

# Defining External Costs of Pollution in TIAM-MACRO to study Co-Benefits of Climate Change Mitigation

Joint proposal from PSI, CRES and UCC

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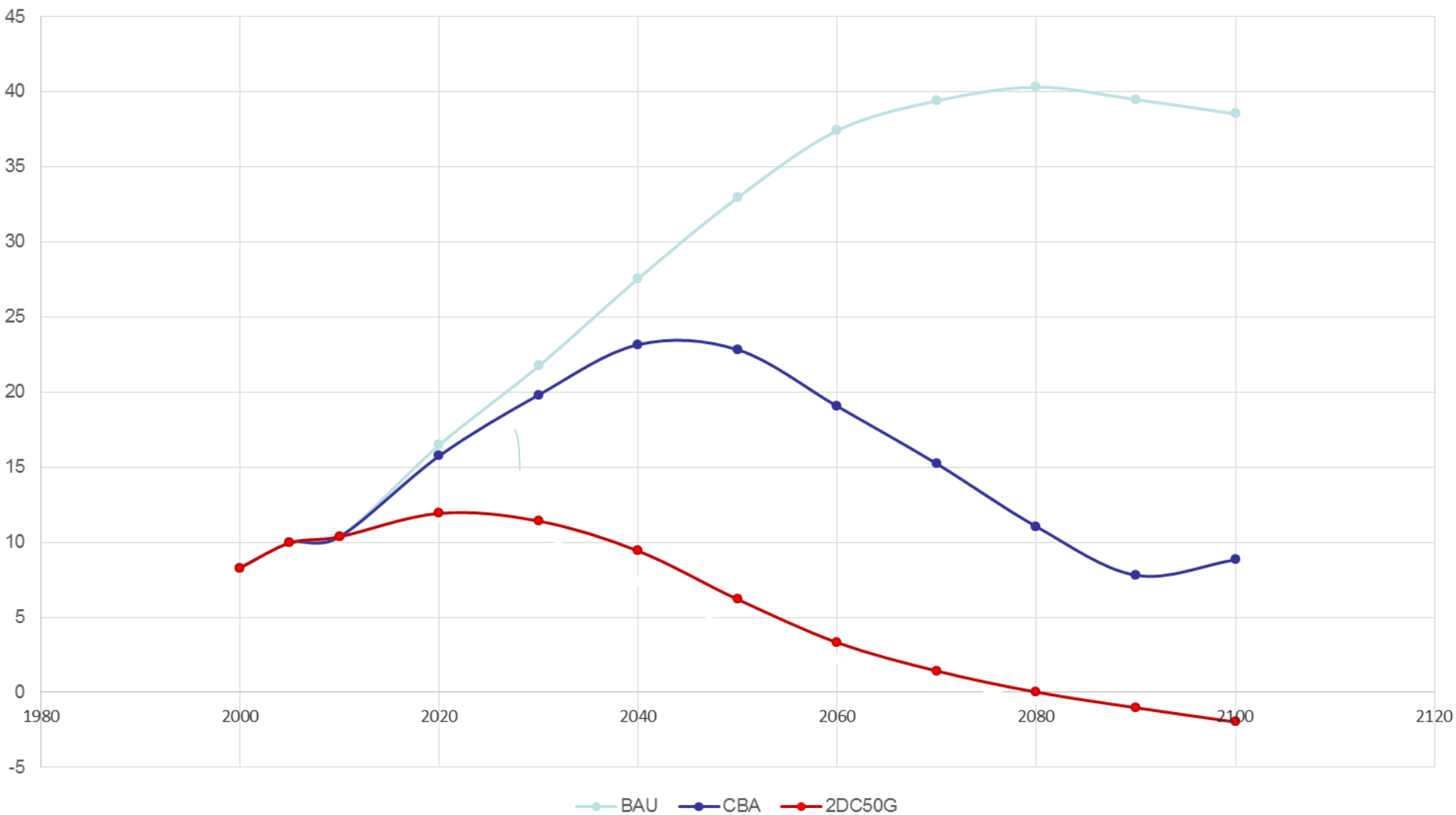


