WP2 Summary
Energy use and ancillary benefits of carbon mitigation

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EUROPEAN COMMISSION
European Research Area

SEVENTH FRAMEWORK
PROGRAMME

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WP2 Partners & Tasks

CUNI – Charles University Prague, Environment Ctr
IHEID – Graduate Institute of Geneva
ISIS – Institute of Studies for the Integration of Systems
TSE – Toulouse School of Economics

Non-market effects & ancillary benefits

- **non-market benefits** of climate change and related to ancillary effects (CUNI)
- **ancillary effects** of GHG mitigating policies (CUNI, HEID, ISIS)
- large scale **health effects** of global change (TSE)

Saving behavior at homes

- residential **energy and water savings** under changes of climate (CUNI, TSE)
- adoption of **micro-generation technology** at homes: a survey in CZE (CUNI)

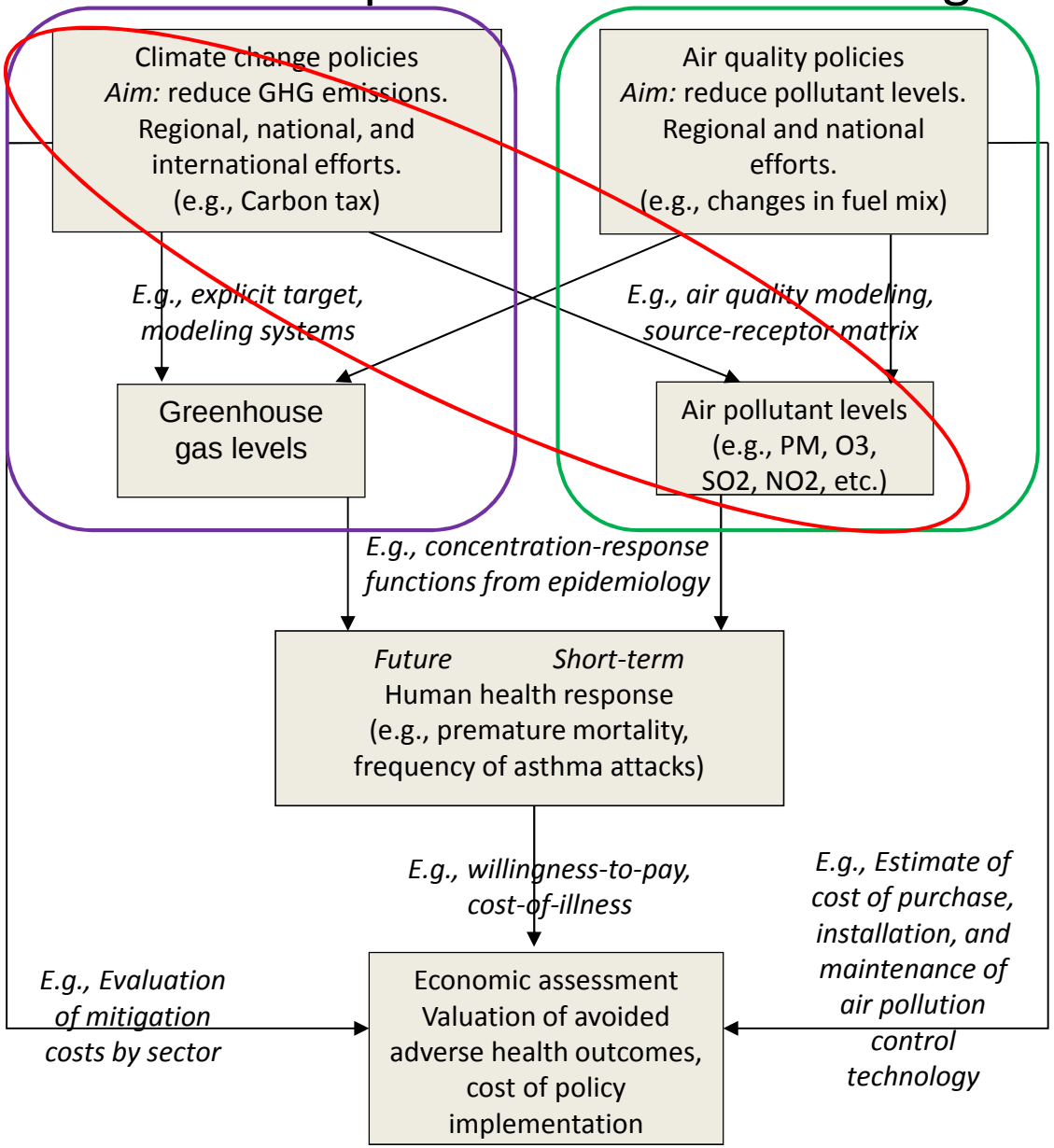
Energy tax incidence

- energy **taxation** and redistributive aspects (CUNI, TSE)
- **elasticity of substitution** of production function (CUNI)

