ExternE methodology
Extended Impact pathway approach

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DIEM Stakeholder WORKSHOP

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Agenda

Extended Impact pathway approach

1 Impact pathway approach

what ? some results

similarities-differences other approaches

2 Extended Impact pathway approach

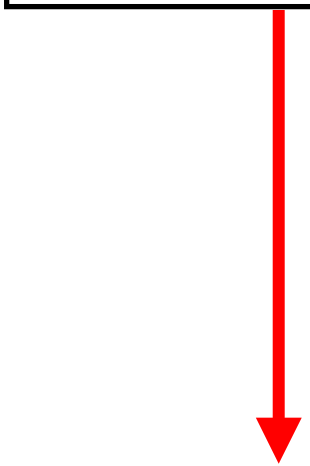
what : standard price

application : acidification & global warming

3 Conclusions

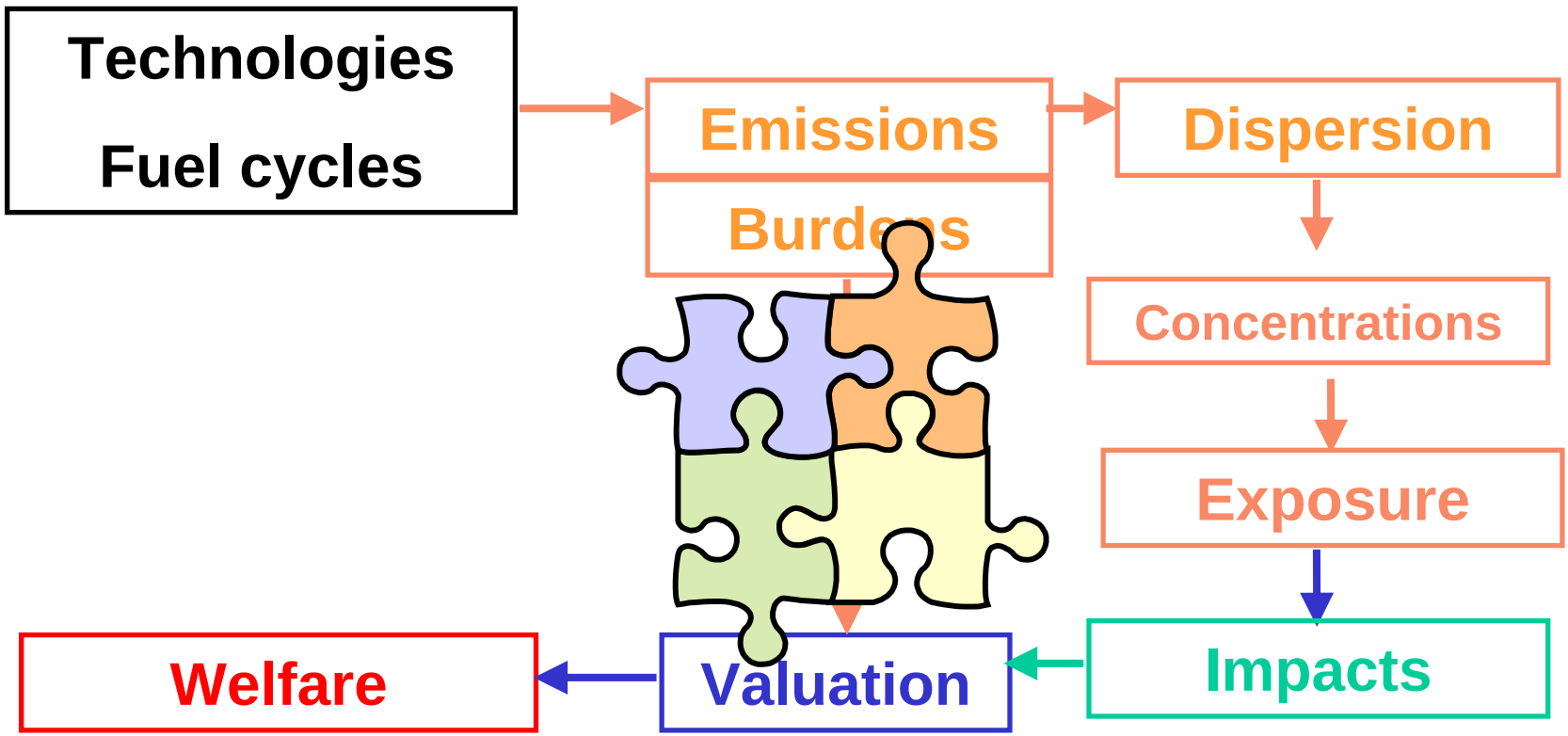
impact pathway 1

Technologies, fuel cycles, …

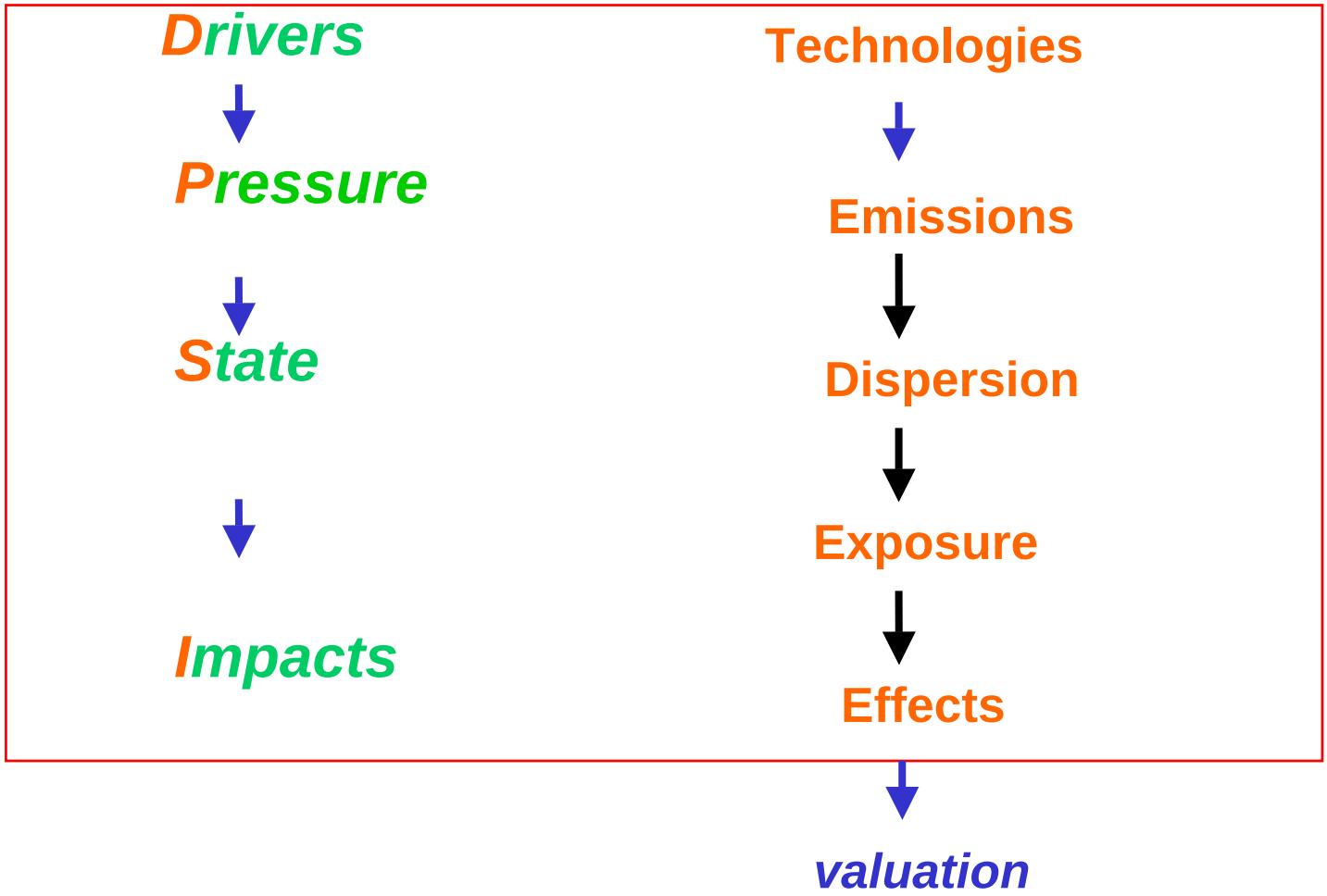


Welfare

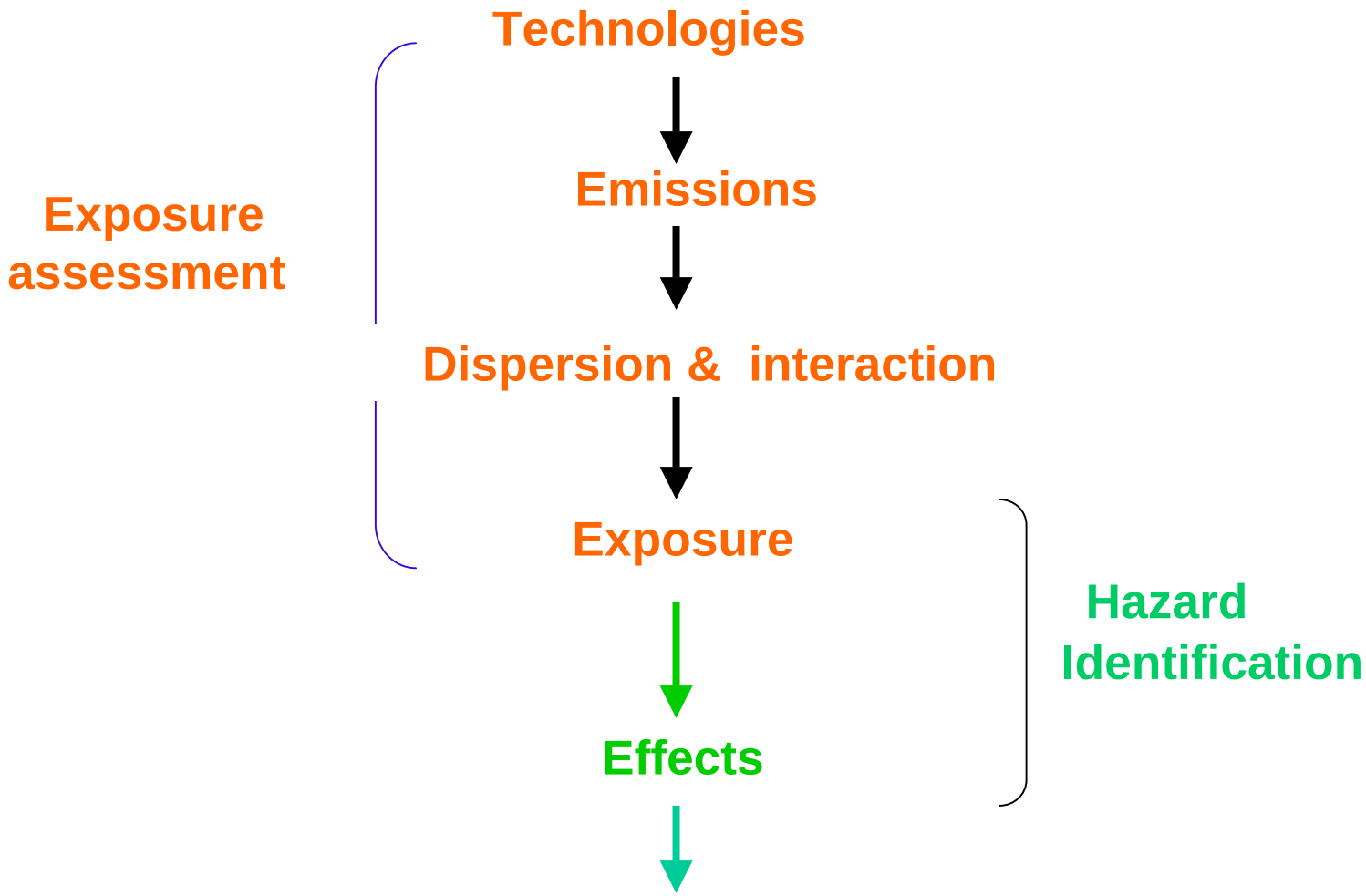
impact pathway 2



Similar to other approaches: DPSIR

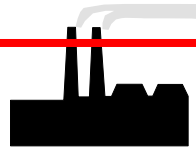


Similarities : risk assessment



Tools-data

1. EMISSIONS



Emission models

Data

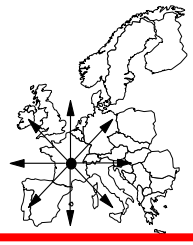
Technology & traffic specific

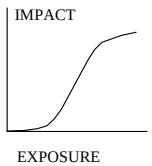
2. Impacts

A) Dispersion

B) exposure

C) IMPACTS





Dispersion models

local, national, regional, global

Exposure models

Exposure-response functions

public health
agriculture
materials
natural environment

