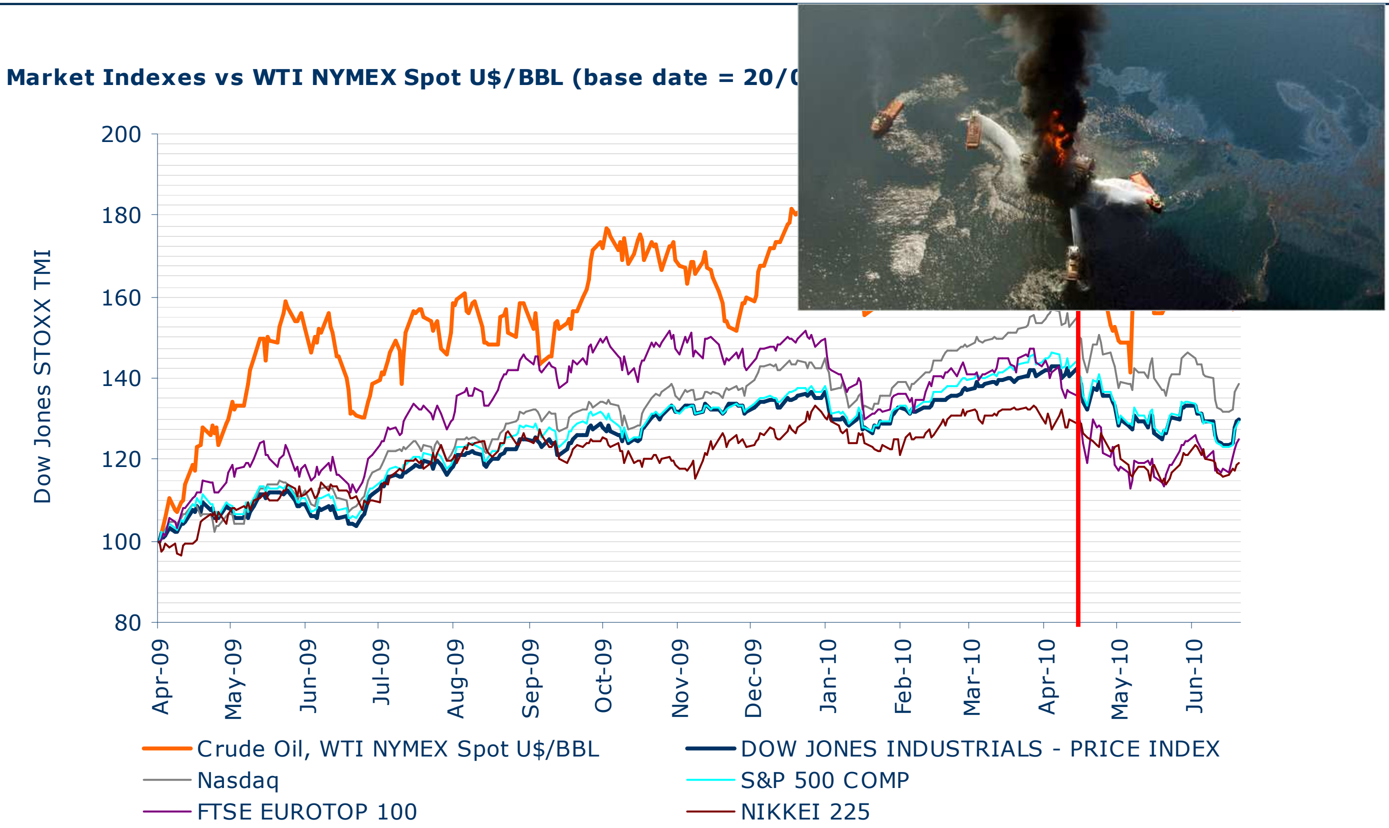


source: ITOPF

The situation was improving, then…

" **The BP/Deepwater Horizon** oil spill flow rate has not been reliably established. Based on estimates of experts it has reached at least 55,660 tonnes of oil leaked by May 24, 2010 but the amount of oil spilling into the Gulf of Mexico may be 20 times the size of BP's earlier claims of 5000 barrels per day (2.4 million gallons spilled as of May 24, 2010), according to an exclusive analysis conducted for NPR" (Wikipedia)

Effect of BP spill on the markets



source: Own computations on Datastream

Evaluating Oil spill damages

For this kind of externality, the perception of citizens of the risks involved in carrying oil to their country and the associated risk aversion are particularly important.

Methodology (main steps):

- identify the possible causes of an oil spill;
- evaluate the probabilities related to these types of accidents;
- monetize probabilistic externalities;
- introduce risk aversion and lay risk assessment in a theoretically sound and empirically founded framework

