Integrated assessment modelling to identify efficient policies under **emission constraints** including **energy measures**

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Measures

Emissions

Concentrations

Exposure/impacts

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The MAQ system

Multi-objective approach

$$\min_{x,z,s} J(x,z,s) = \min_{x,z,s}[AQI(x,z,s) \quad C(x,z,s)]$$

$$x \in X, 0 \leq x \leq 1$$

$$z \in Z, 0 \leq z \leq 1$$

$$x \in S, s \leq 1$$

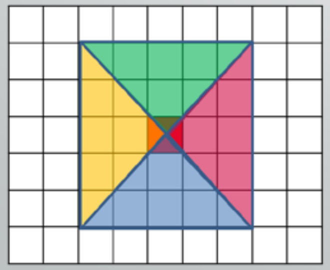
$$E(x,z,s) = NEC\% * E(x^{CLE}, z^{CLE}, s^{CLE}$$

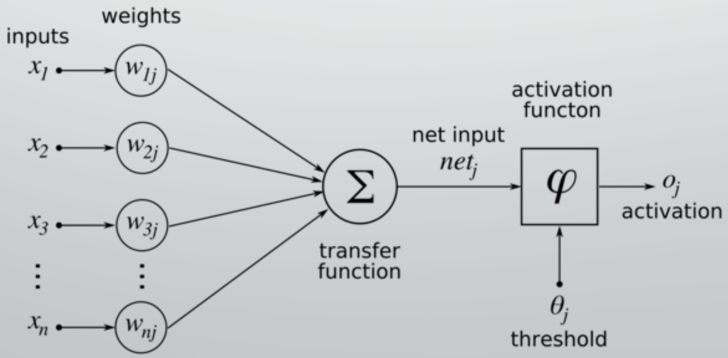
End-of-pipe measures (x)

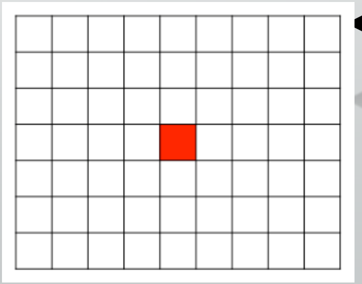
Energy measures (z)

measures (s)

$$\text{AQI}(x,z,s) = f(E(x,z,s))$$







Emissions

$$E^{d,p}(x,z,S)=\sum_{k\in K}\sum_{k\in K}\left[\sum_{k\in K} A_k^d \cdot \left(1-\sum_{t\in T_k} s_{tk}^{p}\right) x_k^t \cdot ef_k^p \cdot \left(1-\sum_{t\in T_k} eff_t^p \cdot x_k^t\right)\right]$$