Trade Policy and Climate Policy

- empirical evidence of **competitiveness effects** (HEID)
- new theory of competitiveness with **heterogeneous firms** (HEID)
- climate **policy analysis** (TSE)

Relationship between climate change and air quality policies



- **Air quality policies** = routinely evaluated in terms of the estimated health and environmental effects avoided and their economic impact (**reductions in external costs**)
- Assessment of the health and other environmental impacts of **GHG strategies** often considers **only consequences in the far future** without integration of the short-term benefits
- Full assessment should also include a **potential ancillary benefits**

- The **general structure of the assessment involves** 3 key steps:
- 1. estimating changes in air pollutant concentrations in response to GHG mitigation
- 2. estimating the adverse health and environmental impacts avoided from reduced air pollution
- 3. estimating the monetary benefit from these averted health and environmental consequences (e.g., the **Extern**E methodology)

Source: adapted from Bell et al., 2008

I Ancillary benefits

*"**ancillary benefits**" **of climate change mitigation policies**: reducing GHG emissions can have significant complementarities with domestic environmental targets and can induce direct beneficial spillovers to the local economy*

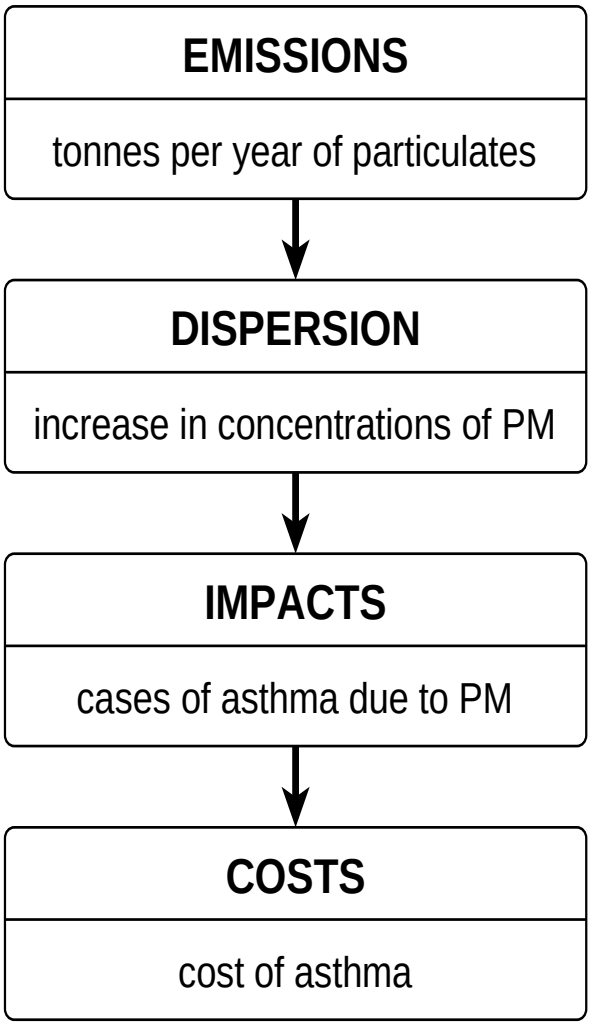
- account for these **complementarities** in global and local policies in policy discussions and climate change negotiations
- if ABs can be measured in **monetary terms**, they should be **subtracted from the costs** incurred on mitigation policies in order to assess properly the social effects

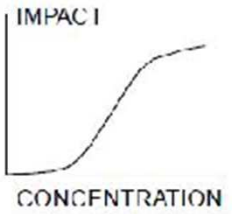
I Ancillary benefits

External costs of energy generation

- The broad variance in the value of ancillary effect estimates ⇒ ranging from 2 to 585 EUR per ton of carbon reduced (Davis et al. 2000)
- CUNI Task to provide an assessment of avoided health and environmental impacts (ancillary benefits) of mitigating policies
  - develop a modelling framework to **link the macro models (WITCH, ICES)** with the assessment of ancillary benefits
  - compute **ancillary benefits of air pollution reduction for Europe** for selected integrated global scenarios developed in the Global-IQ project