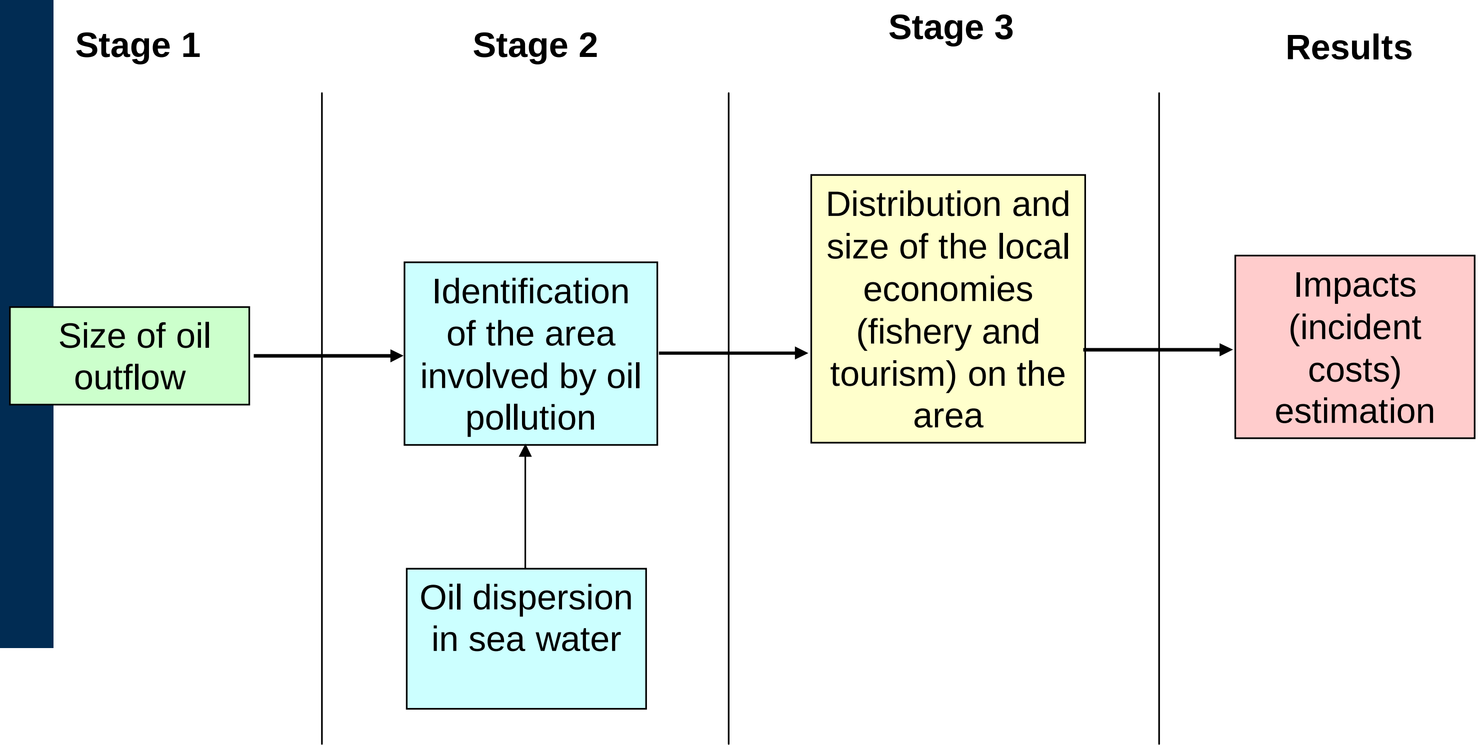
To Put Probabilities in Perspective…

The following are annual probabilities:

- Probability of nuclear accidental release: $1.9^{*}10^{-6}$ (France)[a]
- Probability of dying in airplane crash[b]: 10^{-6} to 10^{-7} (depending on air company)
- Probability of fatal car accident in US[b]: $1.67^{*} 10^{-4}$
- Probability of being killed by lightning in US[b]: $7.14^{*}10^{-7}$
- **Base Case probability of oil spill 10^{-4}**
- **Worst Case probability of oil spill: 10^{-6}**

a **Markandya and Tylor (1999)**
b **http://www.cotf.edu/ete/modules/volcanoes/vrisk.html**

Probabilistic Externalities of oil transportation by tanker route (8):
Impacts on local economy estimation



External costs of oil extraction and transport. Projections to 2010, 2020 and 2030 Euros per ton

2010 High	Extraction Externalities	Tanker Transport Externalities	Total Accident Extrernalities	*Non-GHG costs*	*GHG costs*	***Total emissions costs***	**Total Externalities**
To Atlantic Ports	1,39	0,48	0,013	*1,16*	*0,71*	*1,87*	1,89
To Mediterranenan Ports	1,39	0,41	0,011	*1,10*	*0,70*	*1,81*	1,82
Total EU	1,39	0,45	0,012	*1,14*	*0,71*	*1,85*	**1,86**
Pipeline				*0,00*	*0,74*	*0,74*	0,74
Total Externalities	**1,39**	**1,19**	**0,01**	***1,14***	***1,44***	***2,58***	**2,60**
2020 High	Extraction Externalities	Tanker Transport Externalities	Total Accident Extrernalities	*Non-GHG costs*	*GHG costs*	***Total emissions costs***	**Total Externalities**
To Atlantic Ports	1,72	0,67	0,014	*1,50*	*0,89*	*2,39*	2,41
To Mediterranenan Ports	1,73	0,48	0,007	*1,34*	*0,87*	*2,20*	2,21
Total EU	1,72	0,59	0,011	*1,44*	*0,88*	*2,32*	**2,33**
Pipeline				*0,000*	*0,035*	*0,035*	0,035
Total Externalities	**1,72**	**0,63**	**0,01**	***1,44***	***0,91***	***2,35***	**2,37**
2030 High	Extraction Externalities	Tanker Transport Externalities	Total Accident Extrernalities	*Non-GHG costs*	*GHG costs*	***Total emissions costs***	**Total Externalities**
To Atlantic Ports	1,83	0,72	0,013	*1,69*	*0,86*	*2,55*	2,57
To Mediterranenan Ports	1,84	0,47	0,006	*1,47*	*0,84*	*2,31*	2,31
Total EU	1,83	0,63	0,010	*1,61*	*0,85*	*2,46*	**2,47**
Pipeline				*0,00*	*0,04*	*0,04*	0,04
Total Externalities	**1,83**	**0,66**	**0,01**	***1,61***	***0,89***	***2,49***	**2,51**

high demand scenario

Oil spill case study: summing up

The resulting values are quite low, ranging from 2.32 Euro per ton in 2030 in the Low demand scenarios to 2.60 Euro in 2010 in the High demand scenario.

To put things in perspective:

- Average direct cost of bringing oil to Europe is about 10 $/b (or about 70 $/t of oil).
- Present oil prices are in the order of 130 $/b or 950 $/t.
- Thus externalities represent about **4-5%** of direct **cost** and about **0.3 %** of today's **prices** (2% if the oil price was at 20 $/b).

The main implication for environmental policy is that bringing oil to Europe is not the most noxious phase of the oil life cycle, as actually using oil as a fuel brings about, on average, much more serious consequences for the environment and for human health.

<u>However, there is a non negligible probability of causing very high local damages</u>. The fact that these probabilistic externalities account for a very small fraction of the total external cost of oil transport, once weighted for their occurrence probabilities and the volume of oil transported, by no means should be used as a justification for relaxing pollution prevention and remediation standards in European waters.

The impact on local populations affected can be very substantial.

