ExternE

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‚The ExternE Methodology for Estimating External Costs of Enery Conversion‘

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Reason for estimating external costs

General methodology: the impact pathway approach

External Costs Definition

An external cost arises, when the social or economic activities of one group of persons have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group.

For what purpose are estimates of external costs needed?

-> to take account of external effects, when making decisions

- Internalising external costs: – ‚getting the prices right‘ – or use of other instrument (standards, permits, …)
- Technology assessment: comparison of techniques, identification of weak points
- Cost-Benefit-Analyses, e. g. for measures and directives to protect the environment and human health
- Sustainability and welfare indicator; assessment of impacts/ damage categories;

History of ExternE

***Project ExternE* = *Extern*alities of *E*nergy launched in 1991, financed by the European Commission, DG Research**

scope: development of a framework for estimating environmental external costs of power plants

- **Follow-up projects until now**
- ➢ **improving and extending the methodology, incorporating new knowledge**
- ➢ **extending the field of applications: heat production, transport , industrial activities, agriculture**

Main Features of the Impact Pathway Approach

1) **Assessment and weighting of impacts is as far as possible carried out using quantitative figures and procedures**

   ->ensures transparency and reproducibility

2) **Impacts are expressed in monetary units**

   ->allows transfer of values, units are conceivable, direct use of results in CBA and for internalising via taxes possible

Main Features of the Impact Pathway Approach

3) Assessment of impacts is based on the preferences of the affected well-informed population

This implies:

Valuation of damage, not of effects/pressures (e.g. emissions of pollutants)

Available information should be explained before measuring preferences

->Ensures consistency

4) Impacts depend on the time and site of the activity !

-> Bottom-up approach needed: the 'impact pathway approach'

Main Features of the Impact Pathway Approach

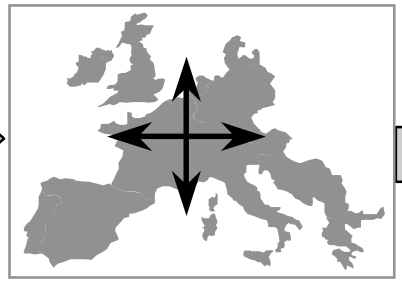
5) Assessment of impacts is needed at all spatial levels: local, regional, hemispheric, global. The relative importance of larger scale impacts is increasing.

6) Life cycle impacts (construction and dismantling, provision of fuels, waste treatment and disposal) should be taken into account (especially important for electricity production from renewable and nuclear energy).

Impact Pathway Approach

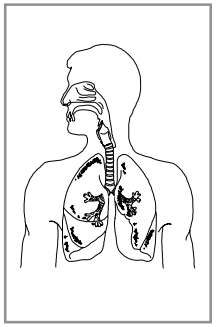
Pollutant/Noise Emission

Transport and Chemical Transformation; Noise Propagation



Calculation is made twice: with and without project!

Differences of Physical Impacts



Monetary Valuation

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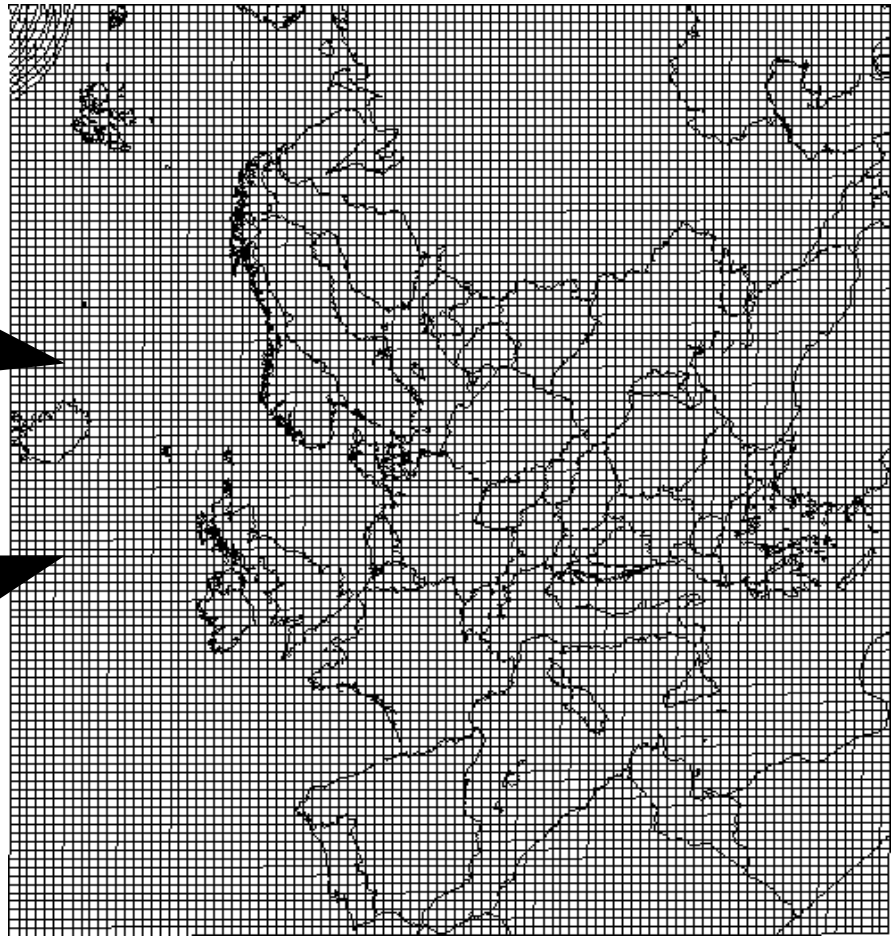
EcoSense - Emission Data Modelling