ExternE – the European methodological framework for damage cost assessme





Source: European Commission, 1995

- **ExternE „Externalities of Energy“** methodology ⇒ developed and used over 20 years in the EU research projects for monetary valuation of external costs arising from electricity and heat production (www.externe.info)
- Based on **the Impact Pathway Analysis** ⇒ analysis of externalities from bottom up

The IPA consists of **four basic processes**:

1. determination of the **source of pollution**, technological and emission parameters

2. calculation of changes in pollutant concentration for all affected regions using an **atmospheric dispersion models**

3. estimation of physical impacts caused by being exposed to a certain pollutant using **dose-response functions**

4. economic valuation of impacts following the WTP/WTA approach

Atmospheric dispersion of pollutants and calculation of external costs ⇒ SW **EcoSenseWeb 1.3** (local, regional and North-hemispheric module)

I Ancillary benefits

External costs of energy generation

- **Linkage with the macro models** (WITCH - integrated assessment model and ICES - general equilibrium model) developed in order to assess ancillary benefits for several Global-IQ integrated global scenarios
- **Soft-linkage** based on estimated damage factors per pollutant considered
- Classical emissions (SOx, Nox, PM10, PM2.5, NMVOC) and heavy metals (Pb, Cd, Hg, As, Cr, Ni) and CO2 calculated from **the primary energy production** as an output from WITCH / ICES model
- **Emission factors** for each fossil fuel category derived from the EMEP / EEA air pollutant emission inventory guidebook (EMEP/EEA, 2010).
- **Damage costs per pollutant** $\Rightarrow$ we used the ExternE country-specific external cost estimates per ton of non-GHG emissions (SO2, NOx, PM10, PM2.5, NMVOC, heavy metals)
- Ancillary benefit measures for each selected Global-IQ scenario computed **as avoided external costs** from the baseline scenario SSP-2.0

I Ancillary benefits

External costs of energy generation

Ancillary benefit measure		Description
Reduced total damage cost	ΔADC	Annually reduced damage costs (Euro)
Reduced damage cost per reduced CO_2	$\Delta ADC/\Delta CO_2$	Reduced annual damage costs per reduced tone of CO_2 emissions (Euro/t CO_2)

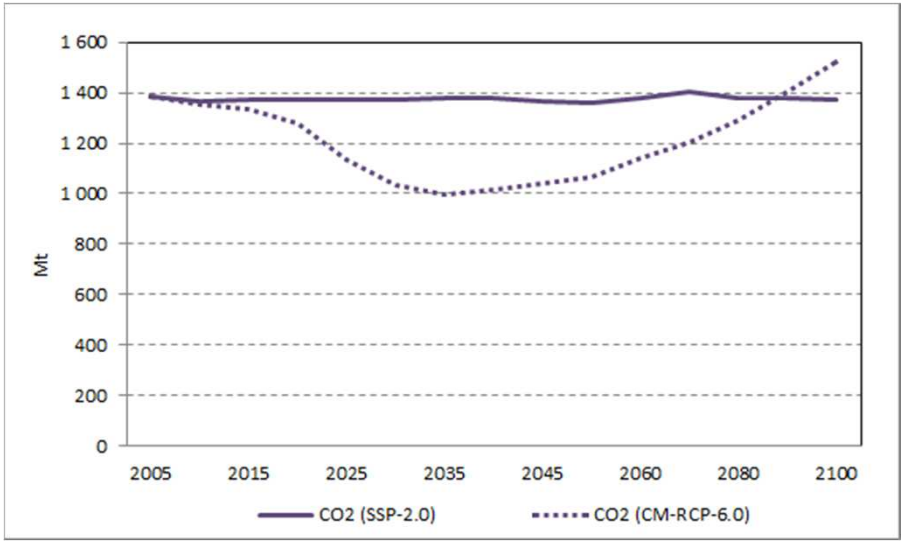
$$\Delta ADC_y = \sum_{p}^{P} \Delta E_{py} \times EC_p$$

