H&W ATHLeTiC
Air qualiTy and Life styles: HeaLTh Cobenefits

Tema: aria

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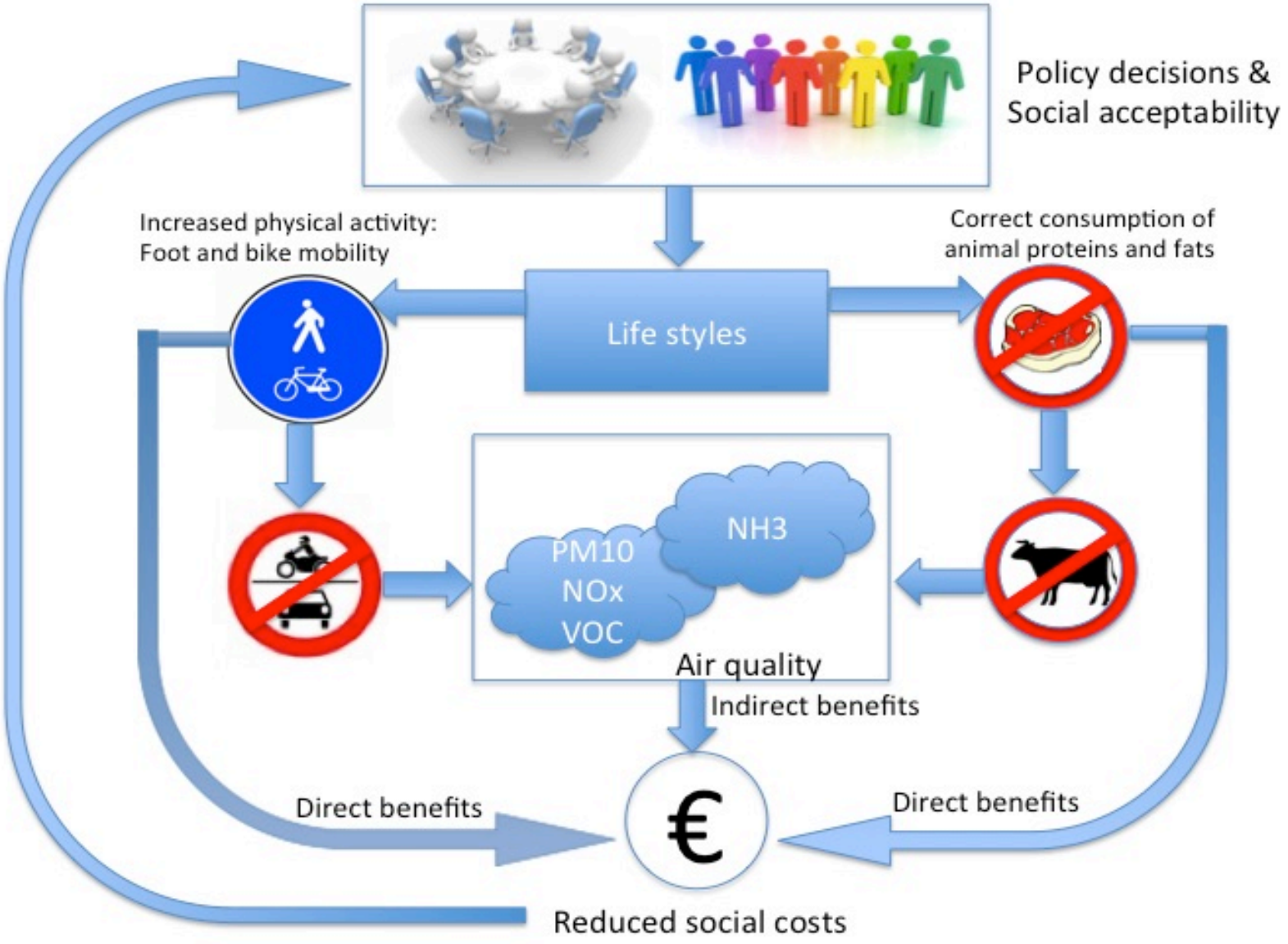
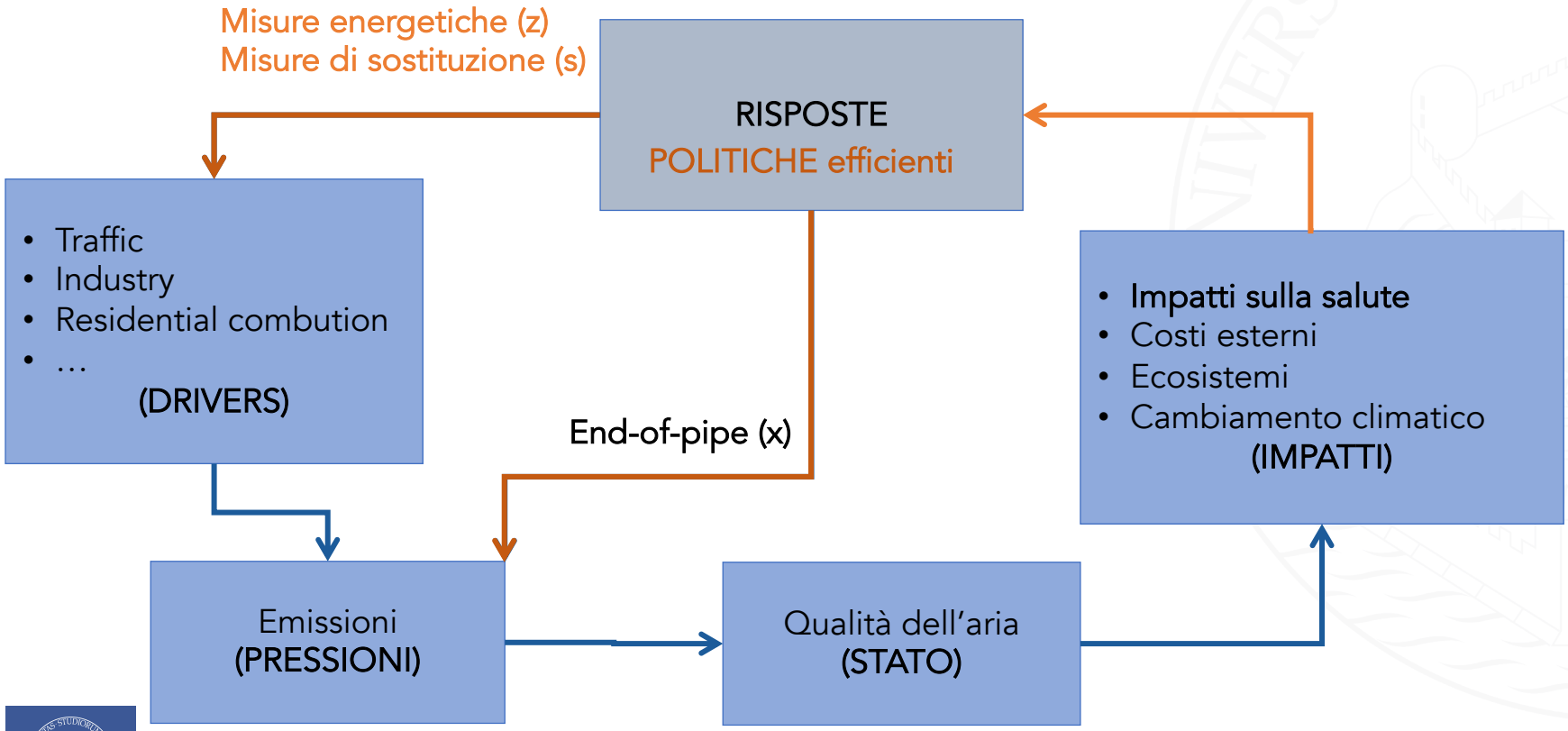