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 <u>at the optimum</u>. 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),

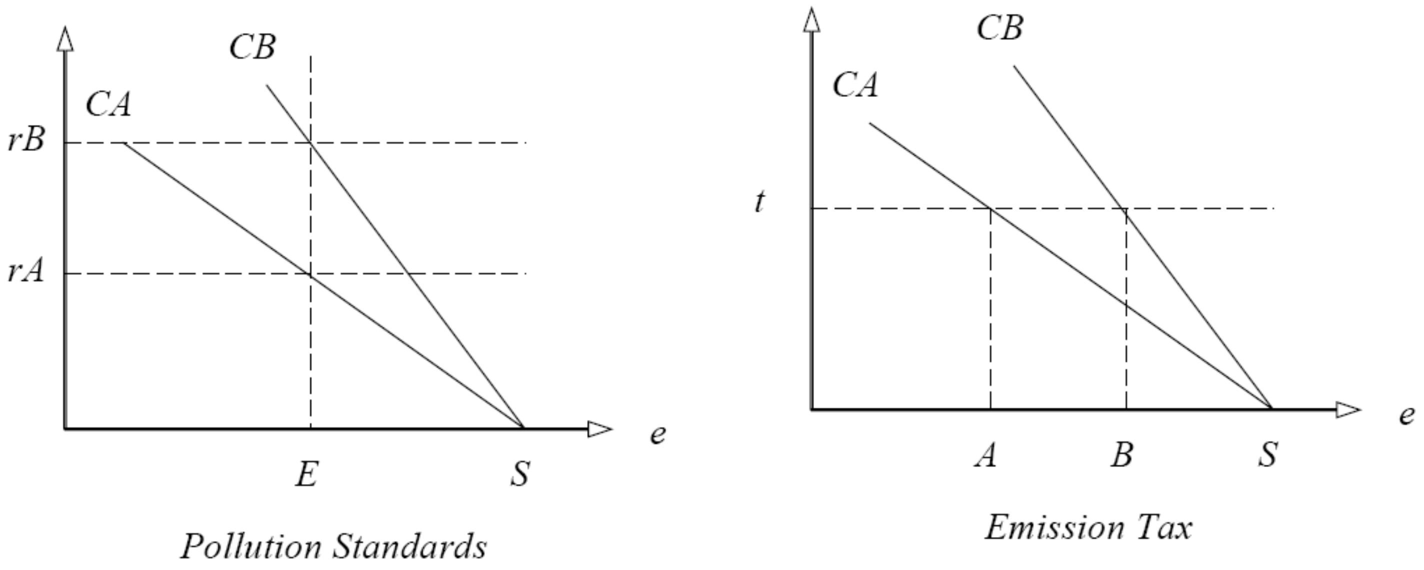
A system of tradable pollution permits,

A system of tradable input permits.

An imperfect world: taxes versus standards

Suppose we do not want more than 2E=A+B emissions.

What is the most efficent policy instrument?

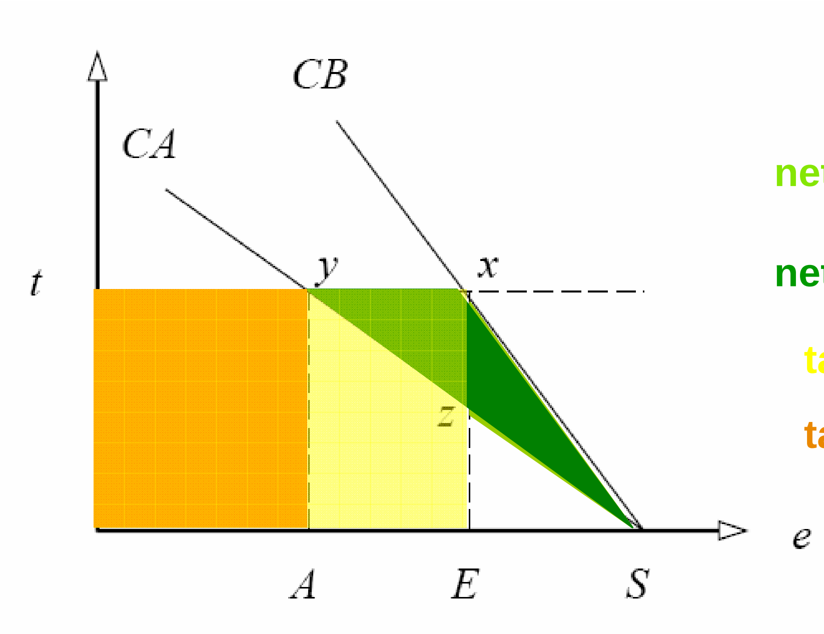


emission taxes minimise abatement costs……

Source: D.G.S Pollock, Environmental Economics

An imperfect world: taxes versus standards

Taxes and technology improvements



net social savings

net social savings

tax bill

tax bill

…and promote the adoption of more efficient technologies.

Source: D.G.S Pollock, Environmental Economics

an imperfect world: problems with taxes

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.

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).

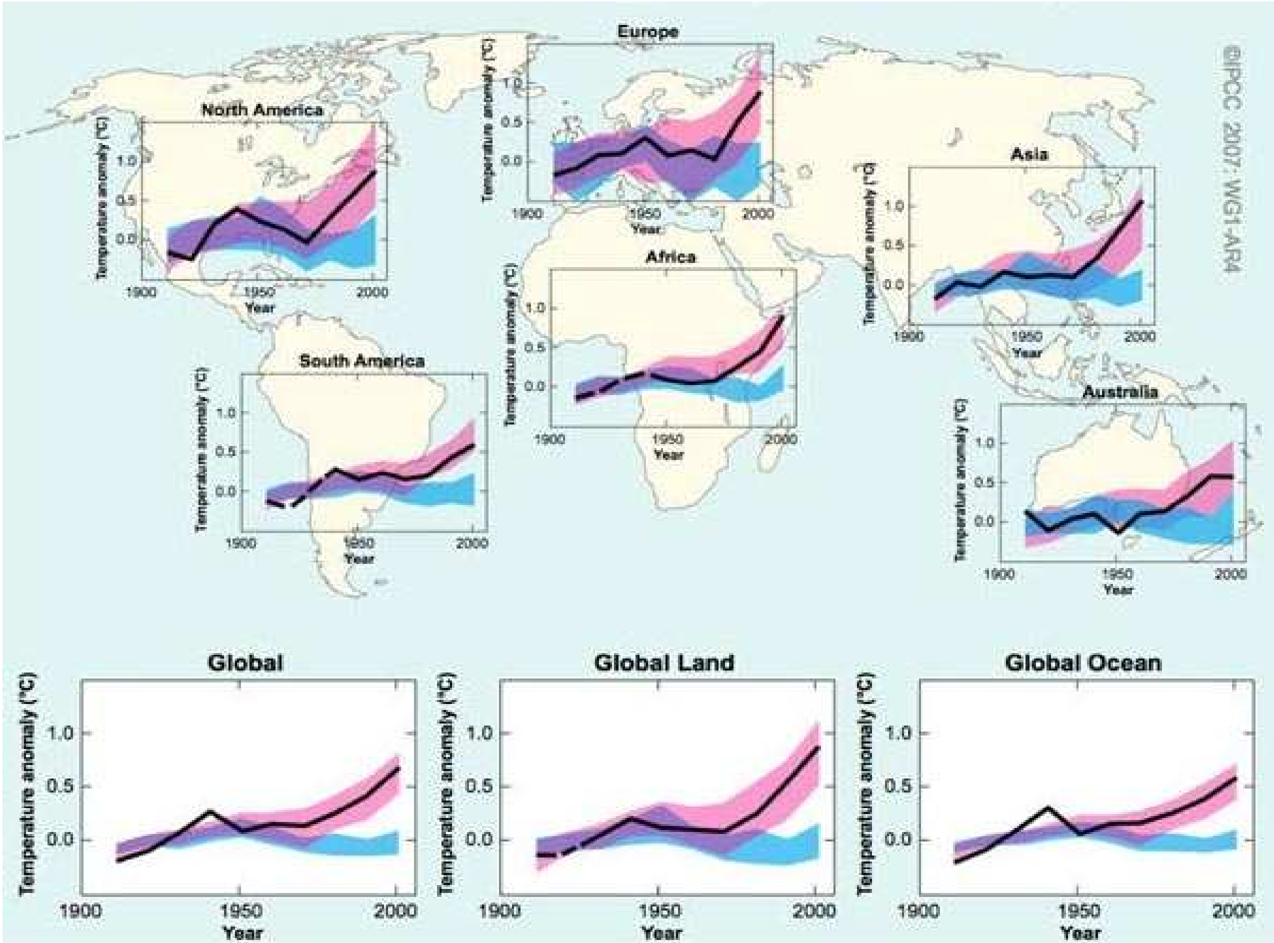
International transport (ships and planes) are very difficult to involve in a cap-and-trade scheme