Critical Loads

'Receptor at risk' data

3. DAMAGES

Tools-data

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data

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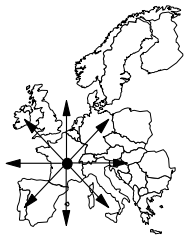
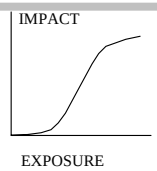
B) exposure

C) IMPACTS





n models

local, national, regional, global

Exposure models

Exposure-response functions

public health

agriculture

materials

natural environment

3. DAMAGES

Valuation

Market prices

Willingness to pay

Costs to meet specified targets

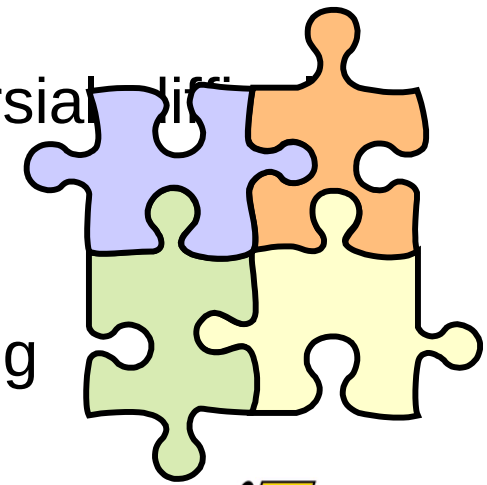
Specific external costs estimation

Similar models and info from other sciences, but different questions

Quantification of effects that affect welfare

Therefore at first view sometimes controversial, difficult to understand

Reflects state of the art of our understanding



Overview of impacts covered 1

☺ Public Health :

dominant impact category, shows the importance of impacts from particles, aerosols and other pollutants on public health,

first : controversial

now : widely accepted

shows that the ‘economic point of view for externality assessment ’ poses the right questions