Policy decisions &
Social acceptability
Increased physical activity:
Foot and bike mobility
Correct consumption of
animal proteins and fats
Life styles
PM10
NOx
VOC
NH3
Air quality
Indirect benefits
Direct benefits
Direct benefits
€
Reduced social costs

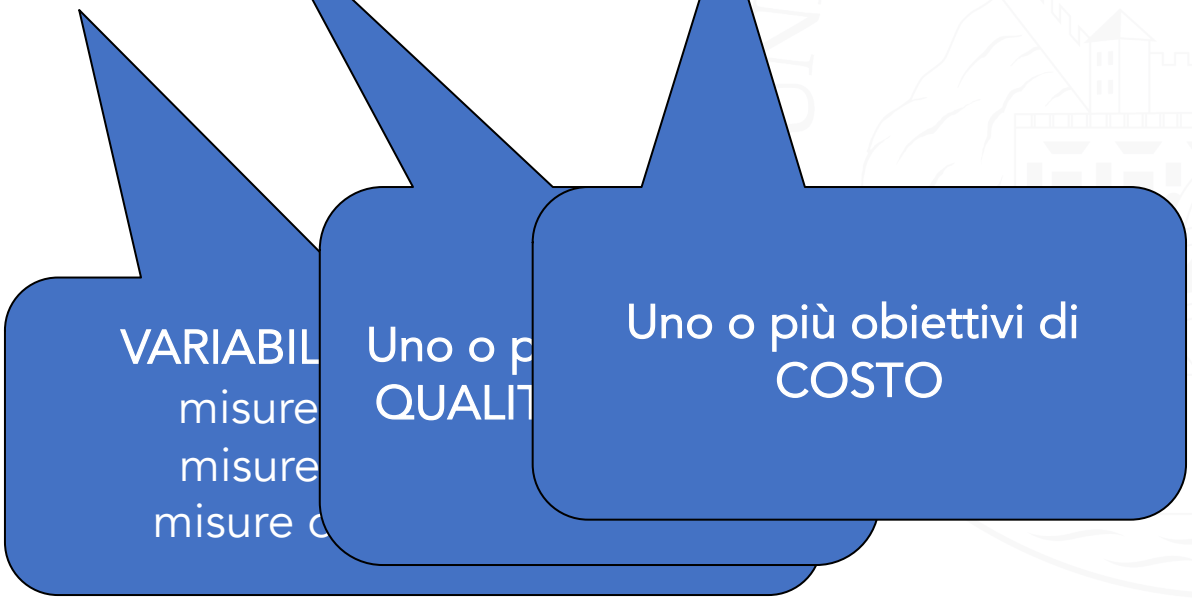
IAM per l'identificazione di misure efficienti di riduzione delle emissioni



Il problema decisionale

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

$$x, y, s \in \Theta$$



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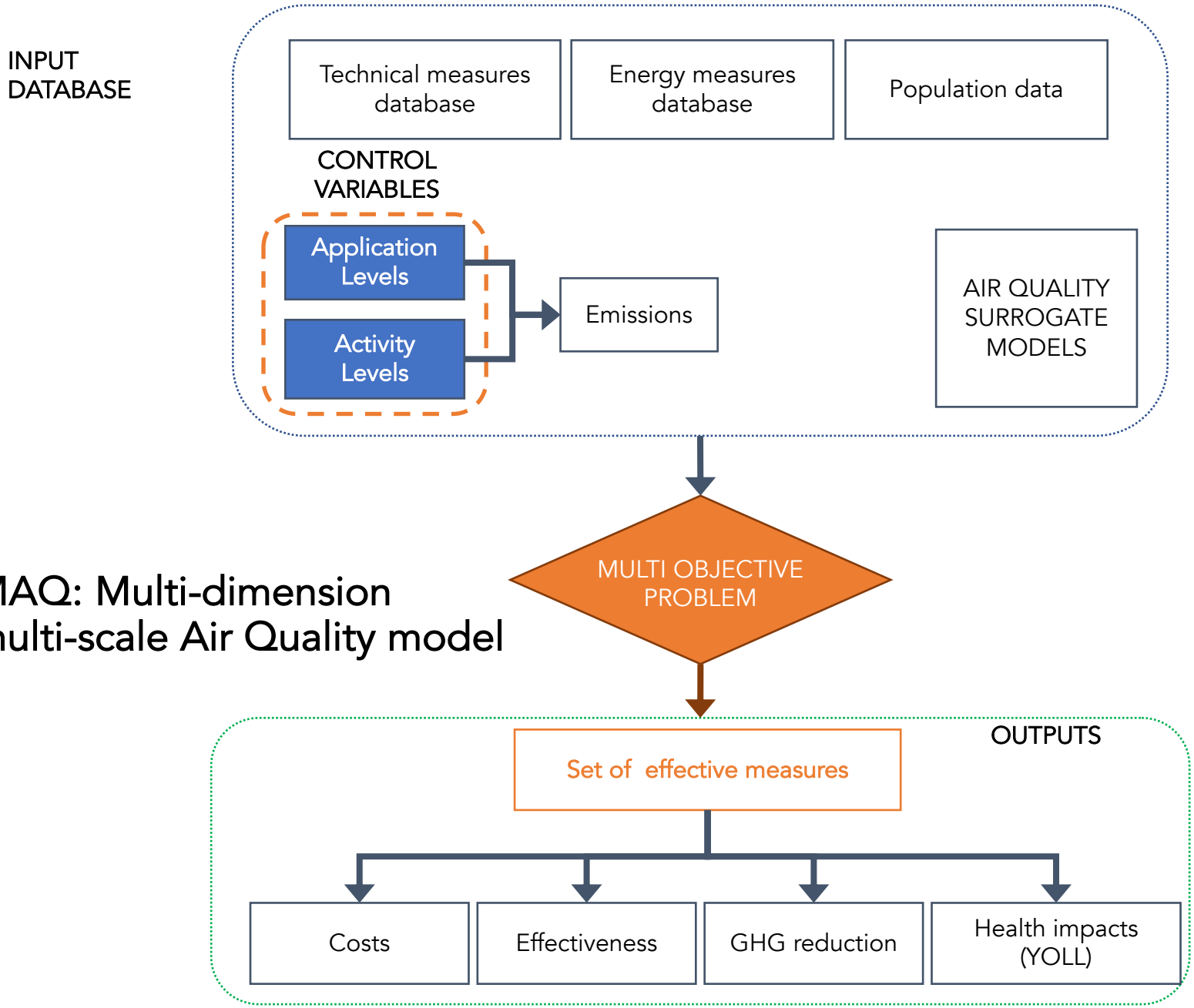
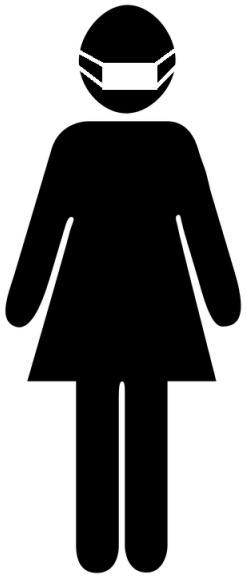
MAQ: Multi-dimension multi-scale Air Quality model