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”.

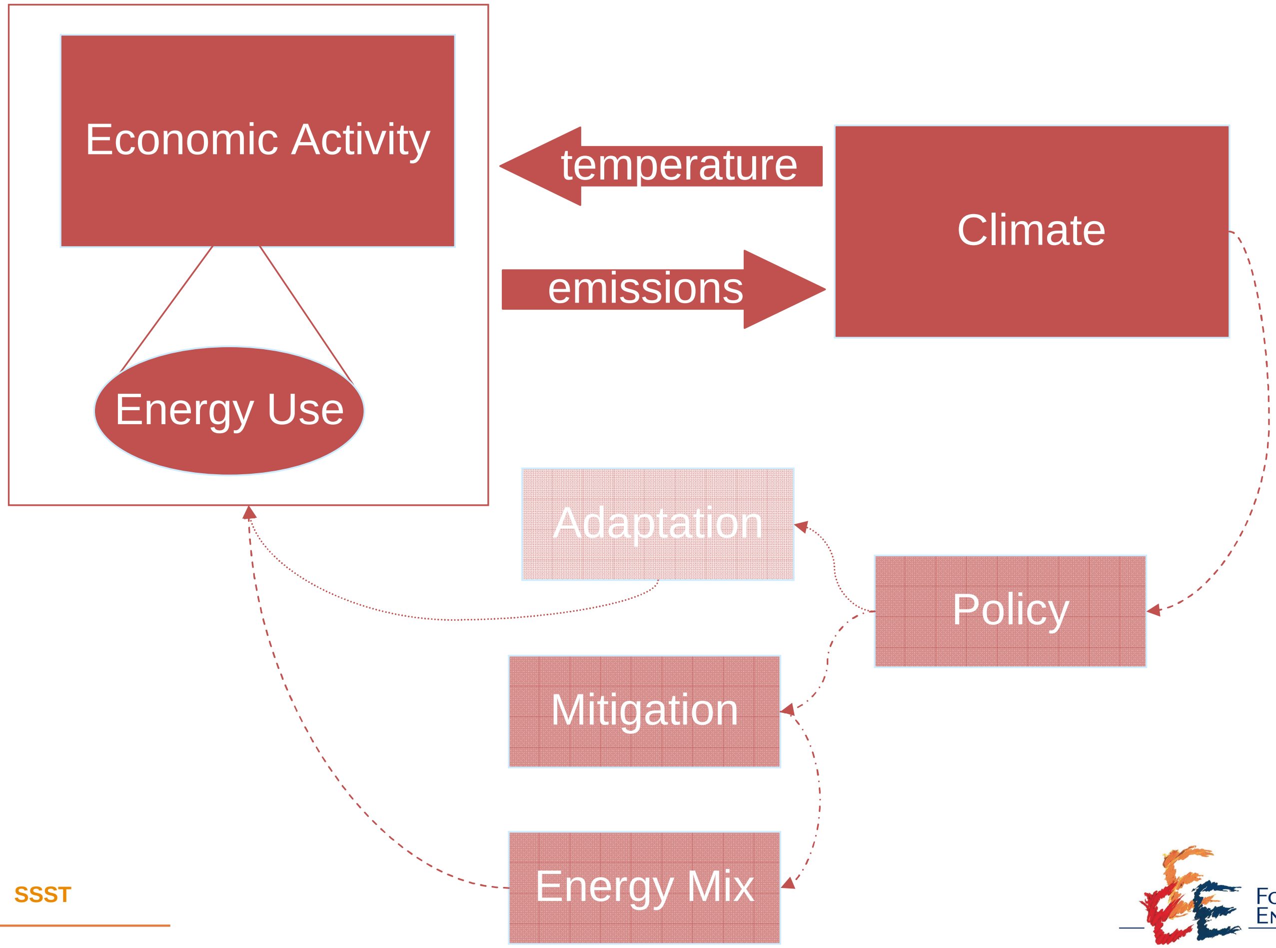
If additional measures are introduced however, it is important that the implicit carbon abatement costs are monitored and take into account in order not to introduce distortions and keep the abatement costs as low as possible.