Specific

Similar models and info from other sciences, but different questions

Quantification of effects that affect welfare

e.g. sum of small incremental impacts

⟷ RA : threshold levels : yes/no

Aggregate over distance :(local, national, Europe, World)

⟷ IA : focus on high, local impacts

Aggregate over time (short, mid-term, very long term)

discounting of future effects

Specific

Quantification of effects, even if uncertain

⟷ RA : Uncertainty ↗ add more safety margins

Evaluation of Technology : impacts of ‘mix of pollutants’

⟷ assessment of toxicity of single pollutants

next presentations:

health impact: assessment + valuation

Quantification of uncertainty : presentation

Overview of impacts covered 2

☺ Public Health : dominant impact category, shows the importance of impacts from particles, aerosols and other pollutants on public health,

☺ Impact categories less important, less controversial (but not complete)

- ☺ Agriculture
- ☺ Materials

😐 Ozone impacts : hard to model, big difference between marginal and aggregated analysis

New approaches

☹ **Ecological impacts** : impacts on critical loads can be quantified,

monetisation based on public preferences difficult (no data willingness to pay directly useable

Therefore extended impact pathway approach

😐 **Global Warming** : positive and negative impacts : a range of data is available, large uncertainties, importance of assumptions

blanks : not all impacts-categories are included,

data limited to impacts to 2100 or 2200

Therefore extended impact pathway approach

extended impact pathway approach

ExternE : Valution based on willingness to pay

of an individual

for a good or service (including services of nature)

Extension is based on standard price approach that

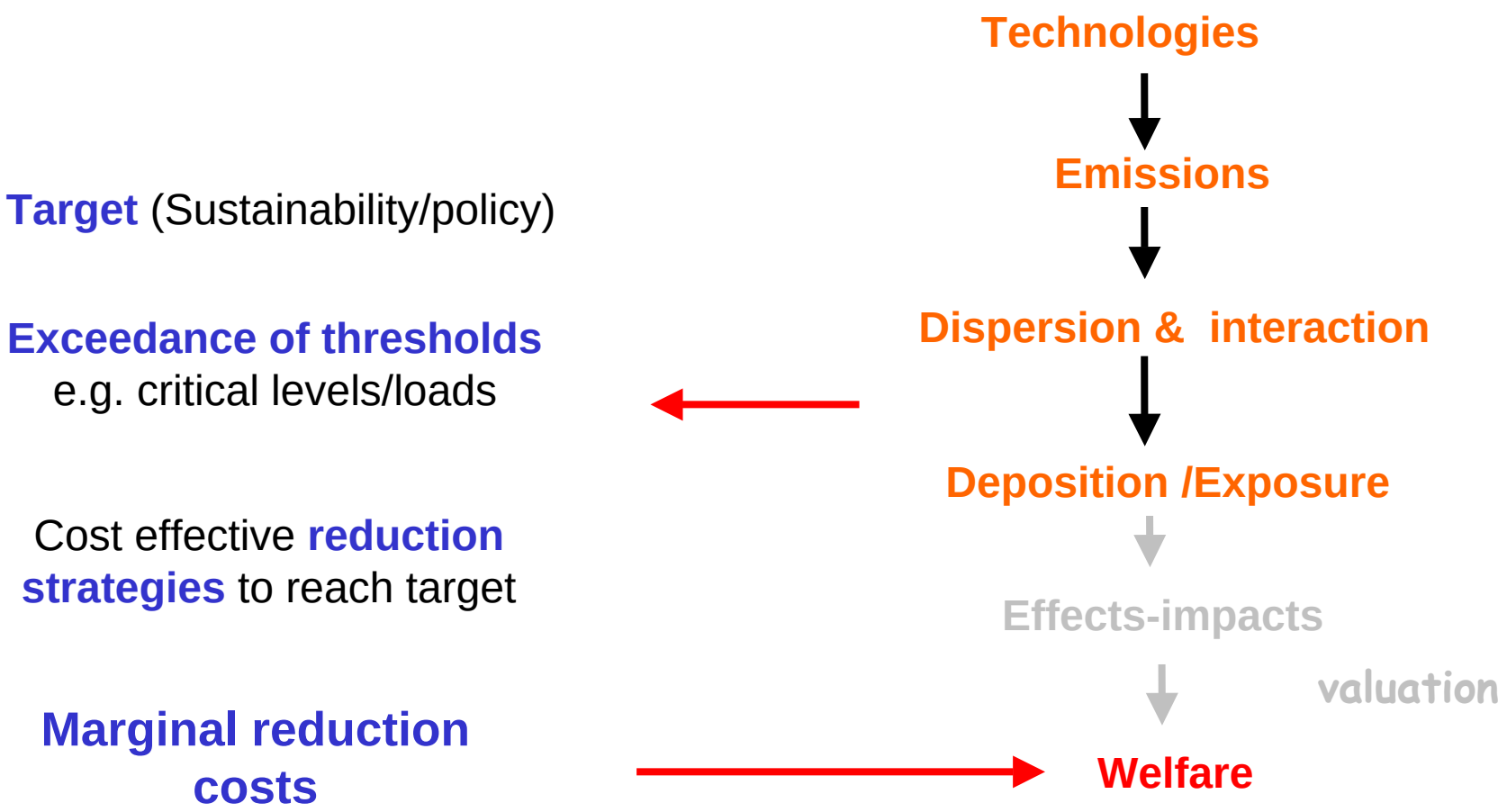
- *takes preferences of policy makers as revealed in policy decisions as proxy for societal preferences*
- Preferences are measured based on costs

  politicians are willing to pose upon society to reach well defined targets

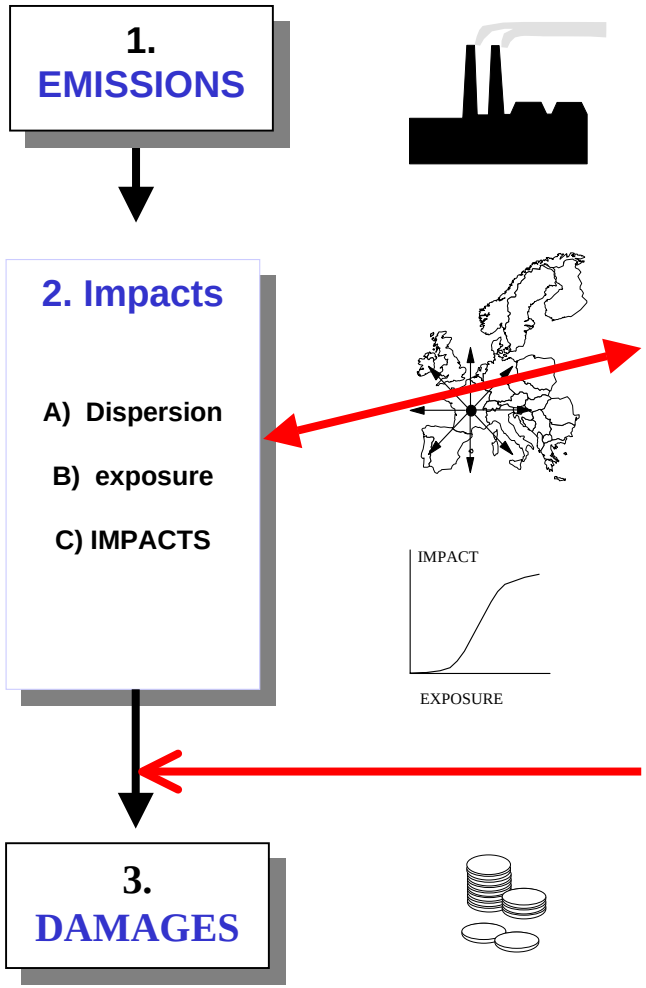
Different from shadow prices

That reflect costs to meet 'scientific' targets

extended impact pathway approach



Tools-data



Target (Sustainability/policy)