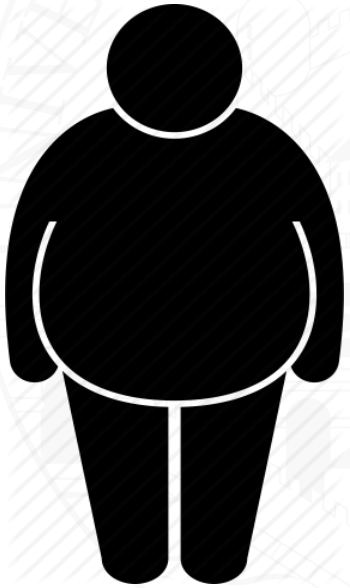
Impatti del trasporto privato sulla salute

INDIRETTI



(W.H.O. , 2014)

DIRETTI



(Wen et al. 2011)

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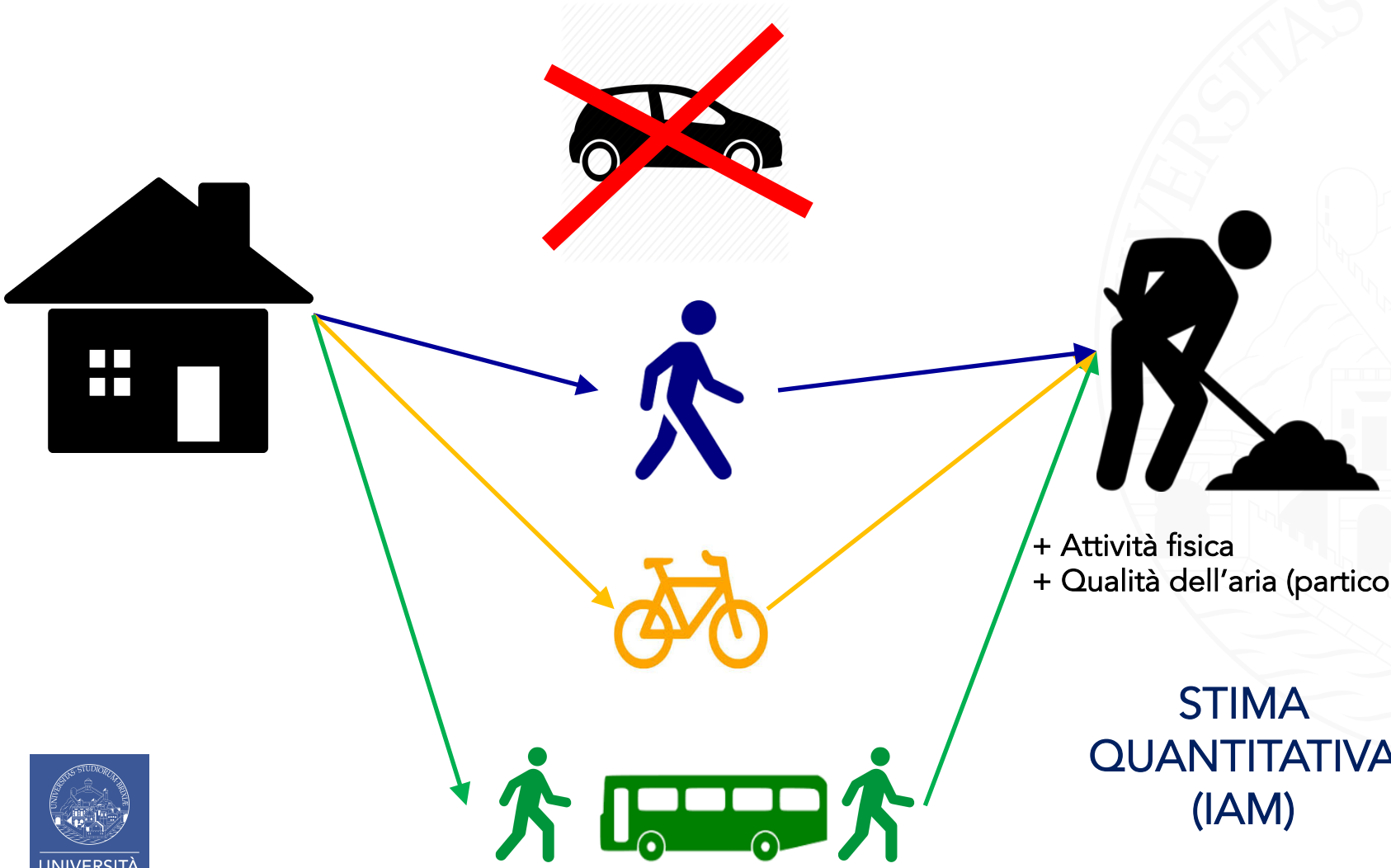
Strategie di mobilità attiva



+ Attività fisica
+ Qualità dell'aria (particolato)

STIMA QUANTITATIVA (IAM)

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Impatti sulla salute

Impatti indiretti (approccio Externe):

- dovuti all'esposizione al PM10
- dovuti alla maggiore ventilazione durante l'attività fisica

Impatti diretti (WHO-HEAT):

- dovuti all'incremento della attività fisica

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Effetti indiretti: esposizione PM10