Single Facility

Multi Source Emission Scenario



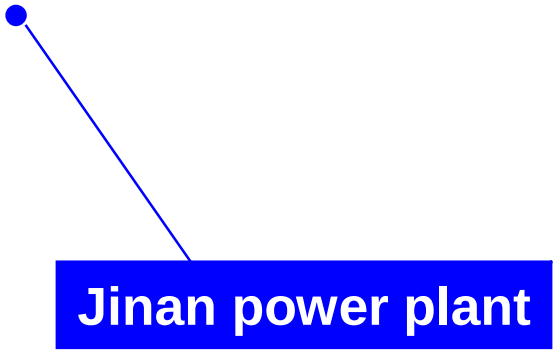
Regional: EMEP 50 km x 50 km

Example: A Fictitious Coal Fired Power Plant in Janin, China

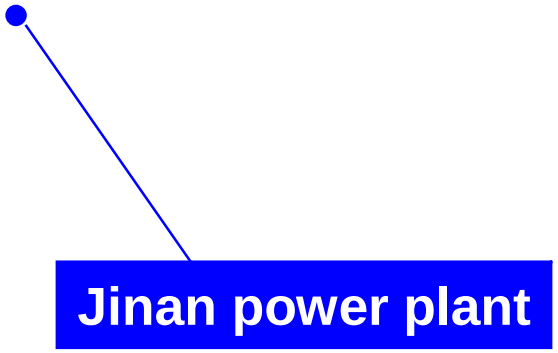
(Reference plant defined in Hirschberg et al. (2003))

- **Capacity: 925 MW**
- **Electricity sent out: 860 MW**
- **Full load hours per year: 5469 h**
- **Stack height: 220m**
- **SO2 emissions: 3.8 g/Nm3**
- **NOX emissions: 1.5 g/Nm3**
- **PM emission: 0.5 g/Nm3**

Change in Concentration: PM10



Location and Population Distribution



Quantification of impacts and costs

Exposure Response Function:

Number of new case of chronic bronchitis

$$= 4.9 \cdot 10^{-5} \cdot \Delta PM10 \cdot Population$$

Quantified number of additional cases of chronic bronchitis due to one TWh electricity produced in the fictive exemplary power plant due to primary and secondary particles:

710

Impacts included (I)

Impact Category	Pollutant / Burden	Effects
Human Health – mortality	PM_{10}	Reduction in life expectancy due to short and long time exposure
	SO_2, O_3	Reduction in life expectancy due to short time exposure
	Benzene, BaP, 1,3-butad., Diesel part., radioactive subst.	Reduction in life expectancy due to long time exposure
	Noise	Reduction in life expectancy due to long time exposure
	Accident risk	Fatality risk from accidents (road, mining, nuclear,…)
Human Health – morbidity	PM_{10}, O_3, SO_2	Respiratory hospital admissions
	PM_{10}, O_3	Restricted activity days
	PM_{10}, CO	Congestive heart failure
	Benzene, BaP, 1,3-butad., Diesel part.	Cancer risk (non-fatal)
	PM_{10}	Cerebrovascular hospital admissions, cases of chronic bronchitis, cases of chronic cough in children, cough in asthmatics, lower respiratory symptoms
	O_3	Asthma attacks, symptom days
	Noise	Myocardial infarction, angina pectoris, hypertension, sleep disturbance
	Accident risk	Risk of injuries from traffic and workplace accidents