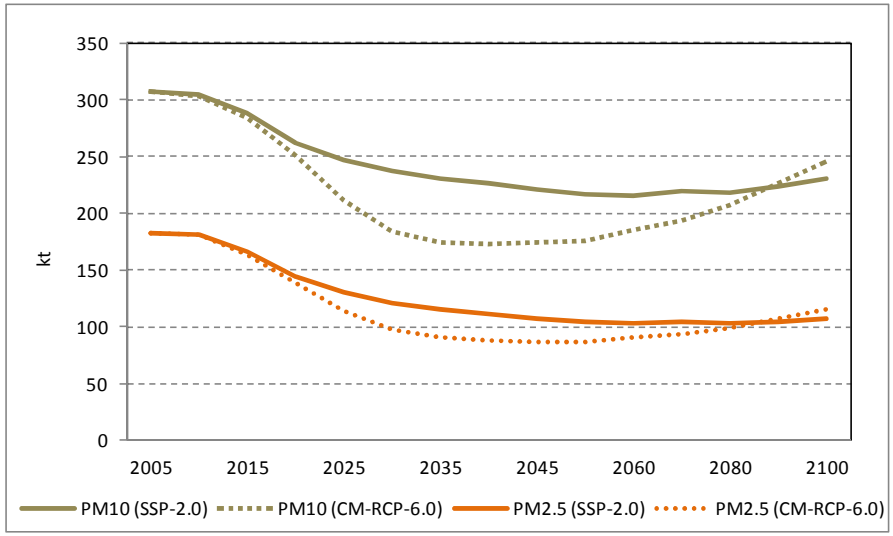
ΔADC_y is the change in total damage costs (in Euro) from the baseline scenario SSP2,
ΔE_{py} is the net change in the emissions of pollutant p (p = 1,…,P) over time period y,
EC_p represents the corresponding external cost per tone of pollutant p (Euro per tone)

Presented results hereafter are for electricity production in **Europe** for the baseline scenario **SSP-2.0** and climate change mitigation scenario **CM-RCP-6.0** with full adaptation simulated by **WITCH model** for the period 2005-2100.