Impatti sulla salute

$$HI_j^m = \sum_{d=1}^{D} \gamma_j^m P_{d,j} \chi_d$$

- γ_j^m is the incidence of the indicator m on population cohort j;
- $P_{d,j}$ is the population, belonging to the cohort j, exposed to PM_{10} pollution cell d;
- χ_d indicates the mean PM_{10} concentrations, in cell d.

receptors	impact indicator
ASTHMATIC	
Adults	
	Bronchodilator usage
	cough
	Respiratory problems
Children	
	Bronchodilator usage
	cough
	Respiratory problems
OVER 65	
	heart attack
CHILDREN	
	chronic cough
ADULTS	
	reduced activity
	chronic bronchitis
TOTAL POPULATION	
	chronic mortality
	hospital admission for respiratory problems
	hospital admission for cardiovasculary problems
OVER 30	
	years of lost life

Costi Esterni

$$HC = \sum_m \left(\sum_j HI_j^m \cdot ev_j^m \right)$$

- HC is the health cost;
- ev_j^m is the economic value associated to the indicator m on population cohort j;

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Effetti indiretti: esposizione PM10

Dovuti all'**aumento della frequenza respiratoria**

Rischio relativo:

$$YOLL_d^w = (RR_d - 1) \cdot PM_{2.5_d} \cdot A \cdot PC_d^w(z)$$

$$RR_d = \exp\left(\ln\left(RR_{PM_{2.5_d}}\right) \cdot \frac{\left(\frac{DPA_d^w}{DNA_d} - 1\right) \cdot PM_{2.5_d}}{10} \right)$$

Dose a riposo Dose attività fisica

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Effetti diretti sulla salute (WHO-HEAT)

Anni di vita guadagnati grazie alla riduzione del rischio dovuto all'incremento di **attività fisica**

$$YOLL_d^w = -\frac{y^w}{100} \cdot A \cdot PC_d^w$$

$$PC_d^w = \min \begin{cases} \rho \cdot 1.3 \cdot \sum (AL_d^w \cdot z) \\ \gamma \cdot P_d \cdot \dfrac{\sum (AL_d^w \cdot z)}{\sum (AL_d^f \cdot z) + \sum (AL_d^b \cdot z)} \end{cases}$$

$$y^f = 0.4586x + 0.0766$$

$$yb = 0.4627x + 0.5951$$

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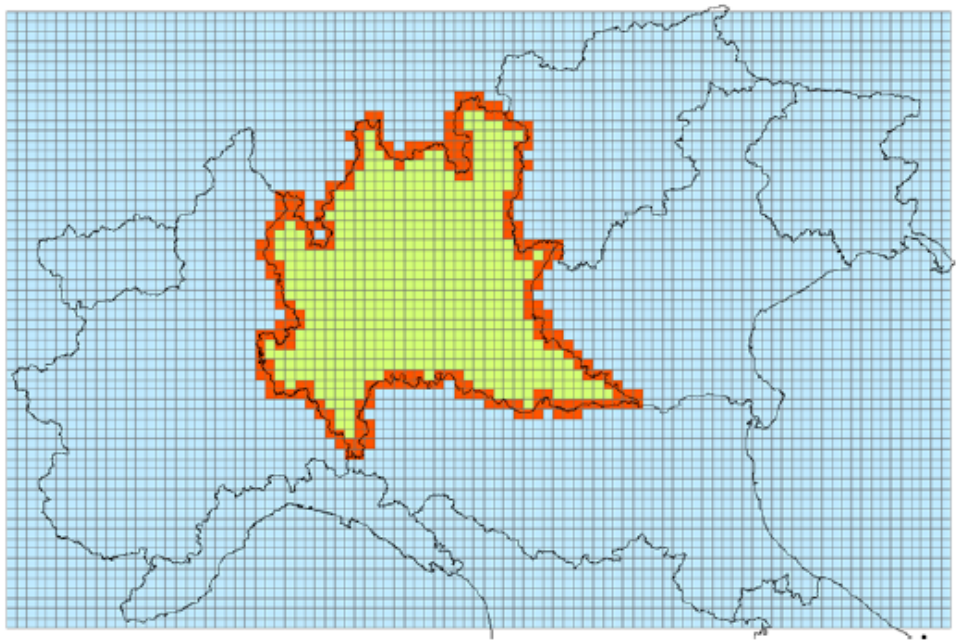
Caso studio

Dominio:



Regione Lombardia
95x62 cells of 6x6 Km^2

- PM10 exceeds limits
- Densely populated and industrialized
- High use of private cars for commuting

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Scenari

Scenario	Min/day	Communication Cost [M€/PJ]	Time Cost [M€/PJ]
Commute by feet	20 walk	0.3300	7.35
Commute by bike	40 bike	0.3300	9.18
Commute by bus	20 walk	0.3300	3.78

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	Scenario1	Scenario 2
Commuters [M]	1.3	2
Km/(commuter*year)	6000	6000
Δ Activity Level (Passenger cars)	-4%	-8%