Climate change: historical data



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

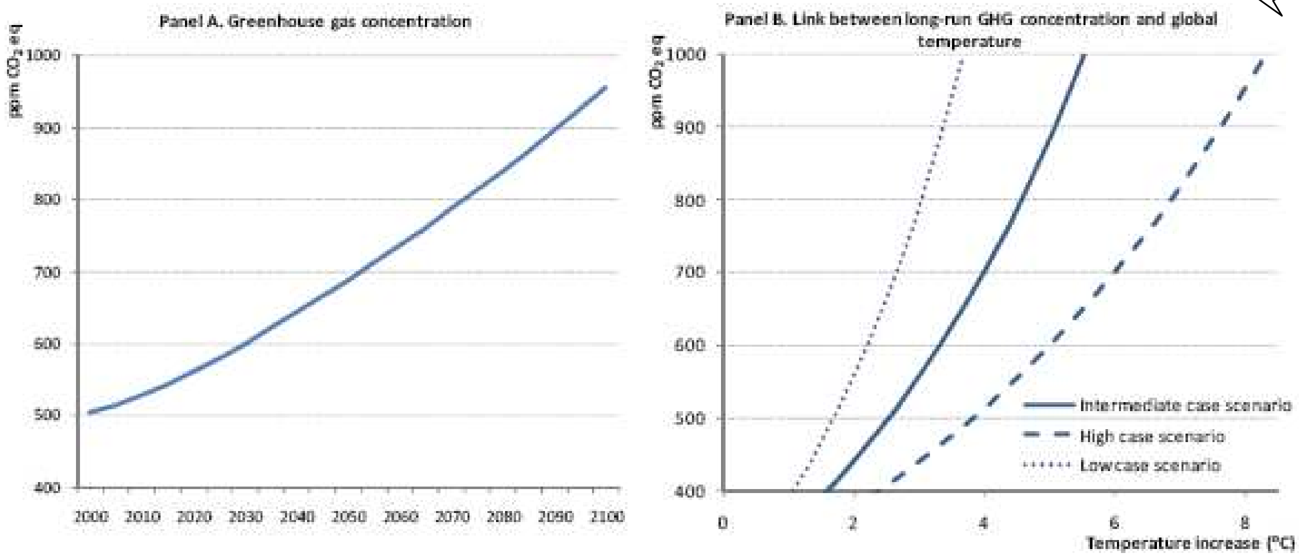
Energy and climate change: the issue



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

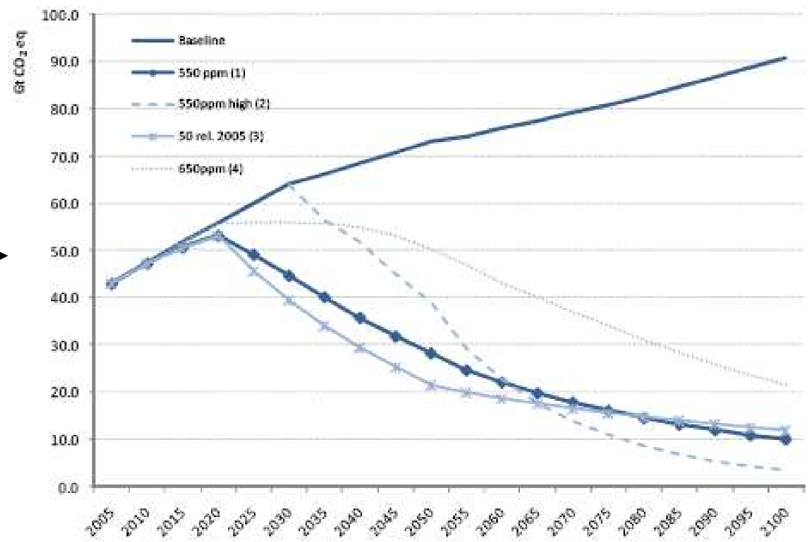
Projected trends in greenhouse gas concentration and associated temperature increases in the absence of new climate change policies (source: OECD 2008)



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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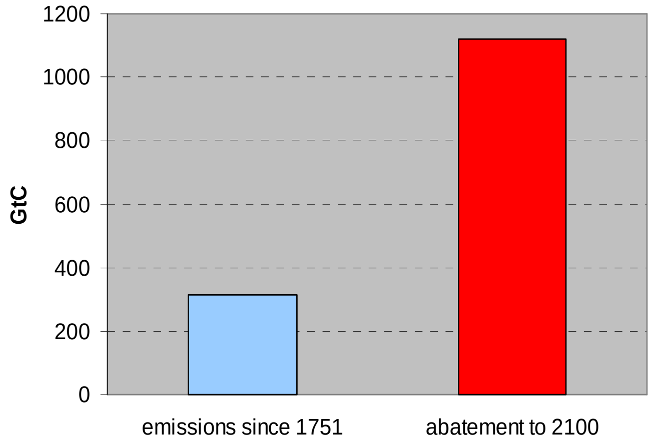
Stabilising the climate will ultimately require large emission cuts

Energy and climate change: the issue

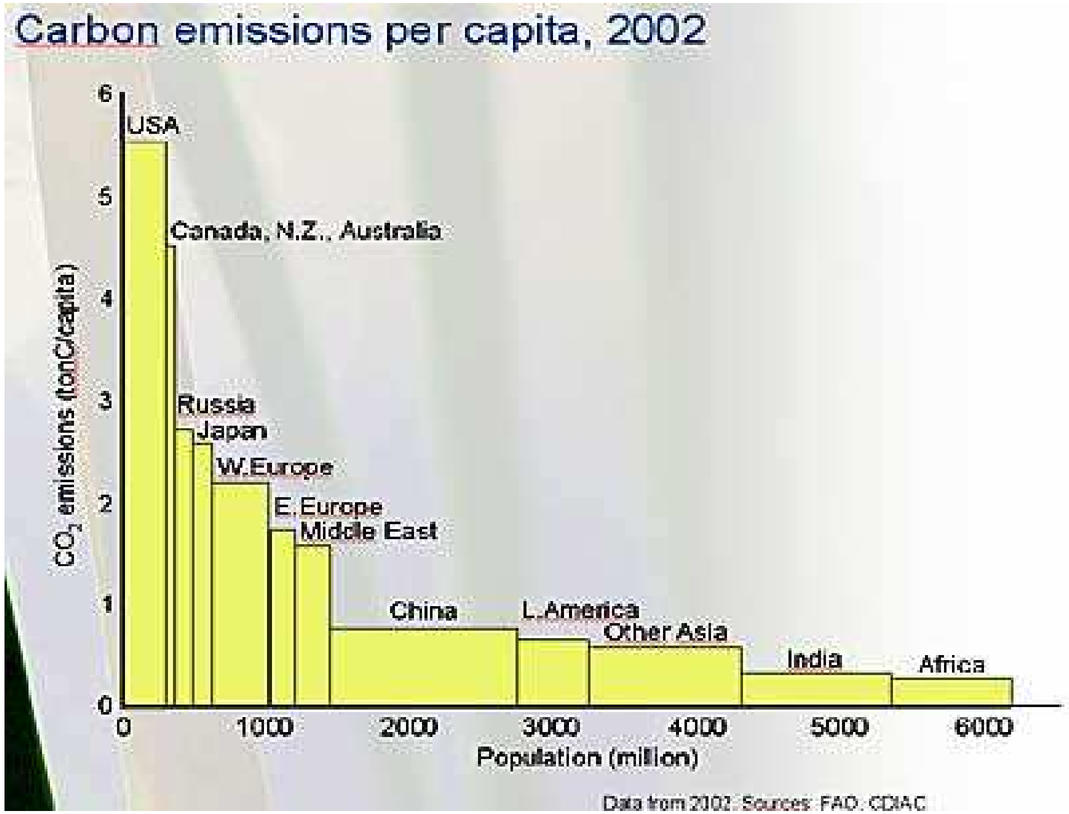
Mitigation effort needed for a 450 ppm di CO_2 stabilization scenario