I Ancillary benefits

External costs of energy generation

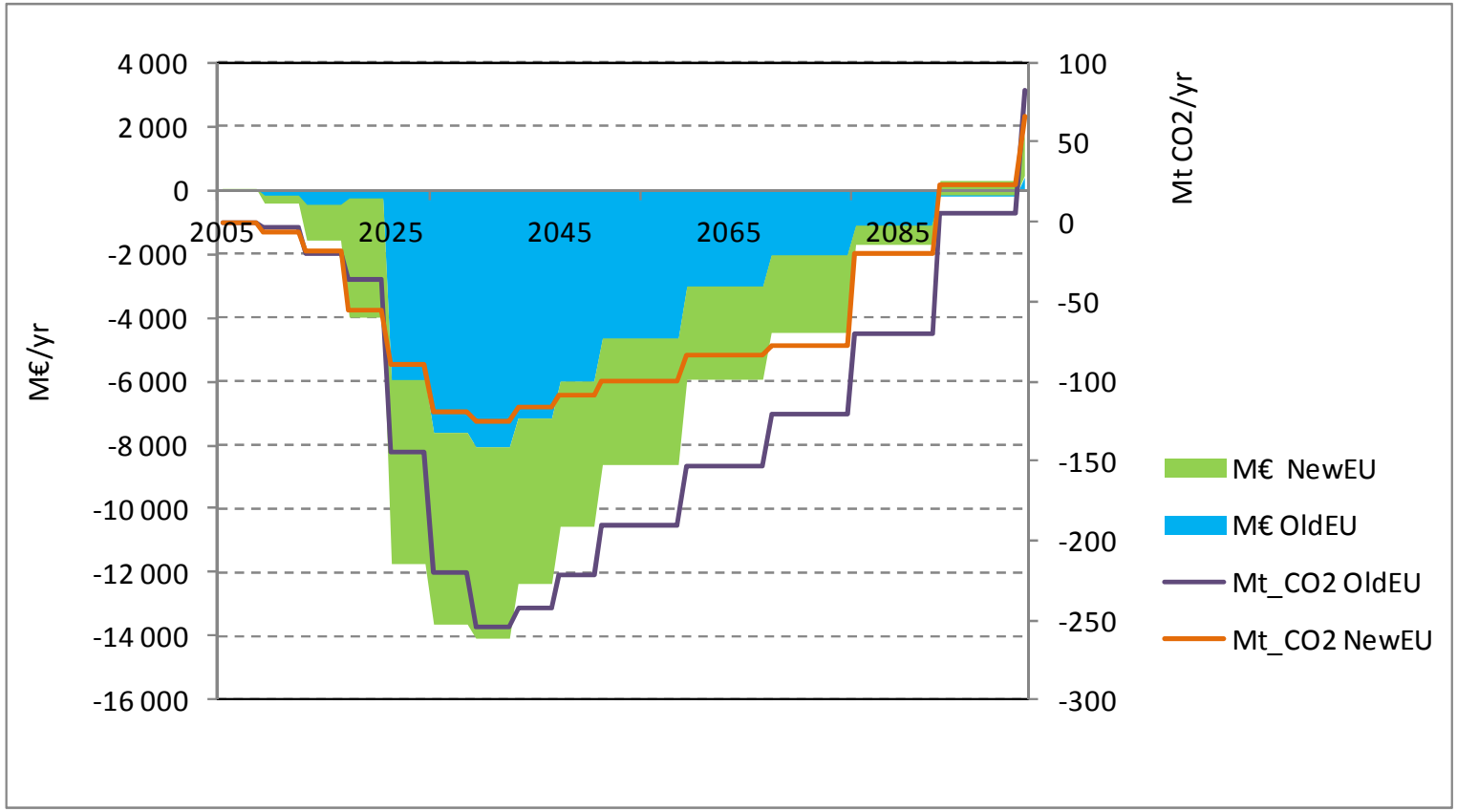




Annual emissions of CO_2 PM_{10} and $PM_{2.5}$ for SSP-2.0 and CM-RCP-6.0 scenario based on WITCH simulations for Europe (2005-2100)