Impacts included (II)

Impact Category	Pollutant / Burden	Effects
Building Material	SO_2, Acid deposition	Ageing of galvanised steel, limestone, mortar, sand-stone, paint, rendering, and zinc for utilitarian buildings
	Combustion particles	Soiling of buildings
Crops	SO_2	Yield change for wheat, barley, rye, oats, potato, sugar beet
	O_3	Yield change for wheat, barley, rye, oats, potato, rice, tobacco, sunflower seed
	Acid deposition	Increased need for liming
	N, S	Fertilising effects
Global Warming	CO_2, CH_4, N_2O, N, S	World-wide effects on mortality, morbidity, coastal impacts, agriculture, energy demand, and economic impacts due to temperature change and sea level rise
Amenity losses	Noise	Amenity losses due to noise exposure
Ecosystems	Acid deposition, nitrogen deposition	Acidity and eutrophication (avoidance costs for reducing areas where critical loads are exceeded)
Energy Insecurity	unexpected oil price	increase change in GDP

Valuation methods for non-market goods

Revealed Preference (RP)
behaviour (shown in the past)

Stated Preference (SP)
surveys (about future of behaviour)

Indirect valuation

assesses costs or efforts that can be linked to the non-market good

- Hedonic Price Method
- Averting Behavior Method
- Travel Cost Method
- Contingent Behavior Method
- Past behaviour of public decision makers

Direct valuation

- Contingent Valuation Method (CVM)
- Attribute Based Choice Modeling (ABCM)
- Participatory approaches
- Surveys for preferences of public decision makers

Quantification of impacts and costs

Quantified number of additional cases of chronic bronchitis due to one TWh electricity produced in the fictive exemplary power plant (primary particles): 710 /TWh$_{el}$

Monetary value (transferred using PPP adjusted income): 24 200 € per case of chronic bronchitis (European value: 169 000 €)

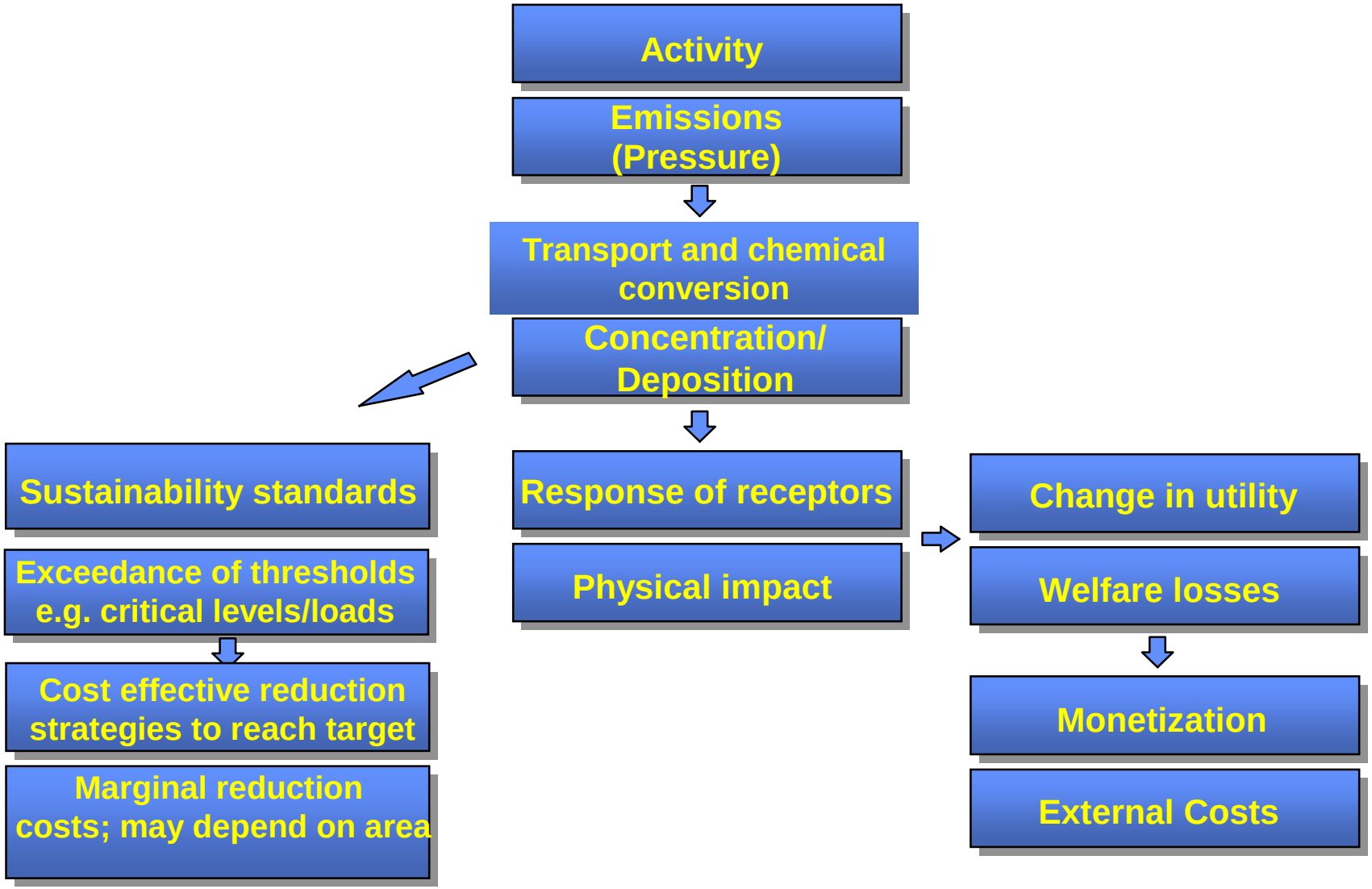
Damage costs of cases of chronic bronchitis per kWh electricity: 0.23 €-Cent per KWh