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

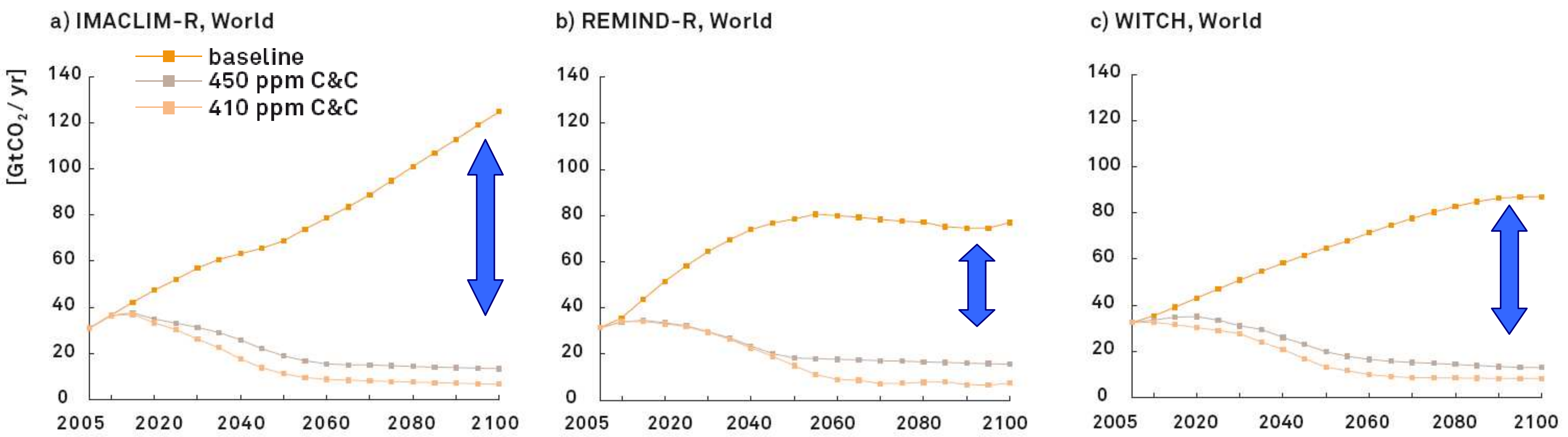
- **The abatement effort needed to stabilise atmospheric CO_2 to 450 ppm is almost 4 times all greenhouse gases emissions from preindustral times to date.**
- **In per capita terms, global average emission must fall from 2 to 0.3 tC per capita per year.**
- **The way we produce and consume energy must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

Climate change: present emissions per capita



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

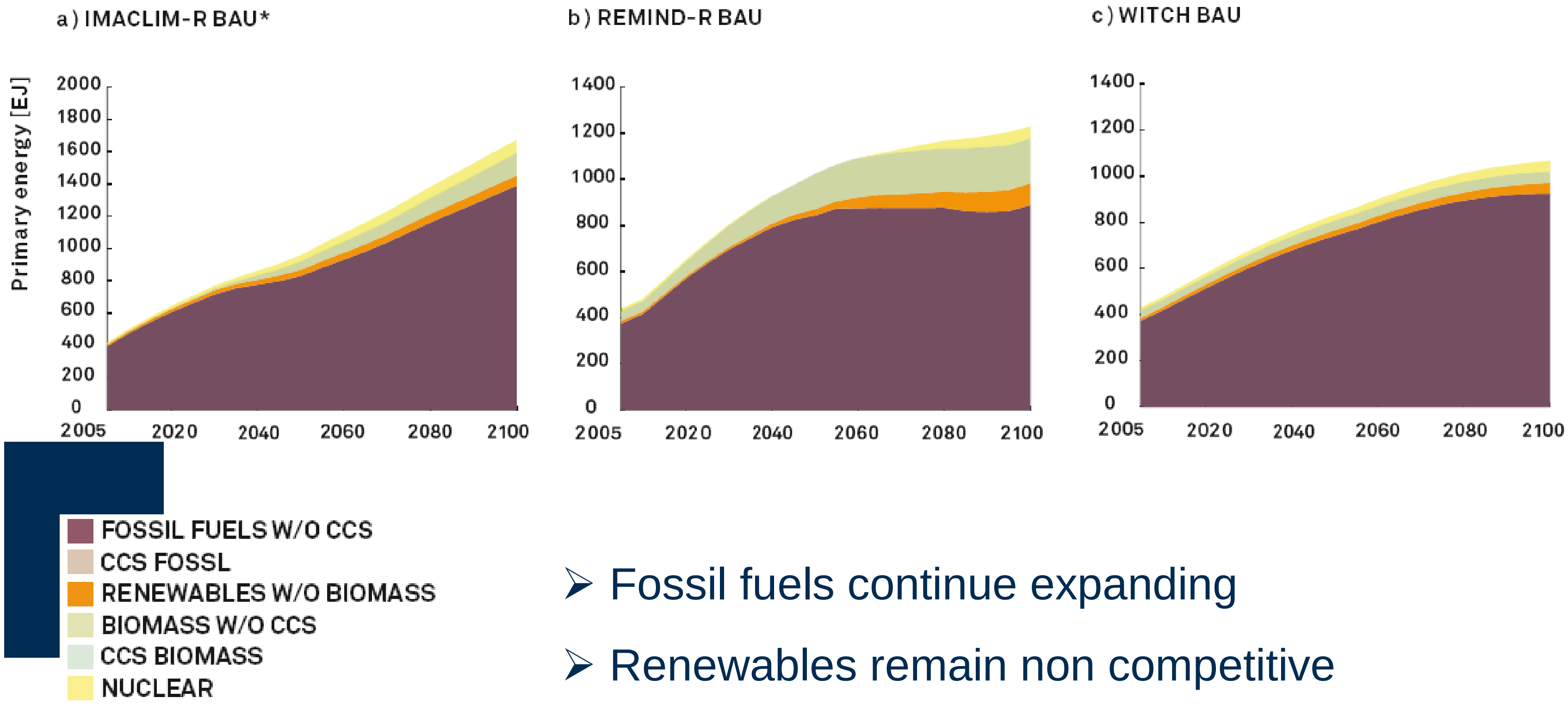
Global CO_2 emission and stabilisation scenarios