# Outline

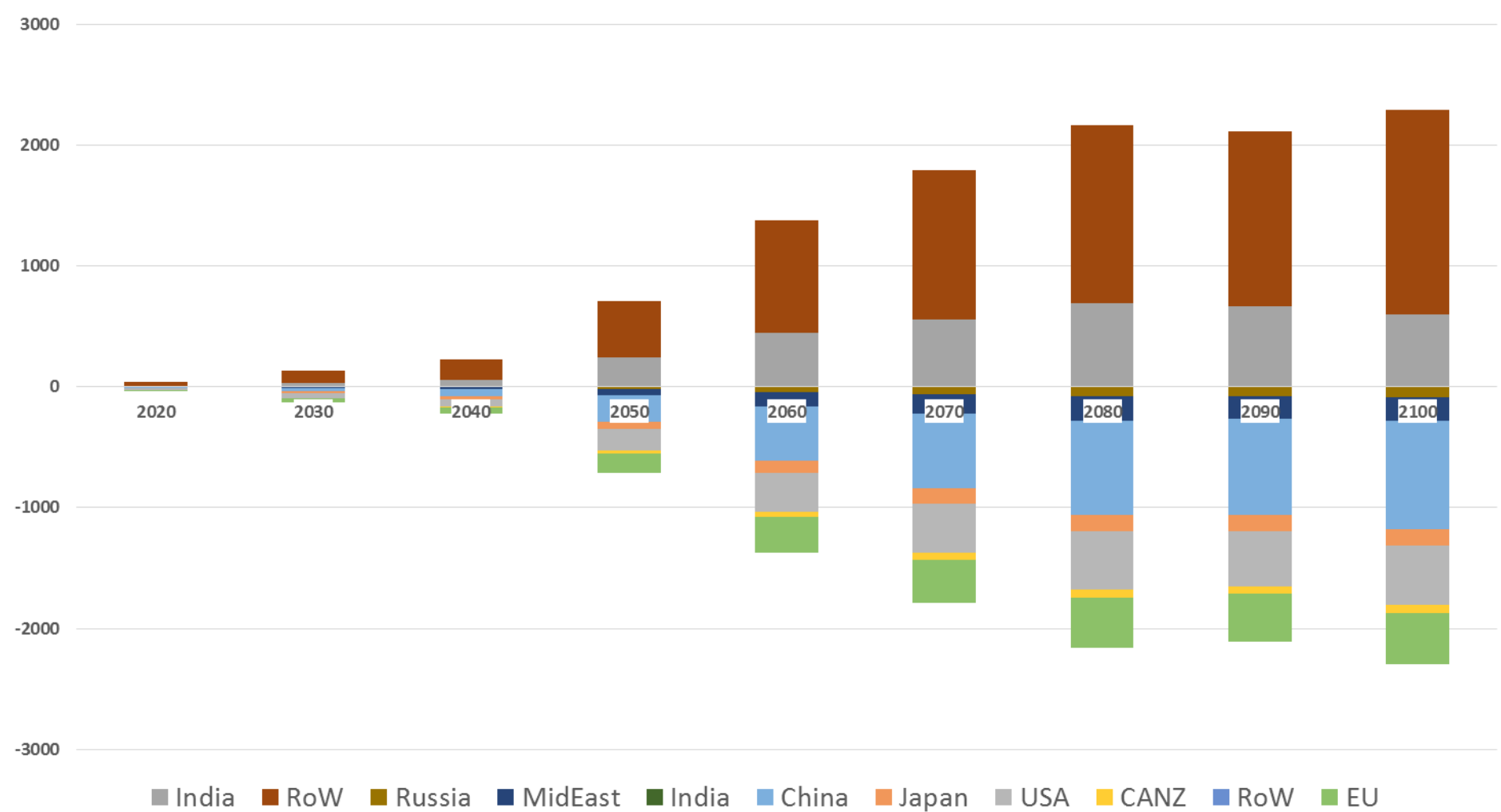
- Scope: Definition of synergies and co-benefits of LAP while solving for GCC
- Present assessment of climate change gives unbalanced Costs to Benefits but excludes benefits of LAP control
- Methodology proposed
- Deliverables and Costs for ETSAP