I Ancillary benefits

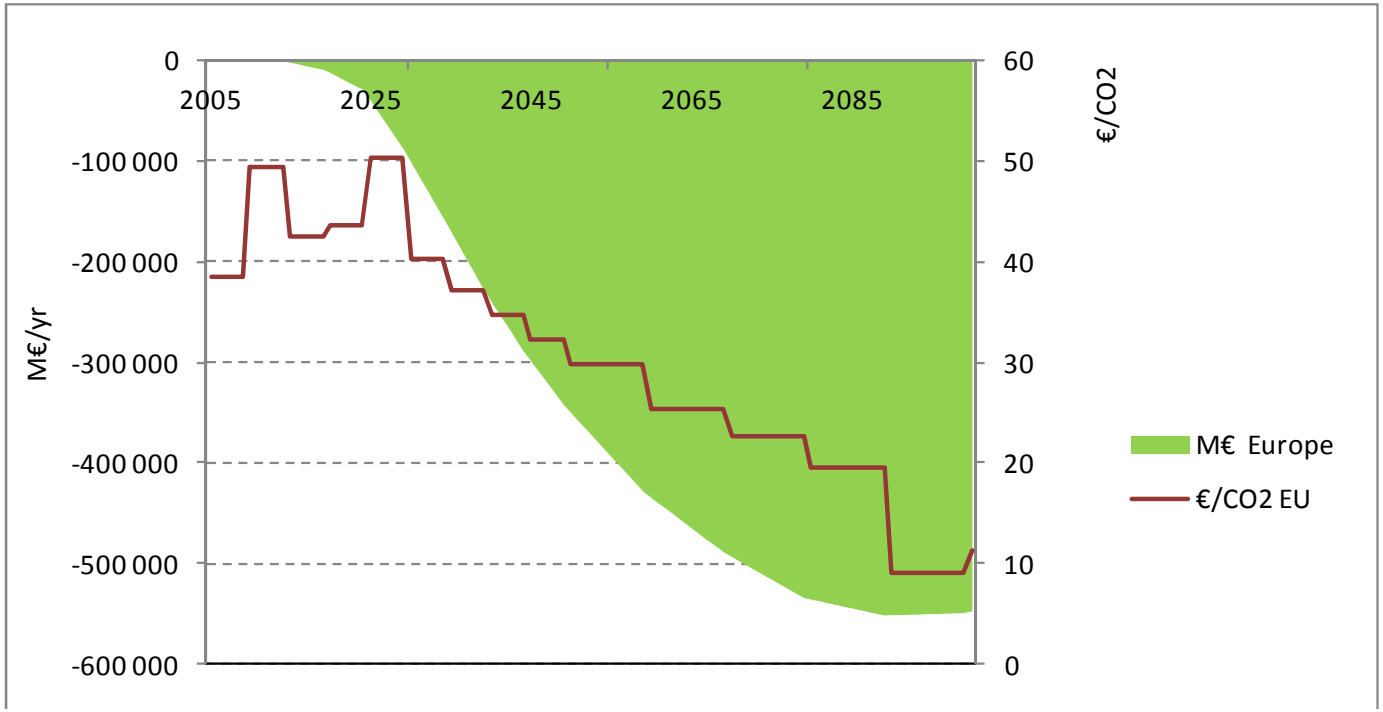
External costs of energy generation



Annual ancillary benefits and **CO_2 reduction** for CM-RCP-6.0 scenario (compared to the baseline scenario SSP-2.0) simulated by WITCH model for old and new EU countries (M Euro 2005)

I Ancillary benefits

External costs of energy generation



Cumulative ancillary benefits: 89 bln € (2030), 343 bln. € (2050)

Per t CO2 reduced ancillary benefits: 48€/t (2005-30), **36€/t** (2030-50), **26€/t** (2050-80), or **33€/t** (2005-2100)

For CM-RCP-6.0 scenario (compared to the baseline scenario SSP-2.0) simulated by WITCH model for old and new EU countries

I Ancillary benefits

A case study in transportation sector (ISIS)

- Brindisi (IT)-Koln (DE), along the South-North European axis, if technological improvement in CO2 emission standards are applied for a typical truck, i.e. from EURO 2 to EURO 4 --- Bologna-Milano A1 motorway, along 192 km
    - potential benefits account annually € 6.5 million (air pollution) and € 1.4 million (climate change)
    - transport external costs in sub-urban areas are higher between +17% and +60% compared to the non-urban areas because of the traffic conditions (more dense resulting in higher consumption per vkm), population density rising the costs for noise emissions, accident risks and congestion
- GRACE computation tool

I Ancillary benefits:

Summary & policy implications

Studies provides a compelling **evidence that ancillary health and environmental benefits from improved air quality are substantial**

Benefits are **probably underestimated** due to not quantified benefits ⇒ only a subset of consequences from air pollution have been quantified or monetized

A broader extent of the impacts covered in GLOBAL-IQ ⇒ besides **health benefits**, other **environmental effects** (crops, ecosystems, materials and toxic pollutants) are also included (the ExternE methodology)

Include these secondary local benefits (and costs) in analysis – for instance, in **integrated assessment modules**

The side-benefits for developing countries are not yet well studies (Task 2.1.2 Literature survey by IHEID)

Developing countries find it particularly **costly to abate GHG emission** – global, long term, uncertain benefits. However they could try **to adopt policies that at the same time give local benefits**, e.g. reducing domestic air pollution and hence the health damages it causes

II Non-market ancillary benefits

Benefits of GHG mitigation in Beijing, China from reduced local air pollution (Task 2.1.3 by IHEID)

- to show the potential ancillary benefits that an emerging country could experience if it coupled GHG emissions abatement with reduction of local air pollution

1. **Cost of Illness from airborne diseases (annual)**
   Direct individual costs (medicines, docs): 2514 RMB
   + Indirect individual costs (wage loss): 812 RMB
   (3000 yuan per year is almost ***one month average wage***, ≈500 USD)
   Total cost for Beijing: cc 21 million RMB per year from hospitalized cases

2. **Willingness to Pay survey (WTP)**
   People would be willing to pay a lot (770,000 RMB , circa 120,000 USD) for reducing one case of respiratory or cardiovascular illness, if given the appropriate instruments to pay – e.g. tax reallocation
   VSL of about 17 million yuan

II Non-market benefits

Valuation studies (Task 1.1 by CUNI)

VALUATION OF MORTALITY RISKS ATTRIBUTABLE TO CLIMATE CHANGE

- **Value of a Statistical Life** derived for the Czech Republic of EUR 2.4 million, comparable with the value of preventing fatality used in IAMs (RICE/DICE, FUND)
- properly designed and administered **on-line surveys** are a reliable method for administering questionnaires, even when the latter are cognitively challenging. However, attention should be paid to sampling and choice regarding the mode of survey administration if the preference of specific population segments is elicited.