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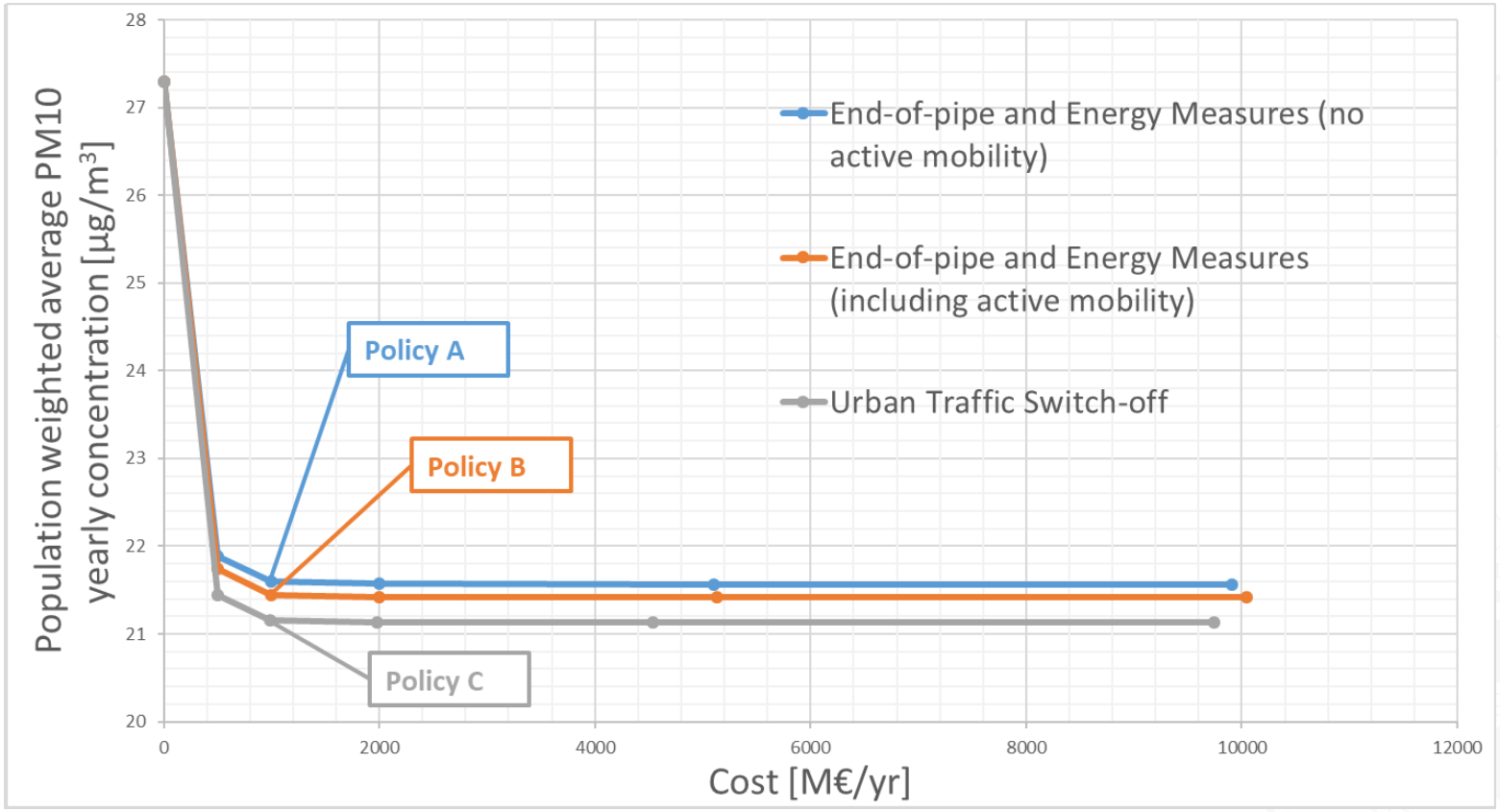
Soluzioni efficienti



Scenario	Cost Over CLE [M€/year]	Population weighted PM10 yearly conc. [µg/m3]
CLE 2020	0	27.29
Policy A	1000	21.59
Policy B	1000	21.446
Policy C	1000	21.15

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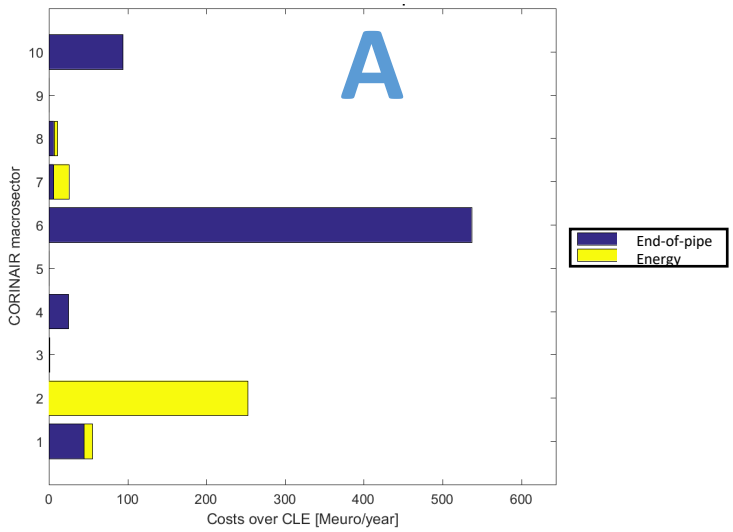
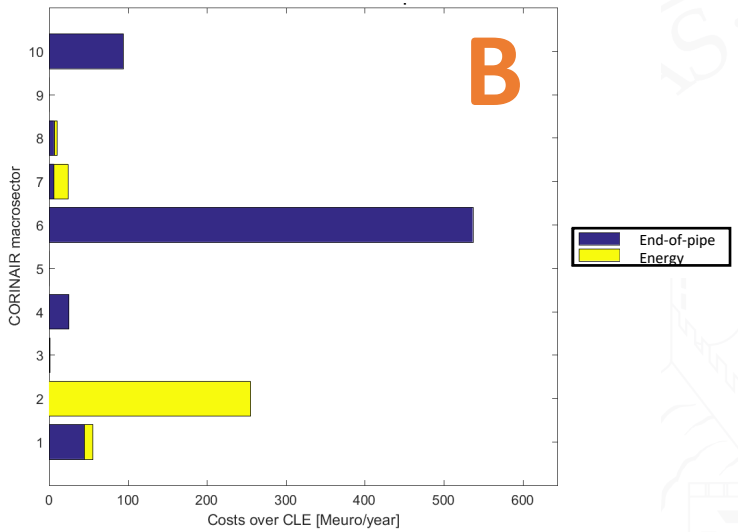
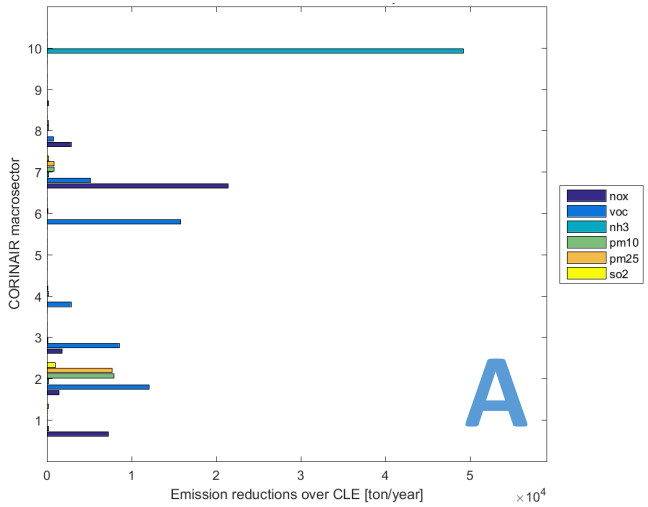
Costi e riduzioni delle emissioni

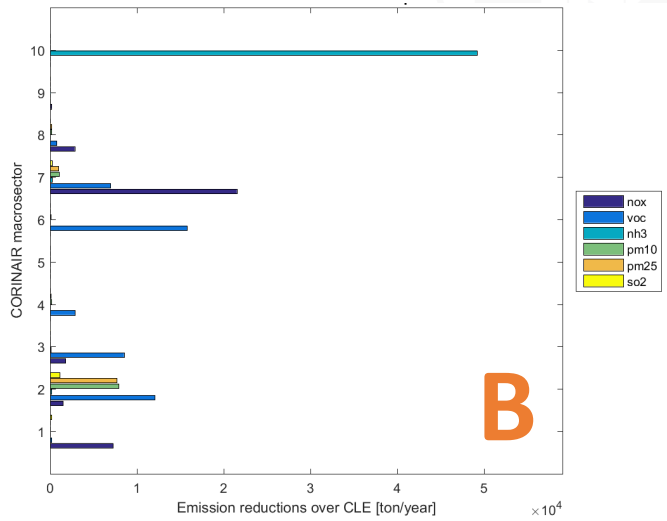
Costs over CLE2020 scenario per macro-sector for Policy A, B [M€/year].