# CO<sub>2</sub>eq Emissions per case (GtCe/yr)

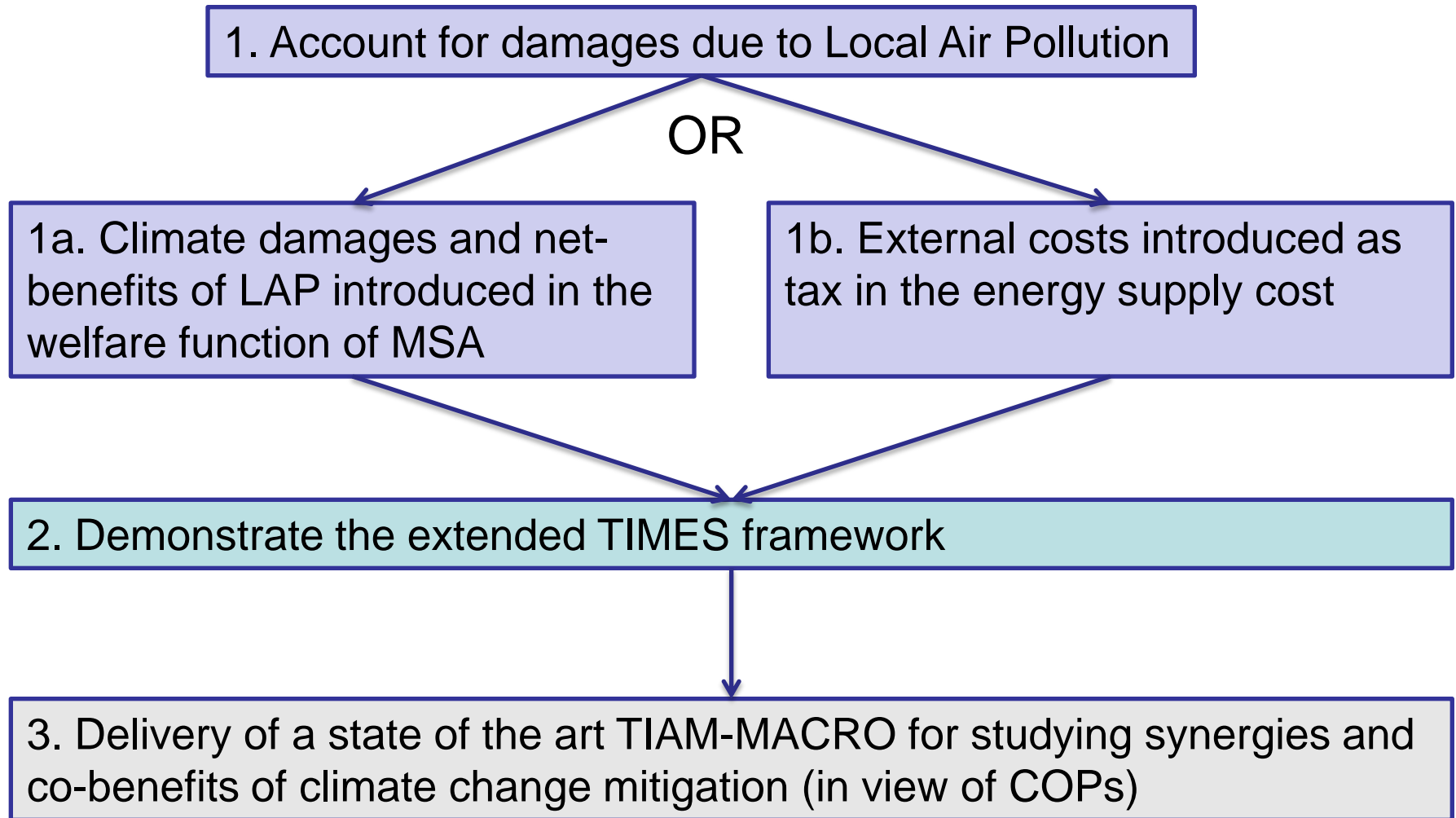
## Cost and Benefits of GCC do not balance