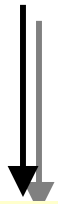
Exceedance of thresholds
e.g. critical levels/loads

Cost effective reduction strategies to reach target

Marginal reduction costs

Acidification-eutrophication 1

Emissions

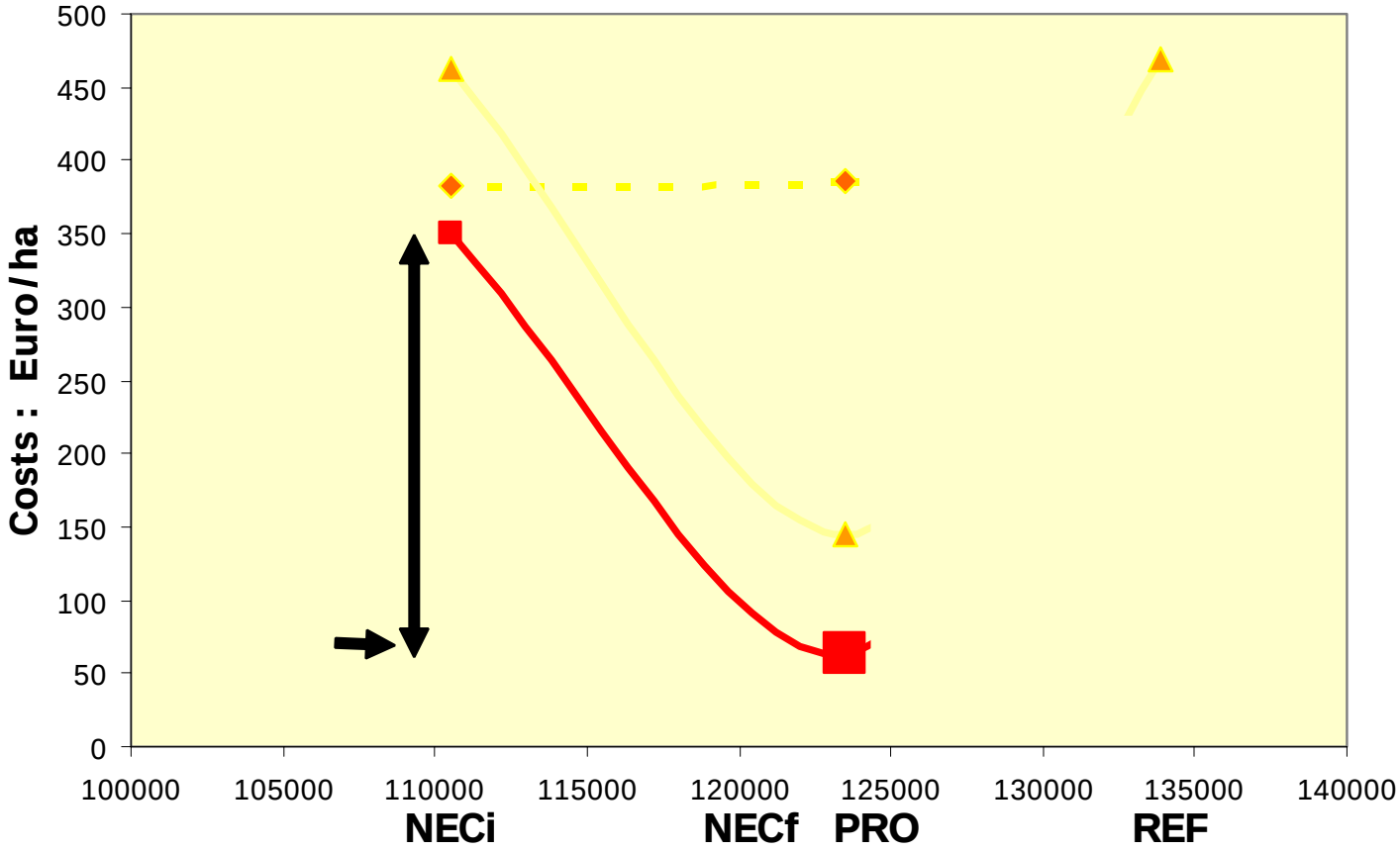


Marginal impacts :
Exceedance of critical loads
(in ha ecosystem protected / ton emission)

WTP for protection of ecosystems :
determined by the standard-price approach

(In €/ha protected)

Ref, PRO, NECf & NECi : "marginal" and average costs per ha protected



Area unprotected Ecosystems (acid + eutro) : 1000 ha

Range for WTP

Best estimate

Acidification-eutrophication 1

Emissions

Marginal impacts :
Exceedance of critical loads
(in ha ecosystem protected / ton emission)

WTP for protection of ecosystems :
determined by the standard-price approach

(In €/ha protected)

SHADOW PRICE of impact on ecosystems

(in €/tonne emission)