LINKING TRAFFIC NOISE, NOISE ANNOYANCE AND LIFE SATISFACTION: A CASE STUDY

- the negative relationship between **residential satisfaction** and traffic noise is relatively well-established, but less is known about the effect of traffic noise on **overall life satisfaction**
- Structural equation modeling support **the negative relationship noise–residential satisfaction**, but **no significant relationship** was found between **noise–overall life satisfaction**

II Non-market benefits

Climate change impacts on human health

- reviews current knowledge on effects from **thermal stress, extreme weather events, and infectious diseases**. For each impact category available exposure-response evidence and valuation is summarized
- relatively wealth of data on causal pathways and monetary estimates for estimation of **direct impacts**
- causal processes and effects are more difficult to quantify for **more indirect pathways** such as climatic risks to health from changes in ***food yields***, ***disruption in fisheries***, ***loss of livelihood*** and ***population displacement*** – these effects are frequently not monetized in impact studies
- relatively poor coverage of **temperature related morbidity** and role of **non-autonomous adaptations**, **ancillary effects on air quality**, **psychosocial impacts** of natural disasters, as well as deficits in monetary values for impacts such as **tick-borne diseases**, or **injuries and mental conditions** from floods and natural disasters

III Behavior: Land use change with dynamically optimizing landowners (by TSE)

- the impact of climate change on land use depends on how land owners respond to changes
- landowners may be willing to pay considerable fixed costs of bringing new land into agricultural production when favorable **prices are expected to last for a long time**, but less willing when prices are only expected to be favorable temporarily
    - ➢ **spatially explicit models of land use** which account for **dynamic decision making**

- **long-run cropland-price elasticity** estimated at 0.3, that is roughly ten times larger than static elasticities estimated using the same data
- taking dynamics into account leads to a **160% larger land use effect** and a **78% smaller price increase** in the long run

III Behavior: KLE elasticity of substitution (CUNI)

- estimate **the elasticity of substitution of production factors** from the constant elasticity of substitution (CES) production function using non-linear estimation techniques – a grid search used to find the best starting values of estimated parameters
- elasticity of substitution between **Capital, Labour and Energy on sector level** in 3 different nesting structures of the CES function in 10 CEEC, 17 WEC and also for whole EU
  - ➢ not found any empirically supported preference for using (KL)E, (KE)L or (EL)K nesting structure as all of them fit the data in a very similar way
  - ➢ sector responses differ in CEE countries and Western Europe --- the partial AES elasticities were found to be smaller in CEE. E.g. (KL)-E Allen-Uzawa partial elasticity in energy intensive industry is 1.6 for CEE and 16.2 for WE
  - ➢ for Hicks-McFadden (HES) direct elasticity between E-L in the (EL)K nest we can reject the null hypothesis that the estimates btw. regions are equal on 5% significance level

IV Competitiveness effects (IHEID)

- asymmetric carbon policies across the globe → possible competitiveness effects and carbon leakages
- evidence about the magnitude of the competitiveness effects and carbon leakages examined --- to identify the shortcomings and areas for research
  - literature on competitiveness effects of unilateral GHG mitigation policies shows **a strong risk of trade protectionism with the excuse of environmental protection** (Subtask 2.4.1)
  - key result: considering firms' heterogeneity, **trade protectionism** to counteract competitiveness losses from carbon policies **might actually protect some inefficient and highly polluting firms**

IV Climate policy in the second best world (TSE)

CONSEQUENCES OF CARBON CONSTRAINTS OVER THE OPTIMAL GROWTH TREND OF GLOBAL ECONOMY

- the economy dynamics exhibit complex **adjustment patterns**, involving temporary adjustments of the capital stocks before it is possible to cope with climate change and return to some positive growth trajectory

CONSEQUENCES OF DEMAND HETEROGENEITY OVER THE OPTIMAL MITIGATION POLICY UNDER A CARBON CONSTRAINT

- **heterogeneous sectors** should face **different carbon price schedules**, either in the form of taxes or through permit prices in a cap and trade system

CONSEQUENCES OF PASSIVE LEARNING-BY-DOING OR ACTIVE R&D UNDER A CARBON CONSTRAINT

- **non monotonous trajectories** for carbon price and for a subsidy rate aimed at financing the learning effort.
- **learning is not a sufficient motive** to trigger early development of abatement techniques while the existence of **decreasing returns to scale** over abatement induces an early start of an active mitigation policy

Thank you !

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