# Transfers due to trade of permits are in the order of trillion USD per annum for the 2 Deg Celsius case



# Project structure



# Plan A: Climate Damages and net-benefits of LAP control are to be defined in the welfare function

$$ELF_{rt} \cong [1 - (\Delta T_t / \Delta T_{catt})^{2.5}]^{hst} \quad \text{economic loss factor of GCC}$$

$$PLF_{rt} = \left[ 1 - \frac{1.06 \cdot N_{rt}}{C_{rt}} \cdot \left( \frac{GDP_{rt} / p_{rt}}{GDP_{0,EU} / p_{0,EU}} \right) \right] \quad \text{ec. loss factor of LAP}$$

$$NMD_{rt} = (1 - ELF_{rt}) \cdot (1 - PLF_{rt}) \cdot C_{rt}$$

$$MD_{rt} = param_{rt} \cdot \left( \frac{\Delta T_t}{2.5} \right) \cdot GDP_{rt}$$

$$MaxU = \sum_{r,t} disc_{rt} \cdot nw_{rt} \cdot \ln[(1 - ELF_{rt}) \cdot (1 - PLF_{rt}) \cdot C_{rt}]$$

## Plan B: Explicit treatment of emissions and externalities of LAP as in the Pan-EU model

Externalities compensate for induced damages of pollution by imposing an external tax per pollutant such that the marginal control costs equal the marginal benefits of avoided emissions.

For example in GMM and in the **Pan-EU model**, the production cost per unit of electricity (GC) could be expressed as a function of the annualized specific capital cost (SC), the fixed (fixom) and variable (varom) O&M cost and the fuel cost (Pr(fuel)). If the emissions generated per unit of kWh (se) contribute to an externality, this can be compensated by applying the corresponding tax (Etax) for the induced damages. The inclusion of the tax will reflect the full cost of power generation.

$$GC = SC \cdot crf + \text{fixom} / (\text{pf} \cdot 8760) + \text{varom} + \text{Pr}(\text{fuel}) / \text{eta} + \text{se} \cdot \text{Etax}$$

# Related PSI-Project GMM-MCDA

- With 15 world regions
- All sectors, all LAP and GCC pollutants
- Region-specific **ecoinvent** emission data for the whole energy system covering potential adjustment factors such as S-content, end-of-pipe technologies, efficiencies and the discount rate.
- External cost factors are from NEEDS adjusted based on
  - GDP development
  - Population density based on GIS data by regions with temporal adjustments as function of the urbanization rate
  - Background pollution data with temporal adjustment based on the sectoral energy systems and fuel use intensity



# Deliverables

- Method of converting EU externalities to those of other world regions
- Extend database of TIAM with emissions, externalities and the end-of-pipe control options for pollutants like  $\text{SO}_2$ ,  $\text{NO}_x$ , and PM based on the Pan-EU TIAM model
- Code & Perform CBA and SBA with TIAM-MACRO considering both GCC and LAP and demonstrate the new features of TIAM-MACRO
- Operational code of burden-sharing (BS) and application of 3-4 BS rules taking into consideration GCC and LAP and finally peer review publication(s)
- All that for 37 kEuro as we hope to benefit from the experience with MERGE (J. Bollen) the EU NEEDS project, the European Consortium for Modelling of Air Pollution and Climate Strategies (EC4MACS) and the related PSI -Project GMM-MCDA