Emission reduction per macro-sector with respect to CLE2020 scenario for Policy A, B and C [ton/year]





Costs and savings for the different Policies

Scenario	Cost Over CLE [M€/year]	End-of-pipe Cost Over CLE [M€/year]	Energy Measures Cost Over CLE [M€/year]	Costs due to all energy measures [M€/year]	Costs due to Active mobility [M€/year]	External costs morbidity [M€/year]	External costs mortality (YOLL) [M€/year]
CLE 2020	0	----	-----	-----	-----	2140.4	3902.1
Policy A	1000	708	292	-2657	-----	1693.5	3087.3
Scenario 1	1000.6	708	292.66	-3009.44	-352.43	1690.2	3081.3
Scenario 2	1126.3	708	418.30	-3361.88	-704.87	1687.4	3076.2
Policy B	1000	707	293	-3805	-1079	1681.9	3066.2

Corinair Macro-sector	End-of-pipe Cost [M€/yr]	Energy Cost [M€/yr]	Savings [M€/yr]
1	44.7	10.5	688.7
2	-6.0	258.4	661.9
3	0.7	0.0	0.0
4	24.8	0.0	0.0
5	0.0	0.0	0.0
6	536.5	0.0	0.0
7	6.1	19.2	1270.3
8	6.3	4.6	35.8
9	0.0	0.0	0.0
10	94.1	0.0	0.0
TOT	707.2	292.8	2656.7

Policy A

Scenario1

Corinair Macro-sector	End-of-pipe Cost [M€/yr]	Energy Cost [M€/yr]	Costs [M€/yr]
7	6.1	19.86	-1622.73

Scenario2

7	6.1	145.5	-1975.17

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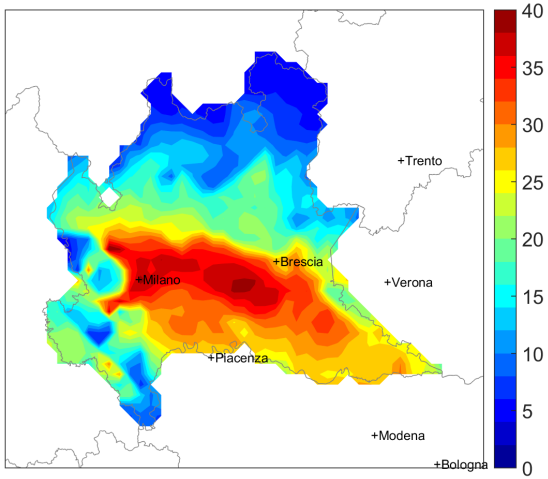
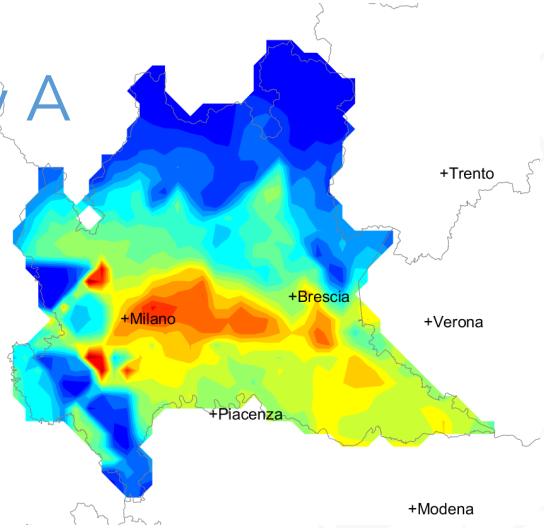
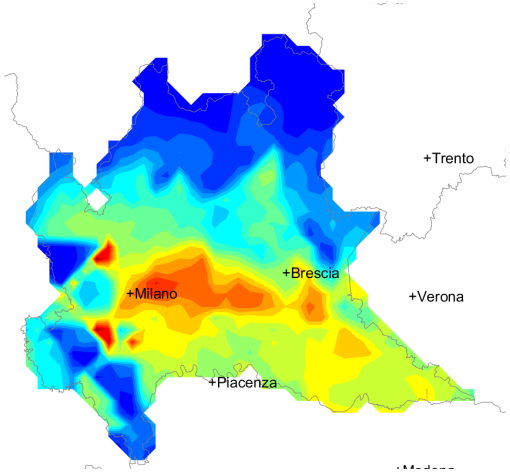
Impact on AQI: PM10 [µg/m3]