Monetary Valuation

Average for West European Countries (best estimate)

Health effects	Monetary value (€ $_{2000}$)
Value of a prevented fatality (VPF)	1,040,000
Year of life lost (chronic effects, 3% discount rate)	50,000
Cerebrovascular hospital admission	16,730
Respiratory hospital admission	4,320
Congestive heart failure	3,260
Chronic cough in children	240
Restricted activity day	110
Asthma attack	75
Cough	45
Minor restricted activity day	45
Symptom day	45
Bronchodilator usage	40
Lower respiratory symptom	8

Extended Impact Pathway Approach



Assessment of Greenhouse Gas Emissions in the EU

Marginal damage costs:

- **2,4 €$_{2000}$ per t CO_2 (ExternE 2000) –median value/ large range (ca. 0,1 to 16 € per t of CO_2in ExternE; up to 165 € per t of CO_2 in other studies)**

Marginal avoidance costs for EU-Kyoto aim -8% CO_2äq. 2008-2012 compared to 1990

- **ca 20 € per t CO_2äq with emission trading**

range ca. 5 – 42 € per t of CO_2

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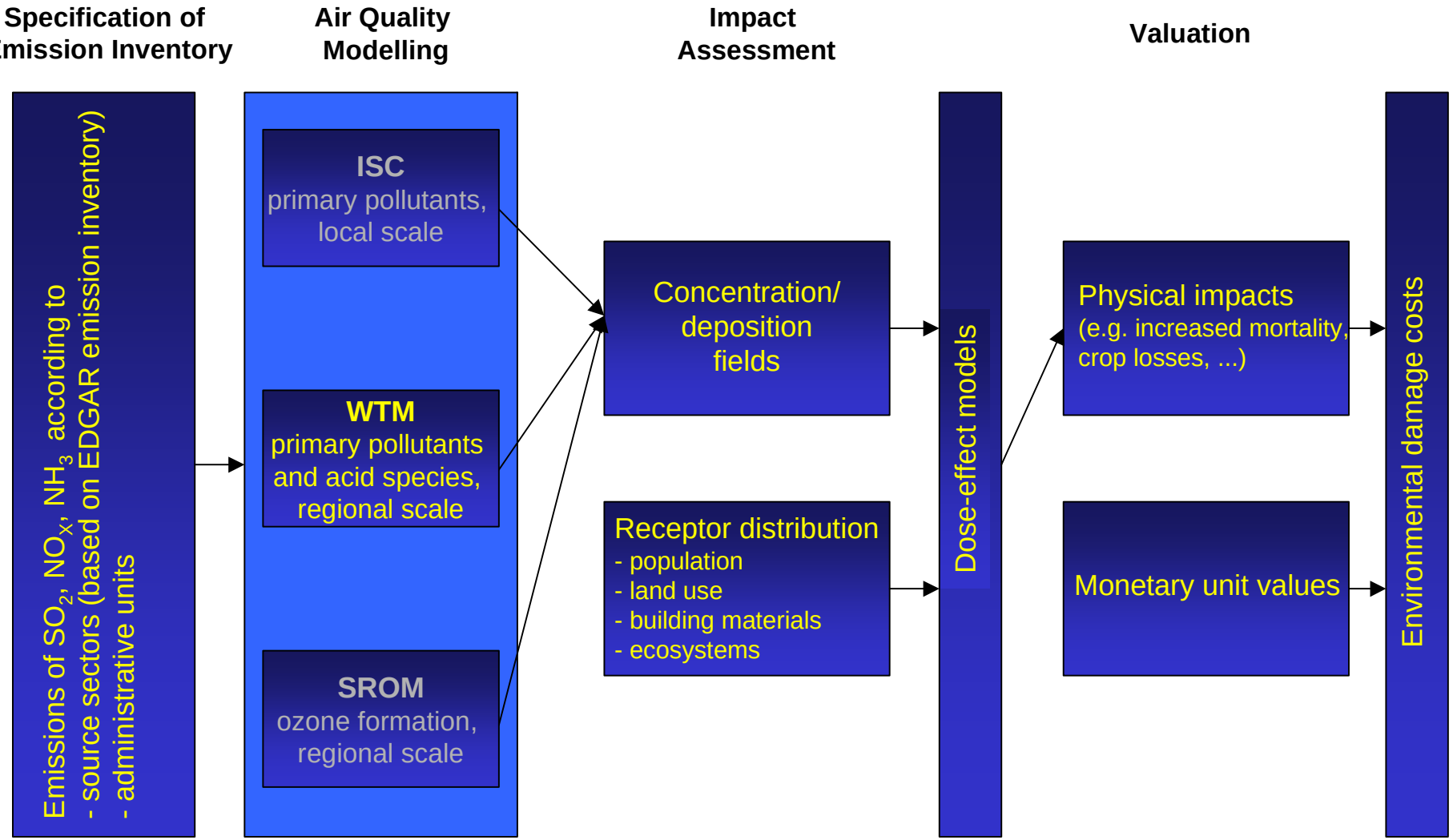
EcoSense Flowchart



Uncertainties of estimations of external costs

Bandwidth of results caused by different assumptions and hypotheses (discount rate, model for assessing mortality risks)

- ***sensitivity analysis***
- ***Stated preference (esp. participative methods)***
- ***Guidelines by decision maker, which hypotheses/assumptions to be used***

➢ ***project HEATCO to propose harmonized guidelines for the transport sector for DG TREN,***

➢***recommendations for VSL and discount rates (DG Env)***

➢***Preparation of guidelines for the German ‚Umweltbundesamt‘***

