Evaluation of sub-sectorial GHGs emissions abatement costs using an open-source energy system optimization model: the Italian case study

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Research context

Increasing use of cost curves as a decision-making supporting tool

Expert-based vs model-based curves

ESOMs to support policy makers

Aim of the work

State of the art:

Expert-based analyses

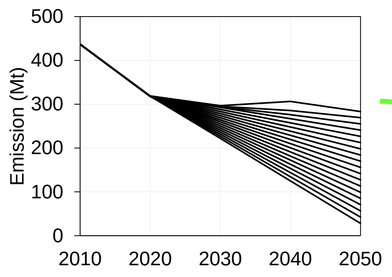
Sectorial analyses

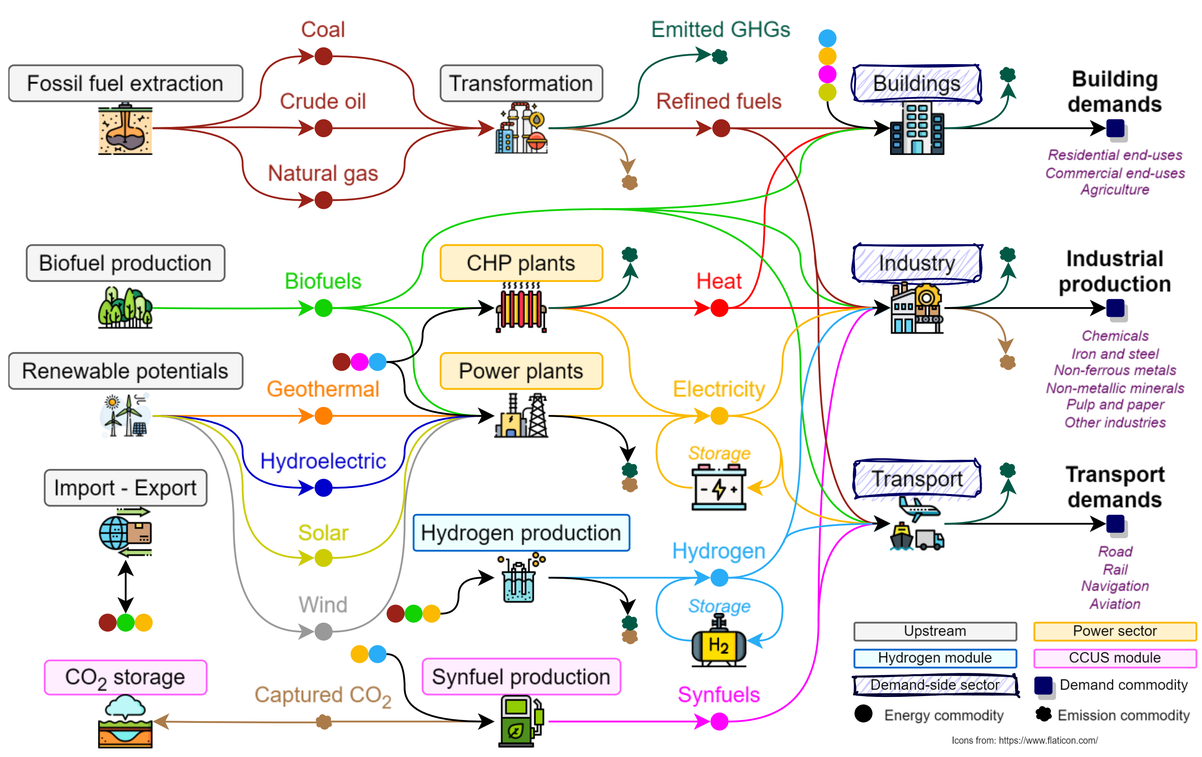
Evaluate the GHGs abatement costs though ESOMs

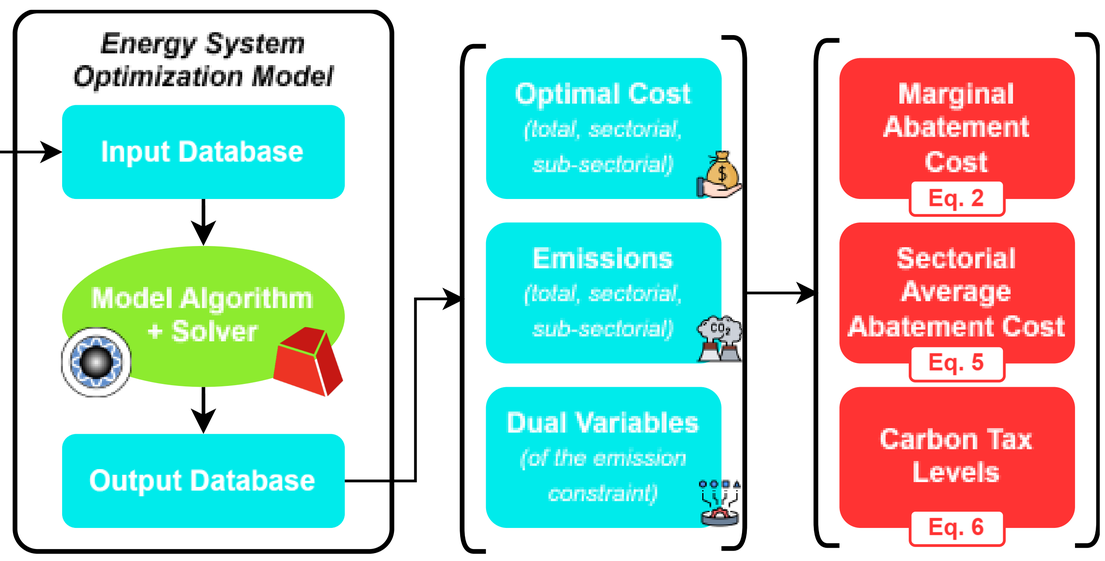
- **Marginal Abatement Cost Curve of an emission reduction trajectory on the whole energy system**
- **Average Abatement Cost at sectorial and sub-sectorial level**