CLE 2020

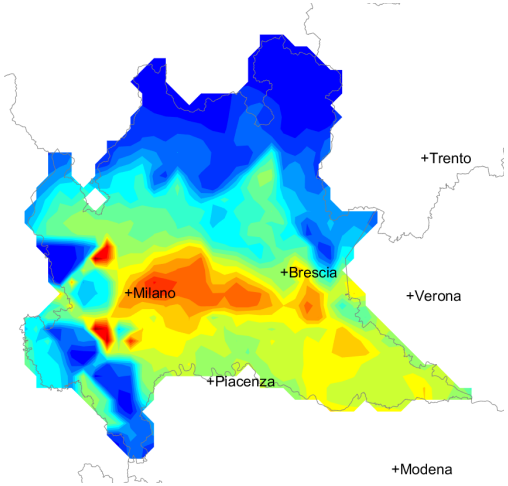


Policy A

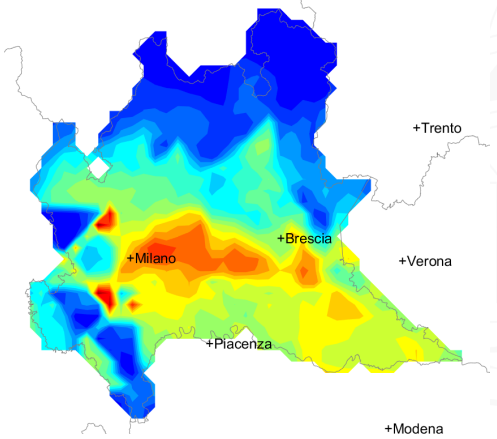




Scenario 1



Scenario 2



Policy B

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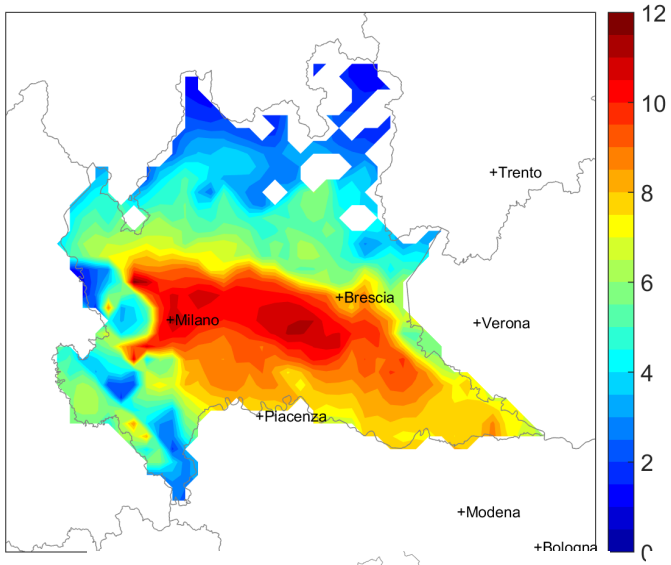
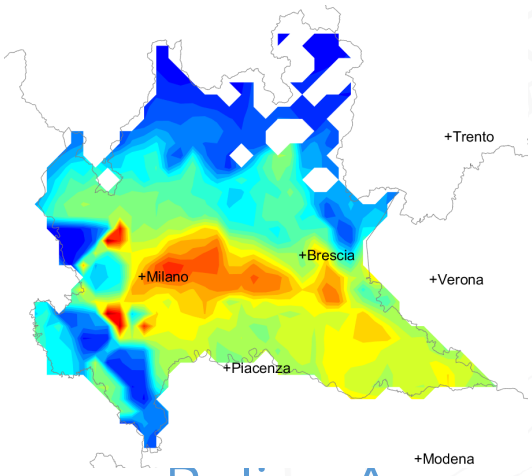
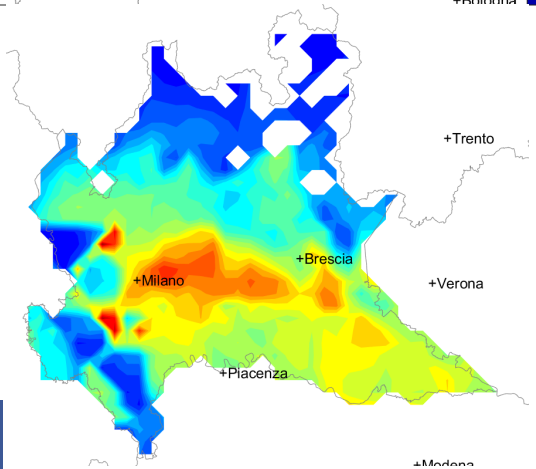
Impact on AQI: YOLL [months/capita]

CLE 2020

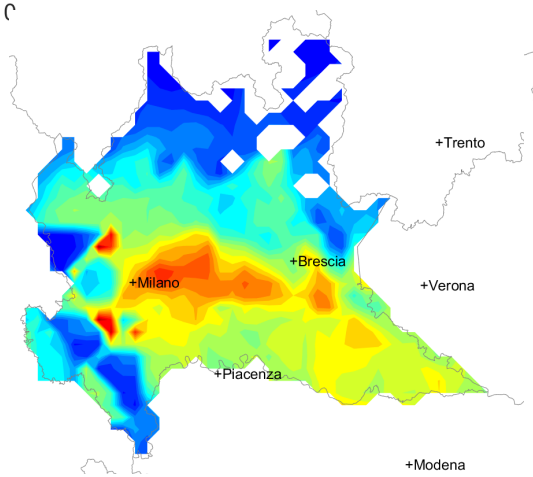




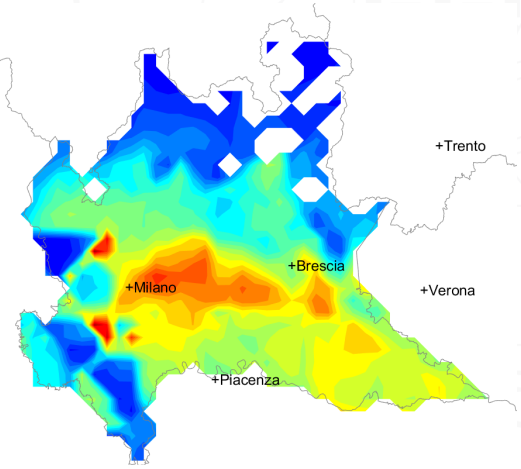
Policy A



Scenario 1



Scenario 2



Policy B

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Direct and indirect impacts

		A		Scenario 1		Scenario 2		B	
									
Commuters adopting AM	[Millions of people]	0	0	0.33	0.82	0.66	1.65	0.95	2.35
Indirect average per capita YOLL loss	[months per capita]	6.21		6.21		6.20		6.18	
Direct impact per commuter (YOLL gain)	[months per commuter]	-	-	-49.72	-24.01	-49.72	-24.01	-49.72	-24.01
Direct impact per commuter (YOLL loss)		-	-	5.14	0.54	5.14	0.54	5.14	0.54