- 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)

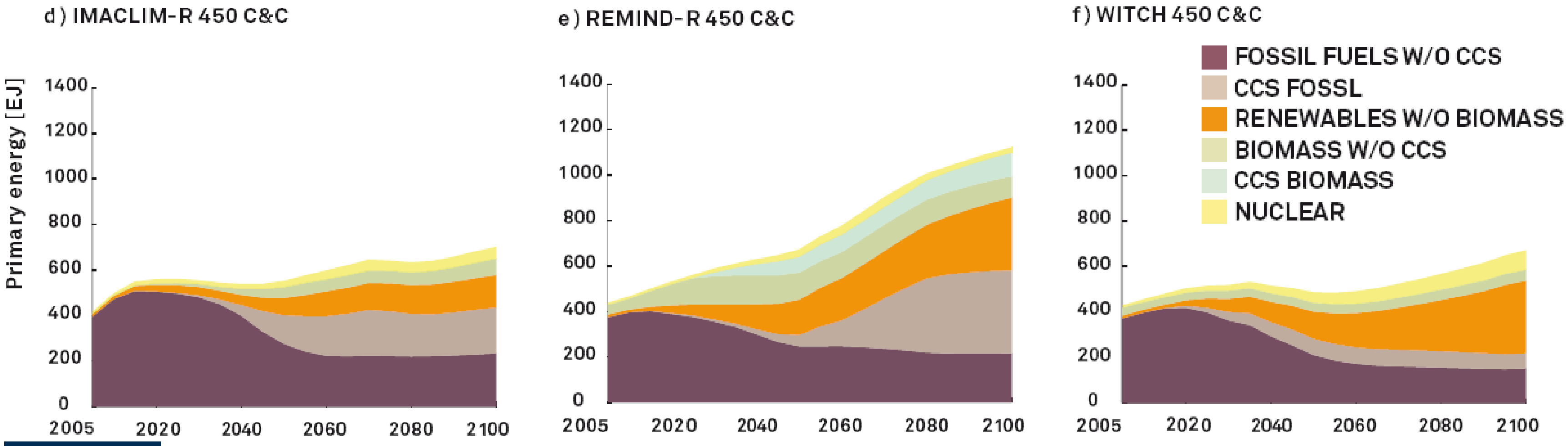
Energy use must change: BAU scenarios



- Fossil fuels continue expanding
- Renewables remain non competitive

Source: RECIPE Project (2009)

Energy use must change: stabilizing at 450 ppm CO_2

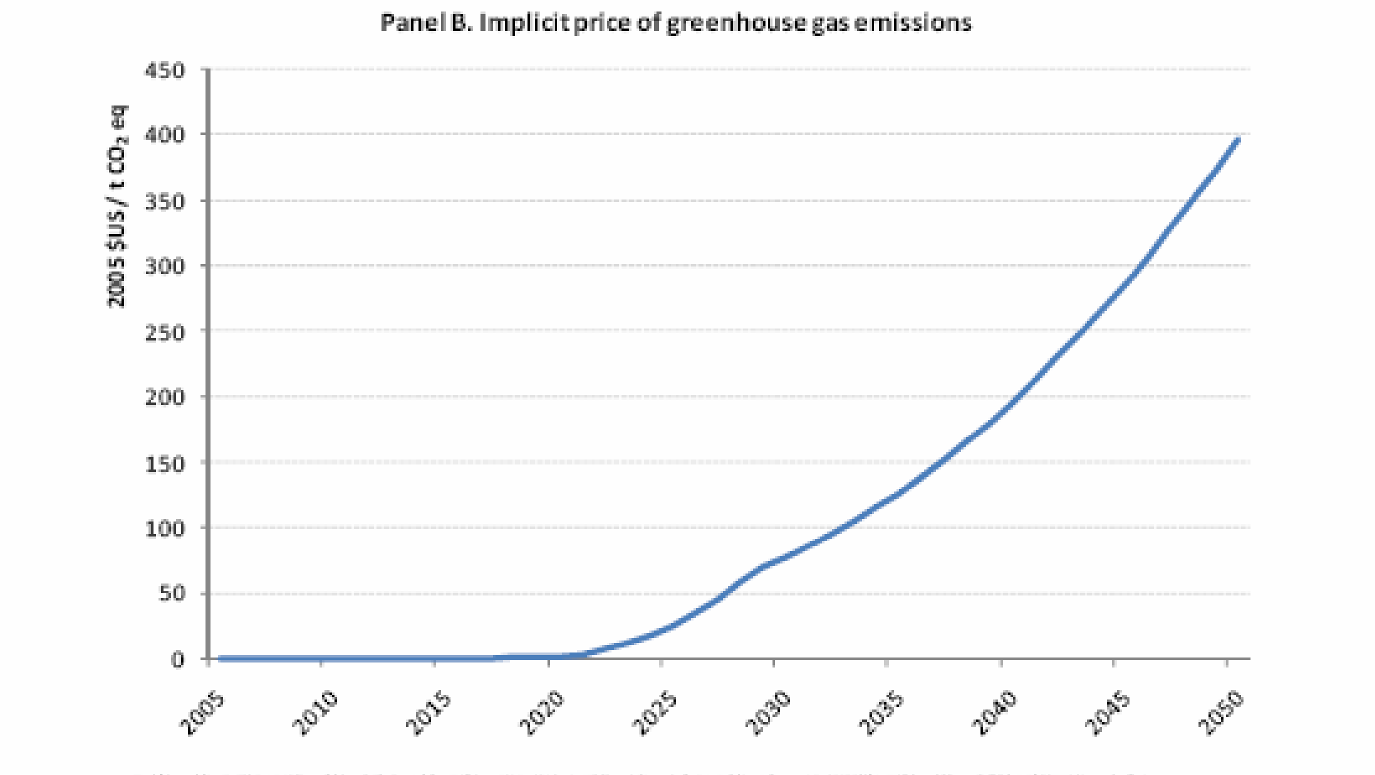


- Energy efficiency: very important in WITCH e IMACLIM-R
- Coal with CCS
- Substantial share for renewables

Source: RECIPE Project (2009)