Acidification-eutrophication 3

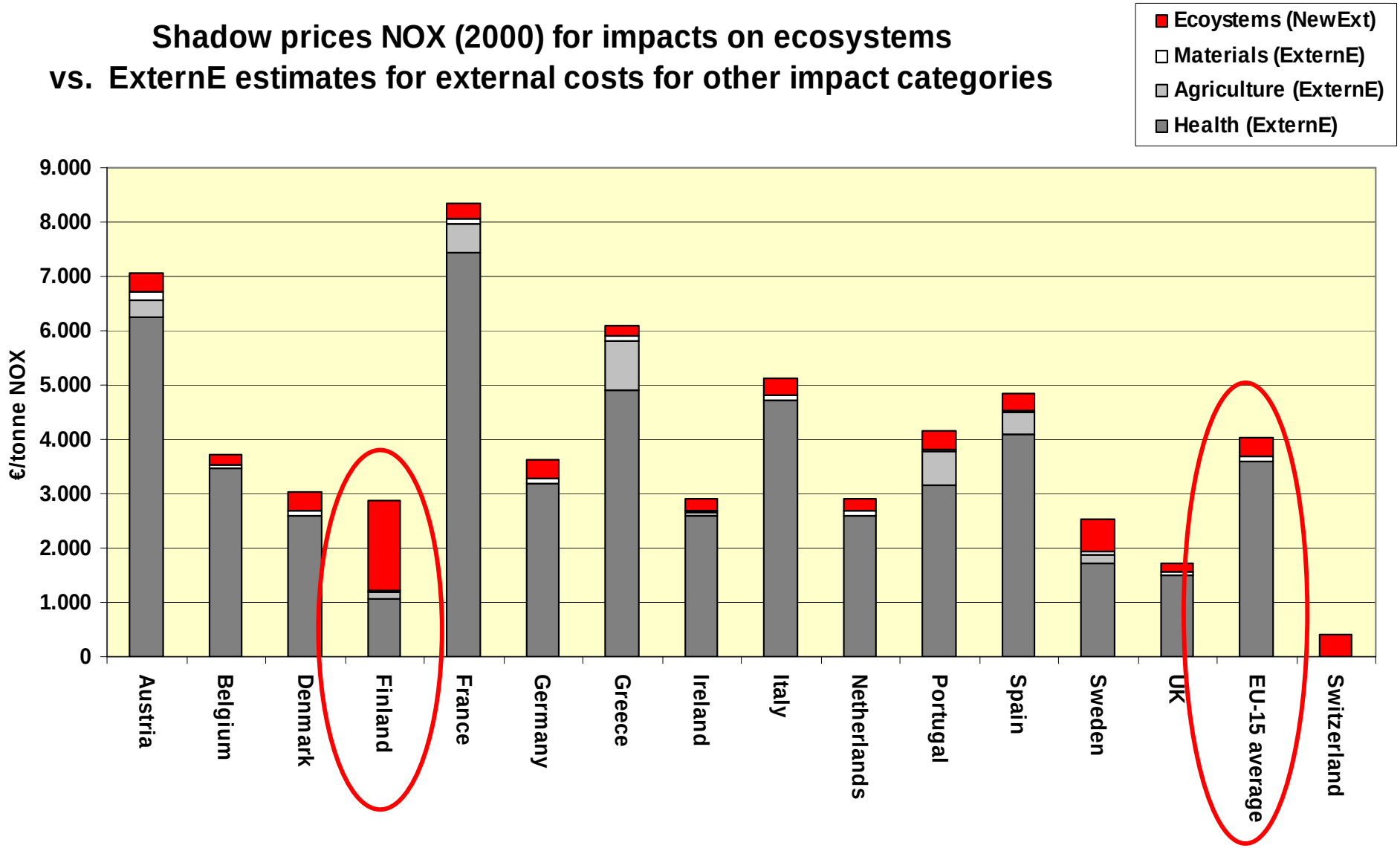
Range WTP/hectare :

- Gotheborg and national emissions ceilings negotiations
- Protocol-NEC Final lower limit, good proxy for WTP, NEC_i upper limit for WTP
- 100 to 350 €/ha*year (for ecosystems protected all over Europe)
- Within this range, best estimate around **100 €/ha**, to be applied to total area of ecosystems protected all over Europe.

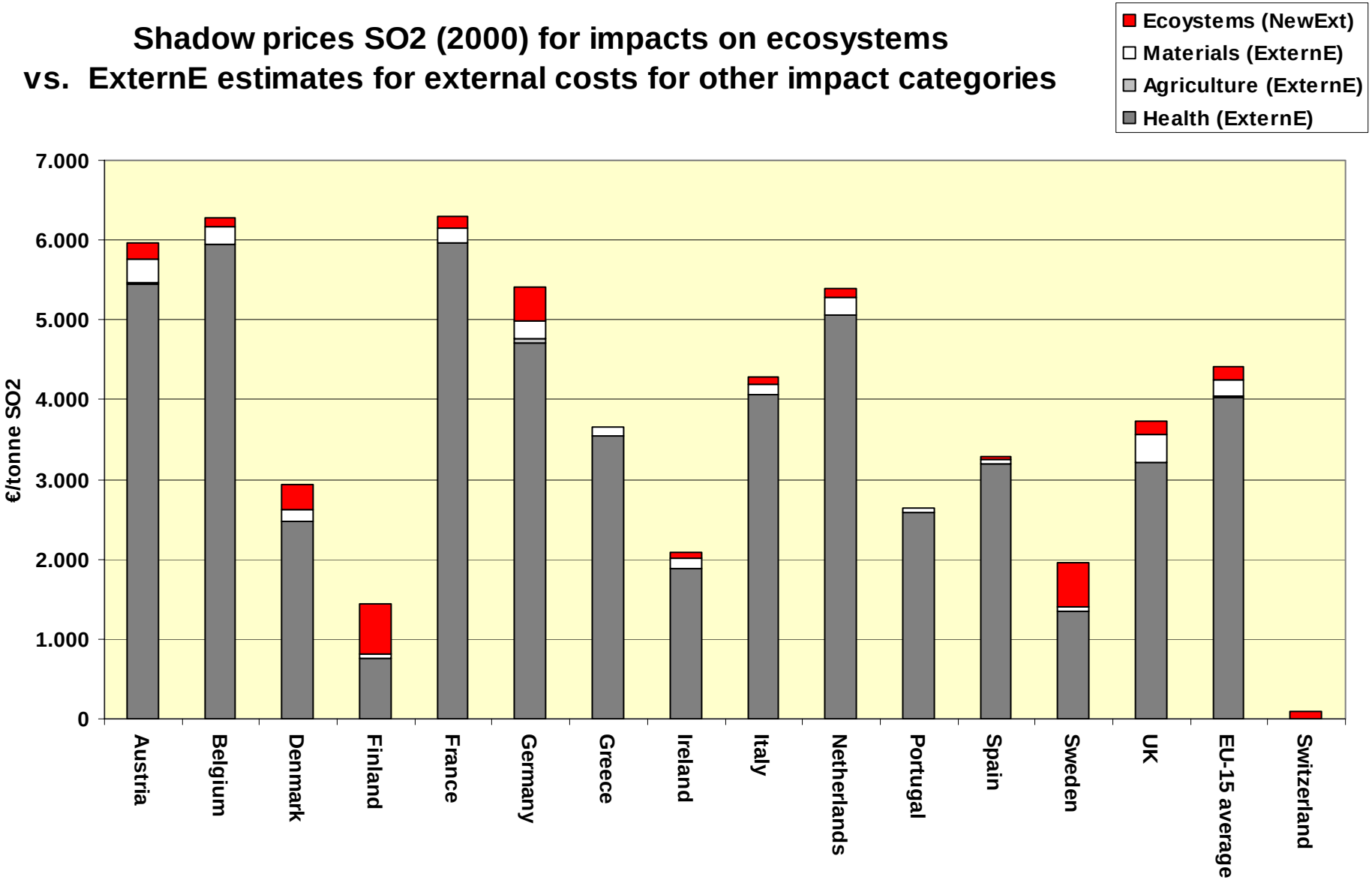
Result: shadow price for impacts on ecosystems results in relatively small increase in external costs (+4% SO_2, +10% NO_X) for EU15 average

Exceptions : Finland and Sweden

Shadow prices NOX (2000) for impacts on ecosystems vs. ExternE estimates for external costs for other impact categories



Shadow prices SO2 (2000) for impacts on ecosystems vs. ExternE estimates for external costs for other impact categories



CO2 : 3 major perspectives

1. Impacts and external costs,
   based on impact pathway, Tol 2000
   - Have been partly assessed and monetised : result
   - = a wide range (**0-16 € /** tonne of CO2-eq)
   - = an **unknown % of an unknown** total
   - Is current value of impacts to be expected in the next 100 years.
   - Impacts and Costs will especially occur in non-OECD countries,

CO2 : standard price approach

Costs of Kyoto and related targets

Targets

1. **Targets for the EU**
2. **Targets for national countries**
   a) inside EU : part of EU strategy + national commitments
   b) outside EU : e.g. Switzerland

→ "Kyoto" is not a single objective, but contains different perspectives/interpretations