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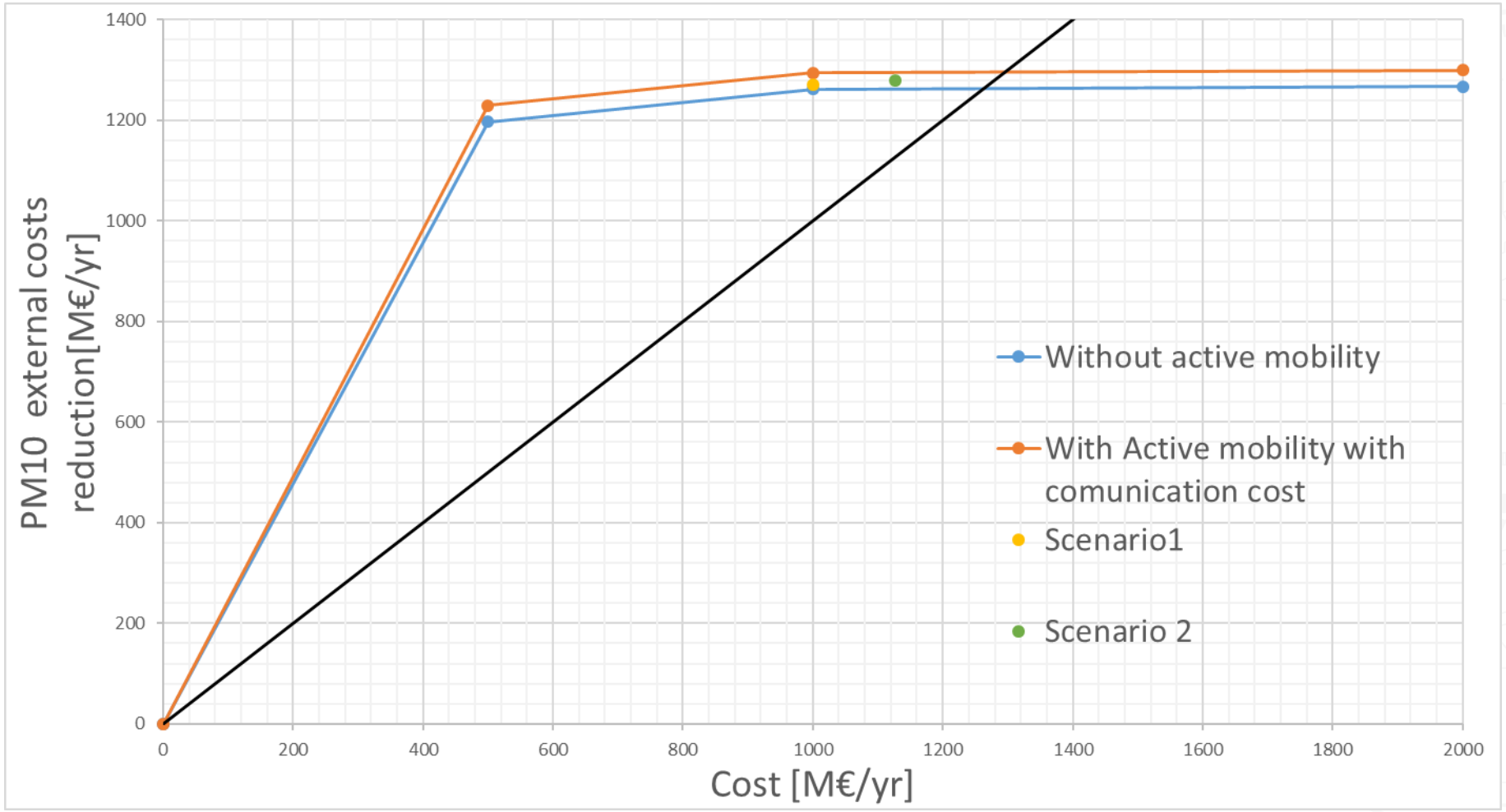
Cost-Benefits analysis



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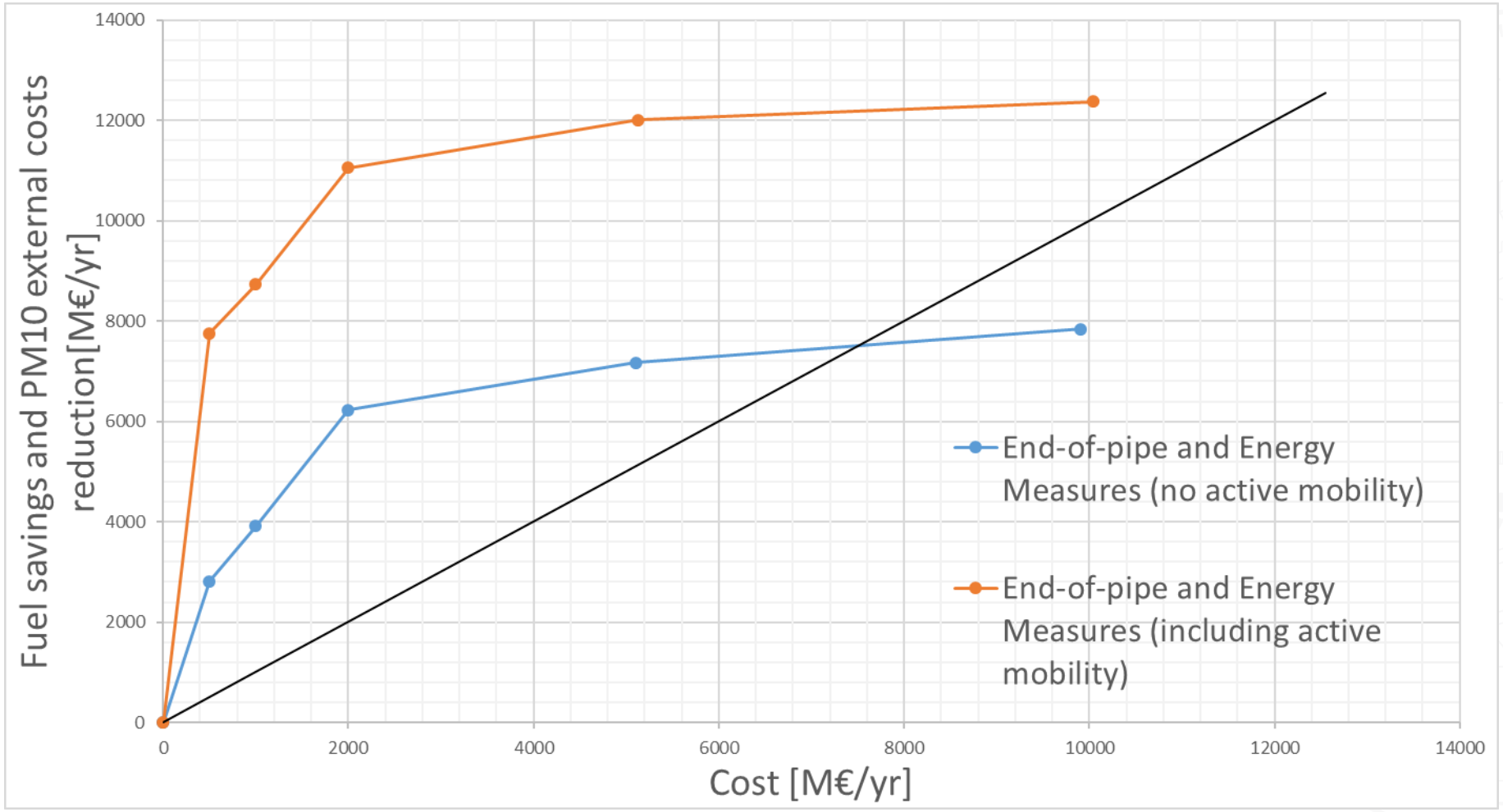
Cost-Benefits analysis



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Conclusioni

- MAQ: IAM per misure energetiche e end-of-pipe
- Valutazione di misure comportamentali
- Impatti diretti e indiretti sulla salute
  - Mobilità attiva