Methodology

TEMOA-Italy







Marginal Abatement Cost *(Objective Function)*

$$\mathbf{MAC_i^{OF}}\left(\frac{€}{t}\right) = -\frac{\mathbf{OF_i}(€) - \mathbf{OF_{i-1}}(€)}{\left(\sum_y \mathbf{E_y^{CO2_{EQ}}}(t)\right)_i - \left(\sum_y \mathbf{E_y^{CO2_{EQ}}}(t)\right)_{i-1}} \quad \textbf{(1)}$$

Marginal Abatement Cost *(Dual Variable)*

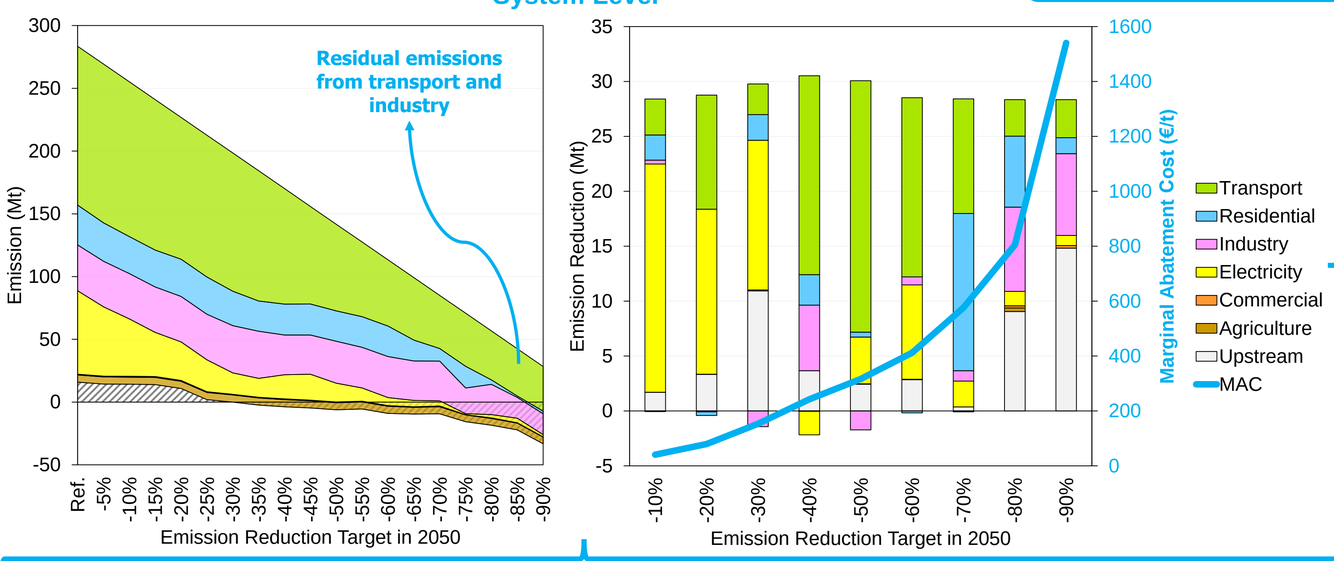
$$\mathbf{MAC_i^{DV}}\left(\frac{€}{t}\right) = -\frac{\sum_y \mathbf{DV_{i,y}^{EC}}\left(\frac{€}{t}\right)}{\mathbf{n_y}} \quad \textbf{(2)}$$

Average Abatement Cost *(Sectorial)*

$$\mathbf{AAC_y^S}\left(\frac{€}{t}\right) = \frac{\sum_{i,y} \mathbf{ER_{i,y}^S}(t) \cdot \mathbf{MAC_i^{AVG}}\left(\frac{€}{t}\right)}{\sum_y \mathbf{ER_{CUM,y}^S}(t)} \quad \textbf{(3)}$$