Standard price approach: results

Costs : cost-effective strategies to meet the target

Some strategies are more cost-effective then others

EU-least cost strategy to meet Kyoto

5,00 – 20,00 €/tonne of CO_2

National targets :

- from 0 to 100 €/tonne CO_2 for EU-members
- > 100 € /tonne for CO_2 Switzerland

Indirect WTP : through referendum

3 Perspective of the **Swiss people**, as reflected in referenda related to energy issues.

a WTP has been calculated in the order of 5 to 15 €/ton CO2,

CO2 - CONCLUSIONS

- Several approaches confirm the range of 5-20 €/ton CO_2,
- Non least-costs and purely national Implementation schemes indicate higher numbers, up to 100 €/ton and more, but with large differences between countries.
- Exernal costs ? CO2 external costs may be 'internalised' in decision making, for certain sectors by means of tradeable CO2 emission quota (electricity generation)

Conclusions

Impact pathway approach

- proven to be a challenging but successful framework for impact analysis, and to present state of the art knowledge
- successfully applied to numerous impact categories
- result : air pollution is among the best covered issues in externalities or in risk assessment (quantification)

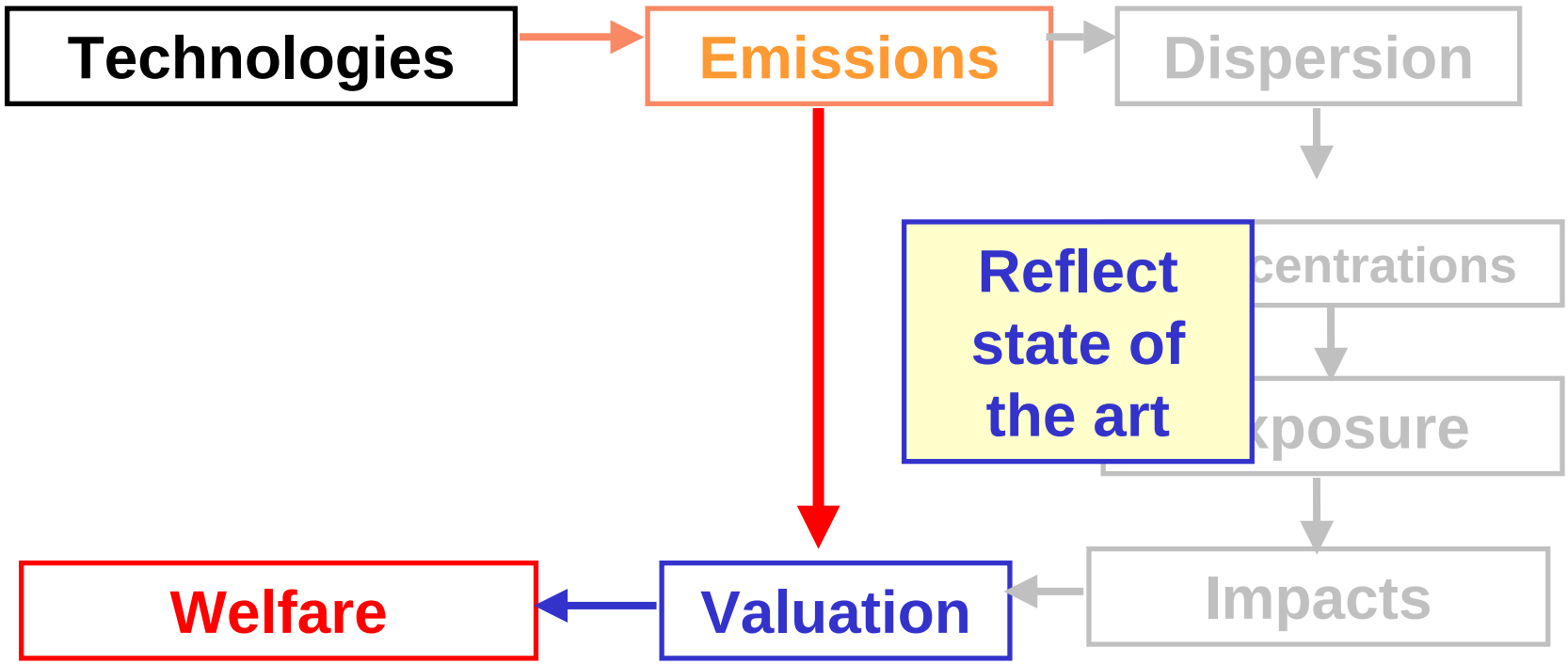
Extended with standard price approach

- to cover more impact categories
- application : acidification & global warming

A lot of data and tools and applications available

Future : Continuous update needed

ExternE 'Shortcut' data



Conclusions

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Extended with standard price approach

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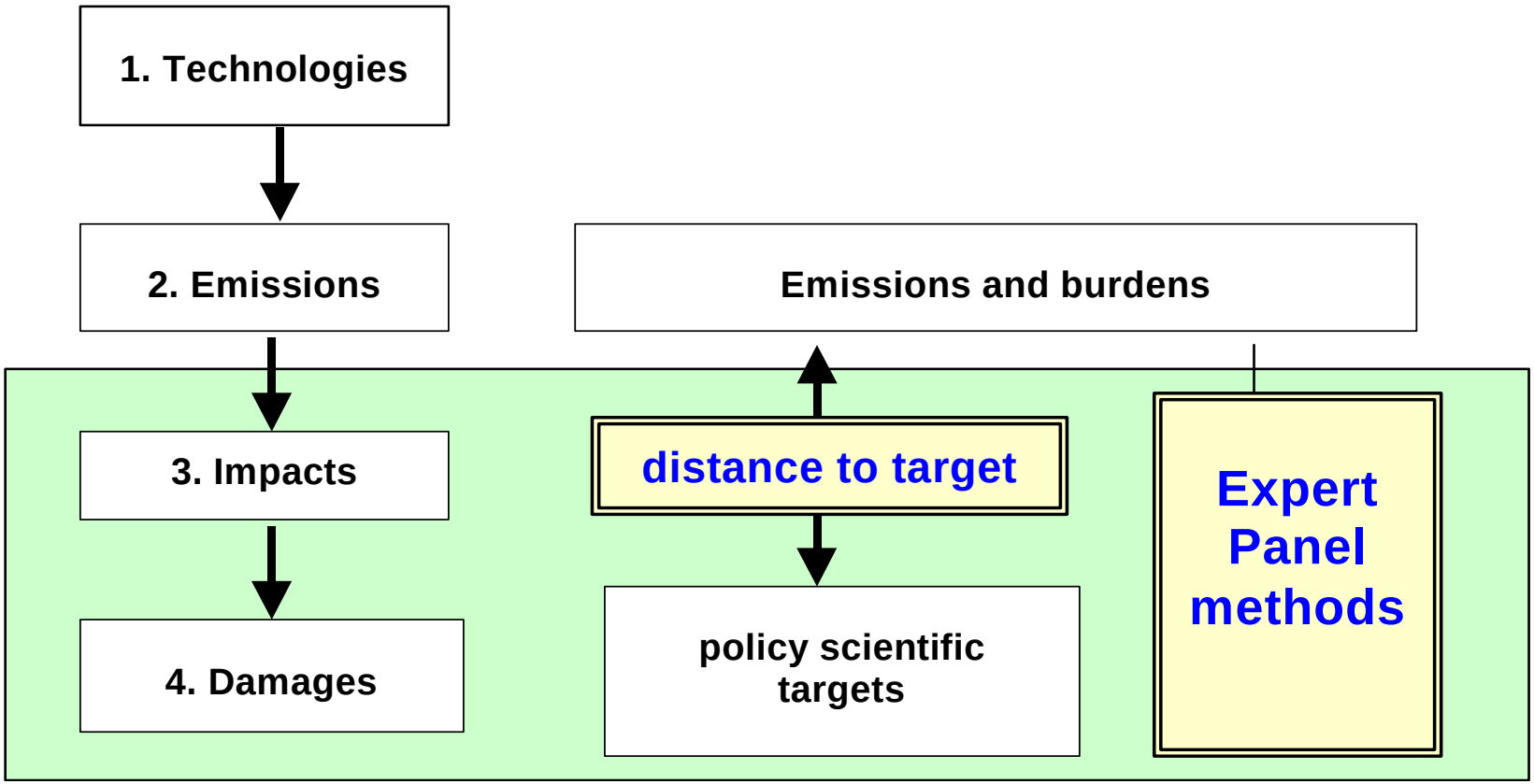
A lot of data and tools and applications available