Applications of the IPA/ExternE Methodology I

European Union:

Energy: justification for promoting and subsidizing renewable energy; recommended cap on subsidies for renewables

Transport: cost-benefit analysis mandatory for all major infrastructure projects; planned to levy tolls according to infrastructure and external costs

Environmental Protection: Cost-benefit analysis for all recently implemented directives for Air Pollution Control:
e.g. Non-Hazardeous Waste Incineration Directive, Large Combustion Plant Directive, National Emissions Ceilings Directive, Daughter Directives to Air Quality Directive: ozone, CO and benzene

UN: cost-benfit analysis for the UN/ECE multi-pollutant multi-effect protocol

Applications of the IPA/ExternE Methodology II

EU member states:
Numerous national applications: UK, Netherlands, Finland, Belgium, France, Ireland, Greece, Spain ..., e.g. in Germany: external costs of biomass; subsidies for renewable energies; extension Frankfurt airport;

In other parts of the world – together with local partners: Russia, China, Brazil, Ukraine, Japan

Summary

- **The *Impact Pathway Approach* estimates impacts of technologies for energy conversion and assesses them based on preferences of the effected population for a large number of impact pathways.**
- **The methodology is already widely used for decision aid in the fields of energy conversion, transport and environmental protection.**
- **Gaps and uncertainties exist, however will be more and more reduced due to ongoing research (e.g. on pathways involving toxic substances, heavy metals, biodiversity, water and soil contamination…)**