Activity level variation due to the application of energy and switch measures

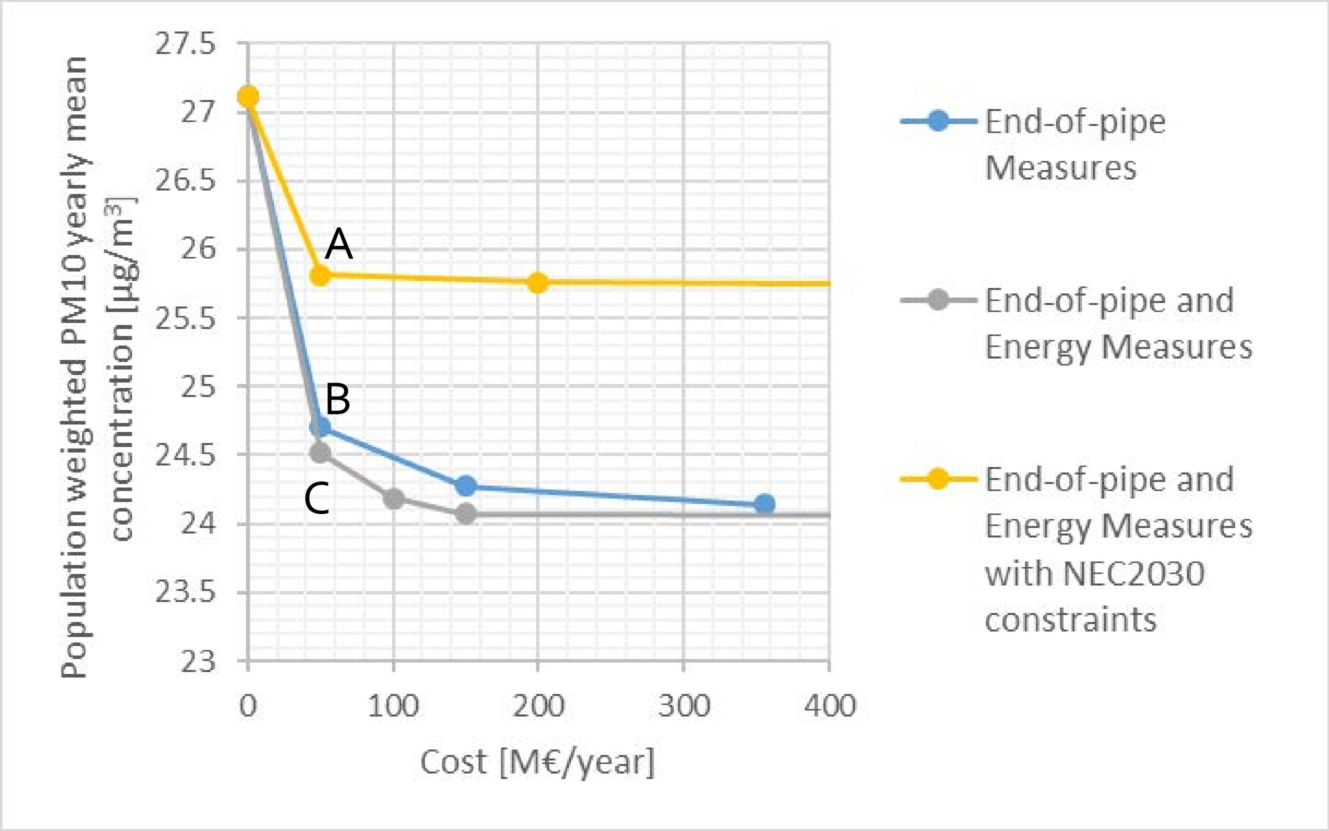
Emission factor of a precursor

ACTIVITY LEVEL: surrogate variable to estimate how much an activity is present on the domain (FUEL CONSUMPTION)

Emission reduction due to the application of end-of-pipe measures

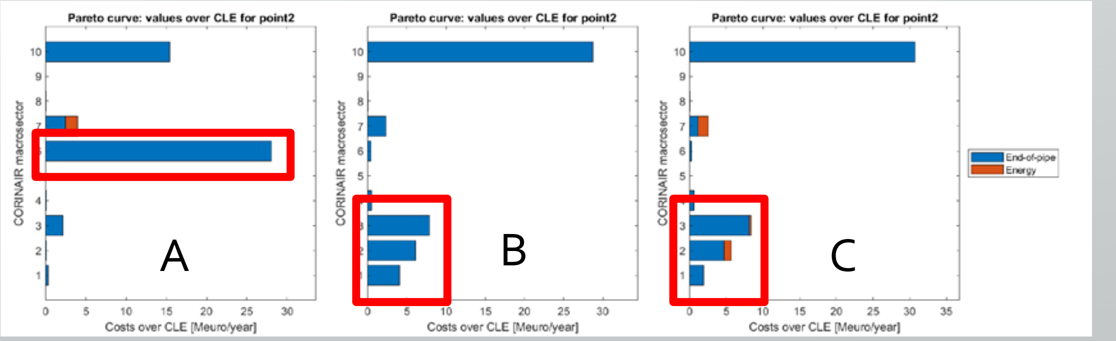
Emission reduction due to the application of end-of-pipe measures

Results



Emission reductions with respect to NEC2030 [ton/year]