Results

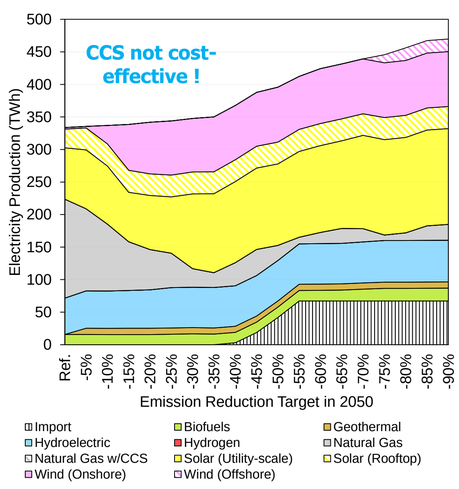
System Level



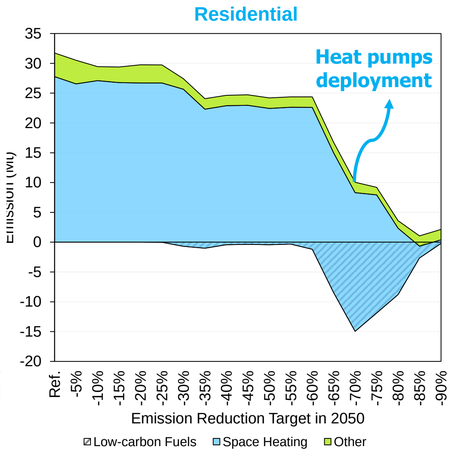
Sector	$\mathbf{AAC_{2050}}\left(\frac{€}{t}\right)$
Power Sector	173
Residential	600
Industry	618
Upstream	523
Transport	373

- The **cheapest** sector to be decarbonized is the **power sector**
- **Highest costs associated with the residential sector** (e.g., boilers substitution with heat pumps) **and the industrial sector** (few subsectors participating to the emission reduction)
- **Transport sector is in the middle,** and it accounts for most of the emissions in the reference scenario

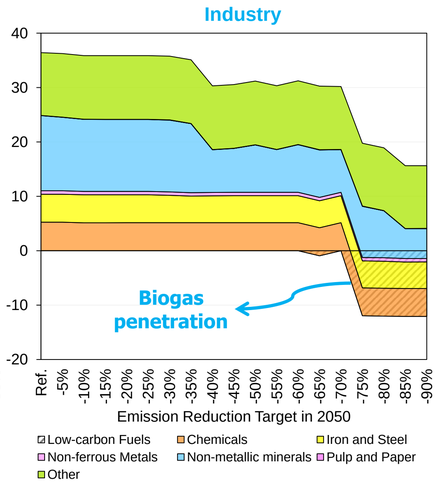
Power



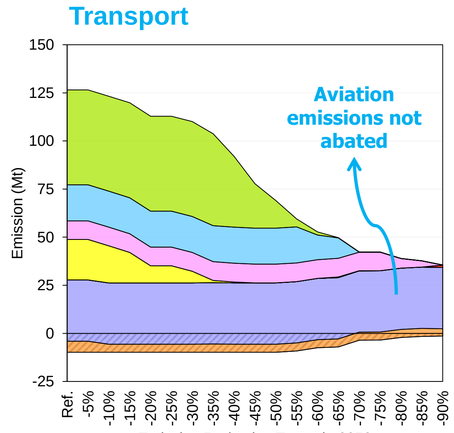
Residential

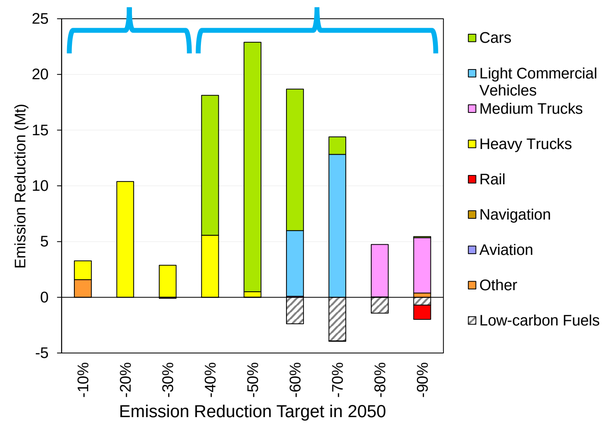


Industry



Transport



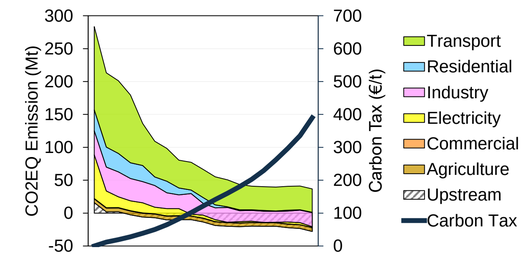


Remarks

- **Possibility to evaluate MACCs at system and sectorial to get insights on cost-optimal technologies**
  - Industry and aviation hard to abate
- **Dependency on some key input data**
  - e.g., CO2 storage potential
  - e.g., future evolution of innovative technologies features

Perspectives

Uncertainties Assessment



Explore insights on Carbon Tax Levels

openmod open energy modelling initiative

12th European Open Energy Modelling Workshop, Grenoble, 26-28 March 2024