Future : Continuous update needed

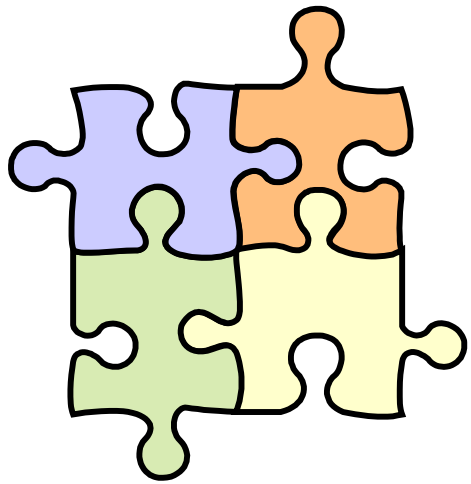
Open for new approaches, methods, stakeholders dialogue

Other valuation/aggregation concepts



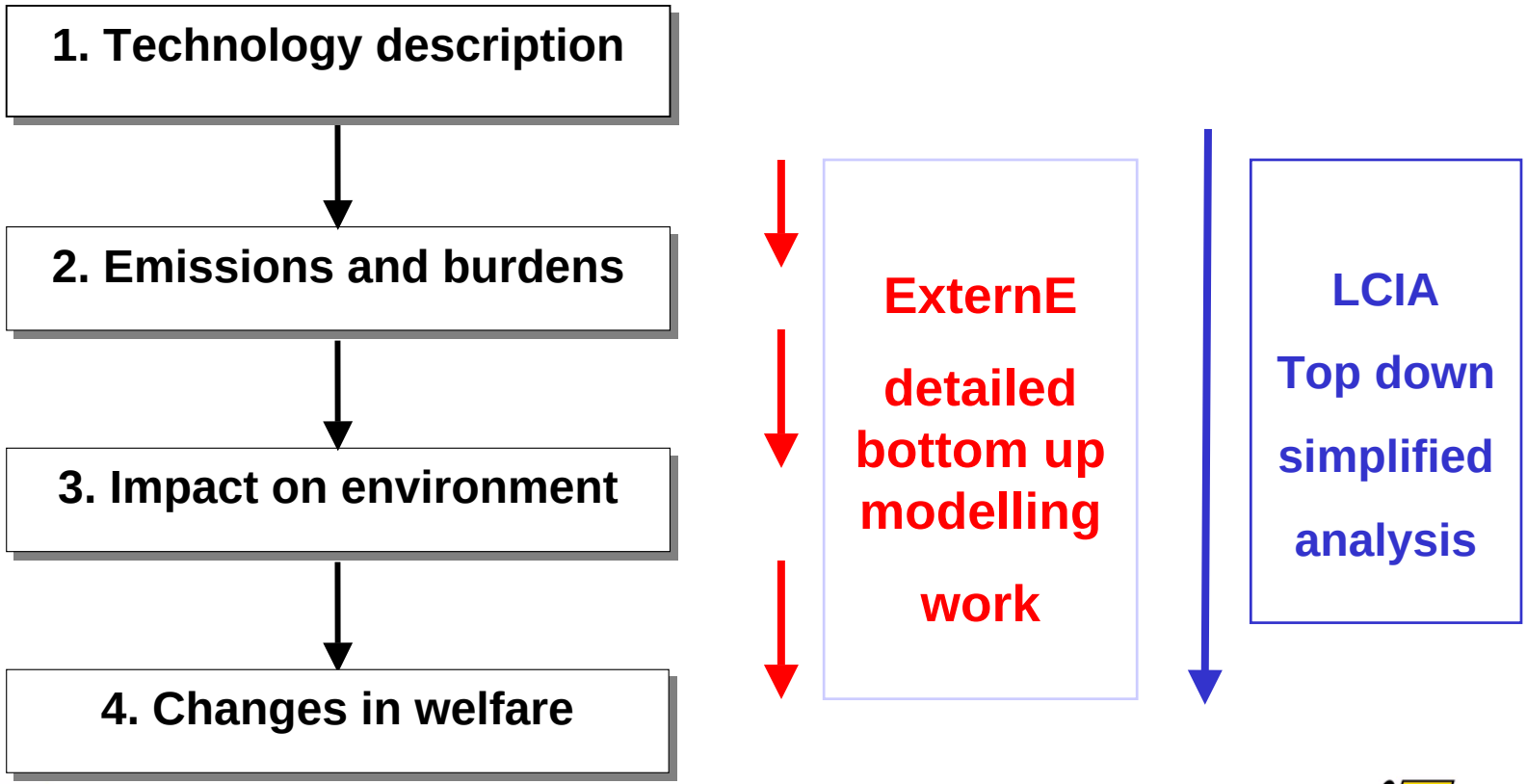
Thanks for listening

Questions ?



Life cycle impact assessment

Marginal analysis :impacts of e.g. an additional vehicle km



CO2 : what have learned

Costs to meet Kyoto :

Best estimate : 5- 20 €/t CO2,

for cost-efficient sollutions and policies

Costs in EU 15 , today, for changes in technology to meet Kyoto

Estimate pending on willingness to select most cost-effective sollutions

but, if not cost-efficient, is it likely to be implemented at all?

CO2 : what have learned

Exernal costs ?

Near future : CO2 external costs may be 'internalised' in decision making, for certain sectors by means of tradeable CO2 emission quota (electricity generation),

People's WTP for reduction of CO2 emissions

New approach, uncertain results

Confirms WTP for lower range of abatement cost estimates, not for the higher estimates

Impact pathway : 0-16 €/t C02

but very uncertain

Costs in non-OECD countries, next 100 years

CO2 : Background

Externalities as treated in ExternE

Real impacts and costs, based on impact pathway:

- Have been partly assessed and monetised : result
- = a wide range (0-16 €/tonne of CO2-eq)
- = an unknown % of an unknown total
- Is current value of impacts to be expected in the next 100 years.
- Impacts and Costs will especially occur in non-OECD countries,

Too uncertain , look for other approaches

CO2

Estimate society's Willingness to pay to limit greenhouse gas emissions

→ Policy makers WTP for implementation of Kyoto as a proxy

→ (proposal)

People's WTP for reduction of CO2 emissions in Switserland (added)

CO_2 : SHADOW PRICE

Well defined political target ?