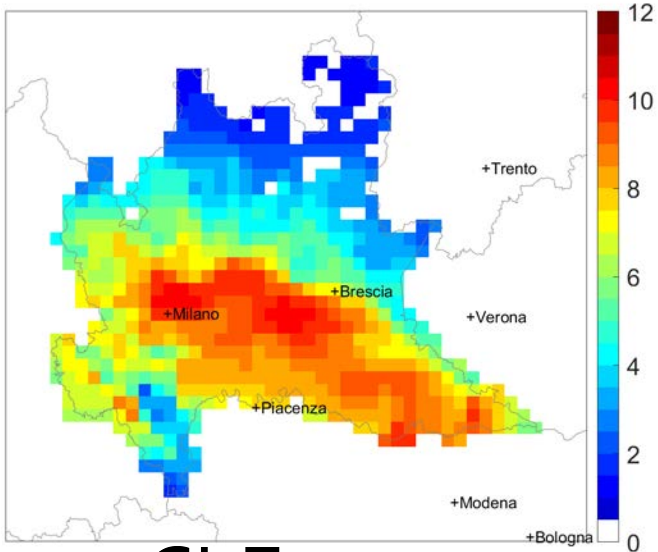
Point	NEC 2030	CLE 2030	A (NEC constr.)	B (end-of-pipe)	C (end-of-pipe+ energy)
NOX	64699	-2311	-22414	-11660	-18512
VOC	132230	52113	24462	50615	48359
NH3	82964	19984	0	-7981	-9261
PM10	12621	124	-3	-4641	-4854
PM2.5	10726	-843	-1130	-4764	-4963
SO2	8760	190	11	-850	-789



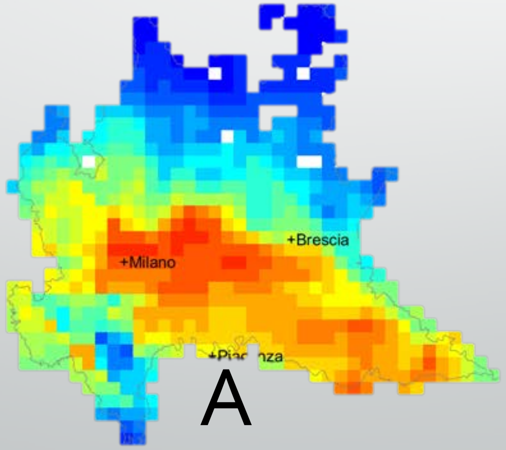
Costs per Macrosector

Health and impacts

YLL per capita [months]

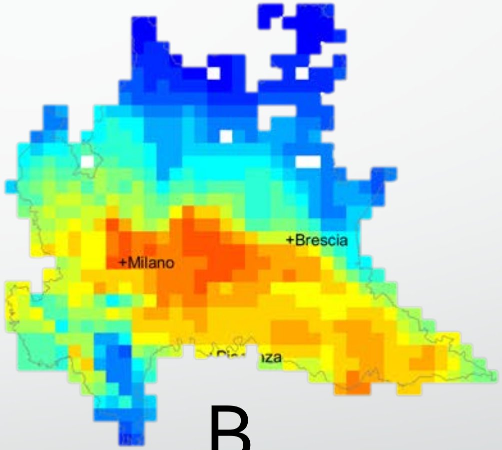


CLE 2030



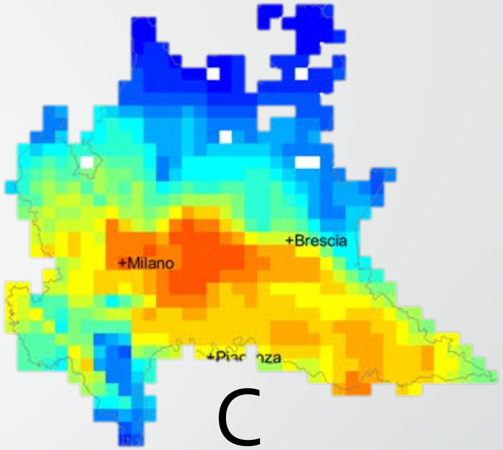
A

NEC constr.



B

End-of-pipe



C

End-of-pipe
+ energy

Final Remarks

- IAM to address two key challenges:
  1. Assessing efficient energy measures
  2. Designing efficient air quality plans constrained by NECD
- Introduction of energy measures making the optimization problem non-linear in both objectives and constraints.
- Constraining emissions (NEC) increases the complexity of the problem by reducing the feasible set for the decision variables.
- Input uncertainties are extremely significant. The system allows to variate the inputs in order to assess their impact on the resulting policies.

Thank you for your attention