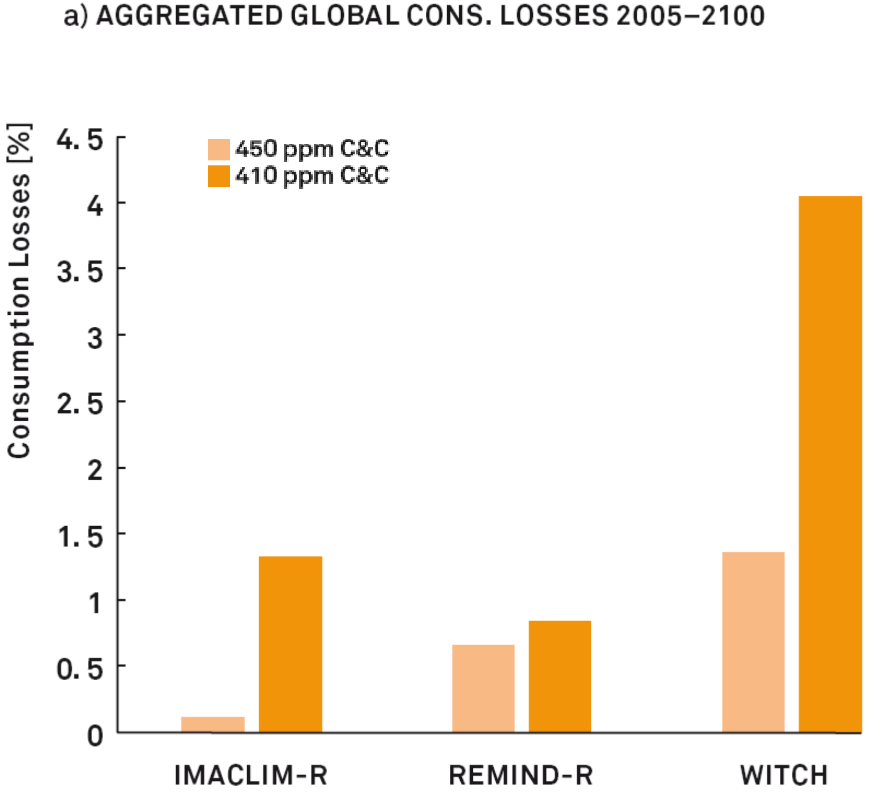
Energy use must change: is it expensive?

"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

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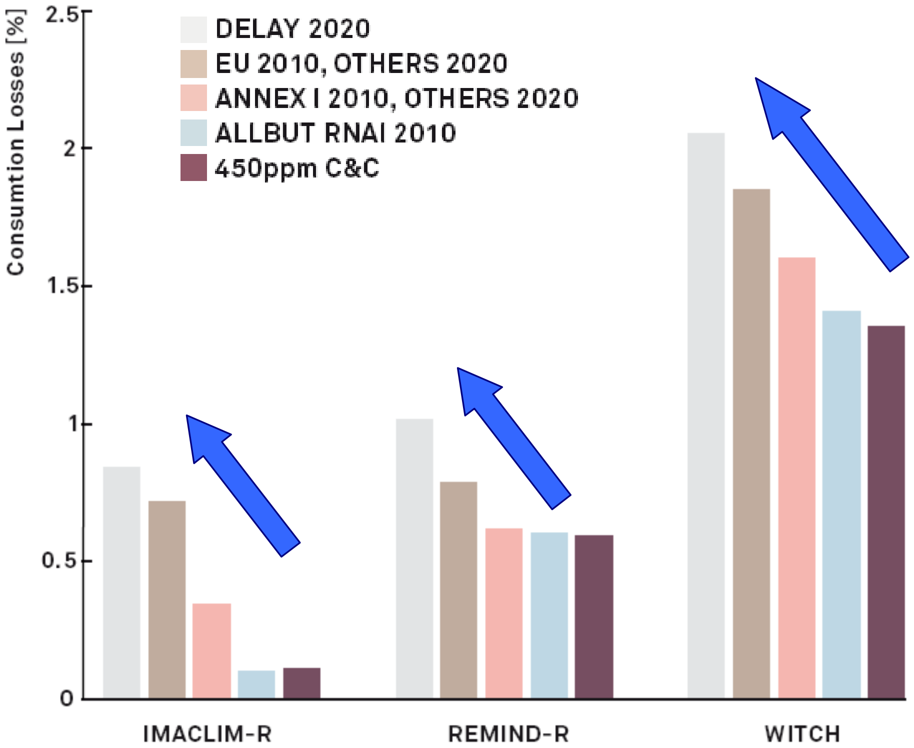
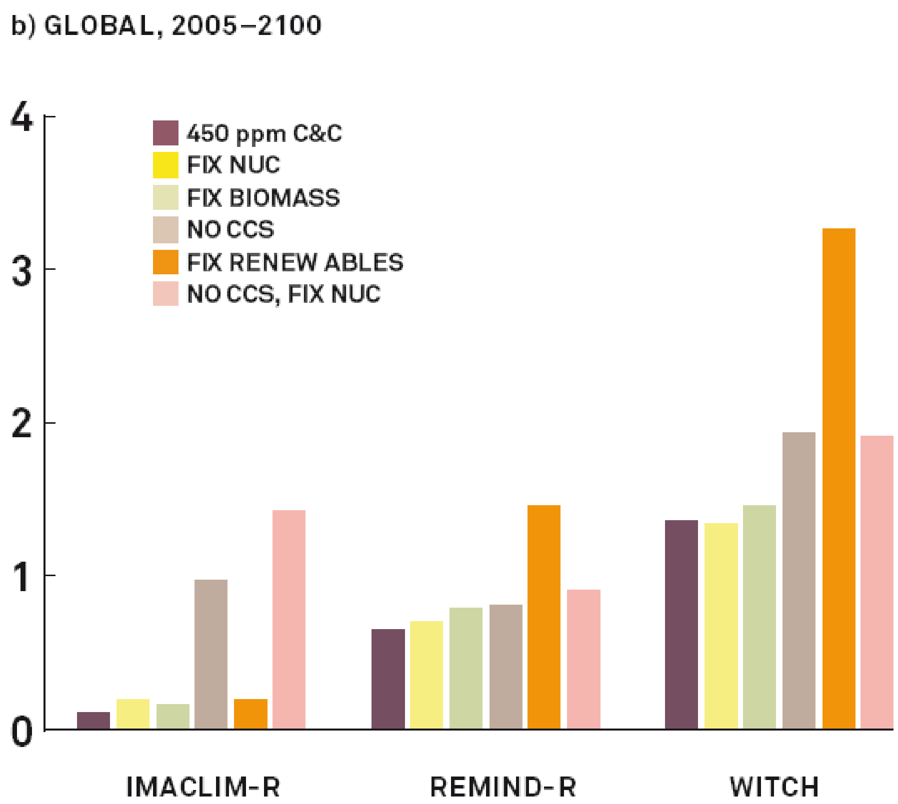
However…



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

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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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 may be 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.

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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