- Not really based on scientific targets
- Policy target, but the rules for implementation have not been specified, therefore not a single answer.

Main assumptions :

- Real willingness to limit CO_2 emissions and to meet Kyoto targets. targets.

  This may be questioned, taken into account the lack of policy measures implemented so far ?

  We do not take no-regret benefits into account

A real cost for society in EU :

cost in EU countries for technological changes (e.g. investment in in energy efficiency/fuel switching) to meet standards

more emissions by technology choice A

will create efforts somewhere in society to reduce CO2 elsewhere elsewhere

COST INFO IN POLICY MAKING PROCESS

General understanding from EU policy makers:

Emission reductions of CO_2 feasible at zero to low costs + the no-regret benefits (impacts on acidificaton, health etc.)

What is the real WTP of policy makers for Kyoto ?

Kyoto protocol

status of ratification

EU level : OK since 2002

Switseland : Ok

has not yet entered into force internationally (pending on Russia ratifying the protocol)

CO2 : KYOTO & RELATED TARGETS

1. **Targets for the EU**
2. **Targets for national countries**
   a) inside EU : part of EU strategy + national commitments
   b) outside EU : e.g. Switzerland

→ *"Kyoto" is not a single objective, but contains different perspectives/interpretations*

3 PERSPECTIVES :

a) ***EU***: EU-least cost strategy to meet Kyoto

5,00 – 20,00 €/tonne of CO_2

b) ***National targets*** :

- from 0 to 100 €/tonne CO_2 for EU-members
- > 100 € /tonne for CO_2 Switzerland

c) Perspective of the ***Swiss people***, as reflected in referenda related to energy issues.

a WTP has been calculated in the order of 5 to 15 €/ton CO2,

1. EU perspective

How to reach EU Kyoto target :

- A least cost path to CO_2 limitation, as identified by technico-economic models :

  Range : 5,00 – 20,00 €/tonne of CO_2

  → this is the lower margin.

- EU target shared among the member states (takes into account national willingness to pay?) : then costs of real policy measures are required.

2. National perspective

- Depend on target agreed by the country + costs of measures to reach the target
- Wide variation between countries, with much higher costs for some countries to meet emission reduction targets :

  e.g. Belgium : up to 80,00 €/tonne CO_2

  Switzerland : > 100,00 €/tonne CO_2

2. National perspective (b)

"National perspective" does not exclude countries to buy emission reductions in other countries : then, the marginal cost may be much cheaper.

e.g. a figure of 5-10 €/tonne CO_2, for emission reductions in Russia

Belgium states its interests to buy emission reduction credits in Russia

3. Swiss Referenda

- In several referenda in Switzerland people were asked whether or not to agree with a price to be paid for increasing renewable energies.
- The answers of these referenda can be interpreted as real WTP experiments for energy policies and CO_2 reductions.
- (some literature for estimates of WTP for CO2 (e.g. in Japan): emerging subject ?

3. Swiss Referenda (b)

Main assumptions :

1. Statistics : Normal Distribution of WTP among population
2. Arguments for renewable energies = limiting CO_2 emissions (although other elements as energy depletion and energy security may play a role)

Results :

From these referenda, a WTP has been calculated in the order of **5 to 15 €/ton CO_2**, this is much lower then the abatement costs in Switzerland of any CO_2 reduction target.

CONCLUSIONS

- At first, it looked easy to identify a CO_2 shadow price, based on Kyoto.
- As the implementation of Kyoto has not fully been decided upon, a single 'shadow price' cannot be defined
- The lower range (5-20 €/ton CO_2) is close to range based on Tol, 2000 (2.4-16 €/ton CO_2)
- Non least-costs and purely national Implementation schemes indicate higher numbers, up to 100 €/ton and more, but with large differences between countries.
- Taking into account the difficulties in implementing Kyoto, the lower range may even be interpreted as

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Step 1

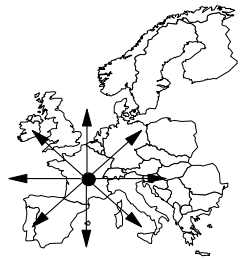
EMISSIONS

(eg. X g NOx /vehicle km for vehicle Y / trajectory Z)

Step 2

Dispersion models

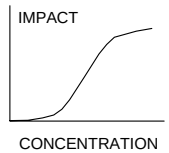
change of concentrations (eg. µg/m³ NOx in affected regions in Europe)



Step 3

IMPACT

(eg. Impact NOx on human health)



Dose-response

Step 4

DAMAGE

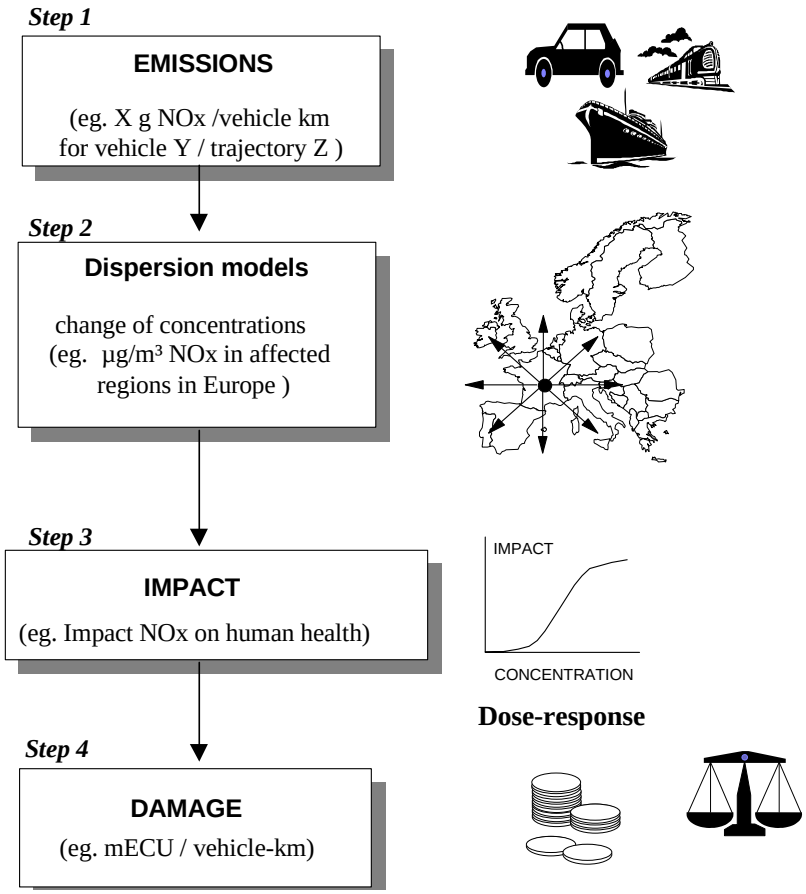
(eg. mECU / vehicle-km)

AGGREGATION

summation for all locations, all vehicles, ...

$$\sum_{Euro0}^{Euro4} cars \sum_{petrol}^{LPG} fuels \sum_{rural}^{urban} locations$$

Impact pathway analysis



PM impacts versus global warming

IMPACTS	local	national	European	outside Europe
immediate				-
chronic, current generation				-
GW 2100	-	-		
GW 2100-2200	-	-		
	most certain			
	relatively certain			
	uncertain			
	very uncertain			
GW	global warming