

ICARUS

Integrated Climate forcing and Air pollution Reduction in Urban Systems

Cost-benefit analysis of carbon mitigation measures in
European cities: the importance of co-benefits

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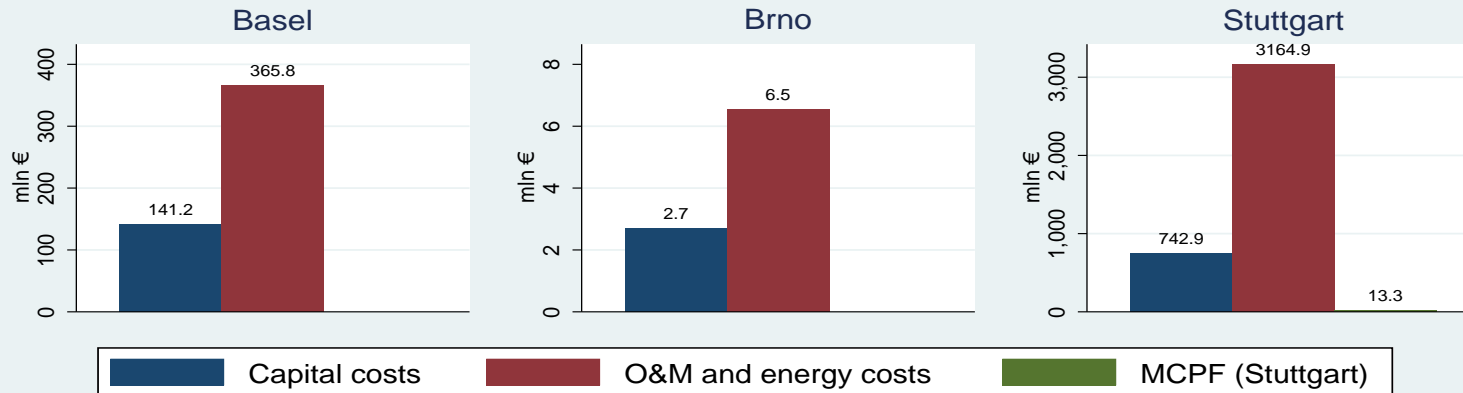
- Cities generate 75% of energy-related carbon emissions globally (1), and there is increasing need for cities to take action to reduce these emissions to meet the Paris Agreement and to reduce the risk of exceeding 1.5 °C temperature rise.
- Air quality and carbon mitigation measures should also have significant health and wellbeing co-benefits and these need to be appropriately estimated to aid decision making on identifying those measures with the highest potential for both reduction of emissions and associated health risks.
- We applied cost-benefit analysis (CBA) to compare nine air quality measures and policies which were proposed by five ICARUS cities (Attica, Basel, Brno, Milan and Stuttgart) within the following areas: energy efficiency in buildings, active transportation and alternative fuel vehicles.

<i>Energy Efficiency Measures</i>	
City	Description
Basel	Replacement of 11,847 gas boilers and 4,468 fuel oil boilers by heating pump and solar. One third of boilers replaced by 2020, and the remaining by 2030.
Brno	Replacement of remaining old residential 800 old coal-fired boilers and stoves for residential sector with: 336 biomass-fired boilers, 224 natural gas-fired boilers, 112 heat pumps, 96 automatic coal fired boilers and 32 solar thermal collectors. 20% of boilers replaced by 2020 and the remaining by 2030
Stuttgart	Replacement of heating system from oil to high efficiency gas boilers, district heating and heat pumps in the residential and commercial sector. Promotion of buildings insulation renovation in residential and non-residential buildings through: founding of an energy centre for public outreach, energy performance contracting and energy consulting for building owners, municipal promotion program for Stuttgart companies and commitment of the companies to climate protection in corporate management.

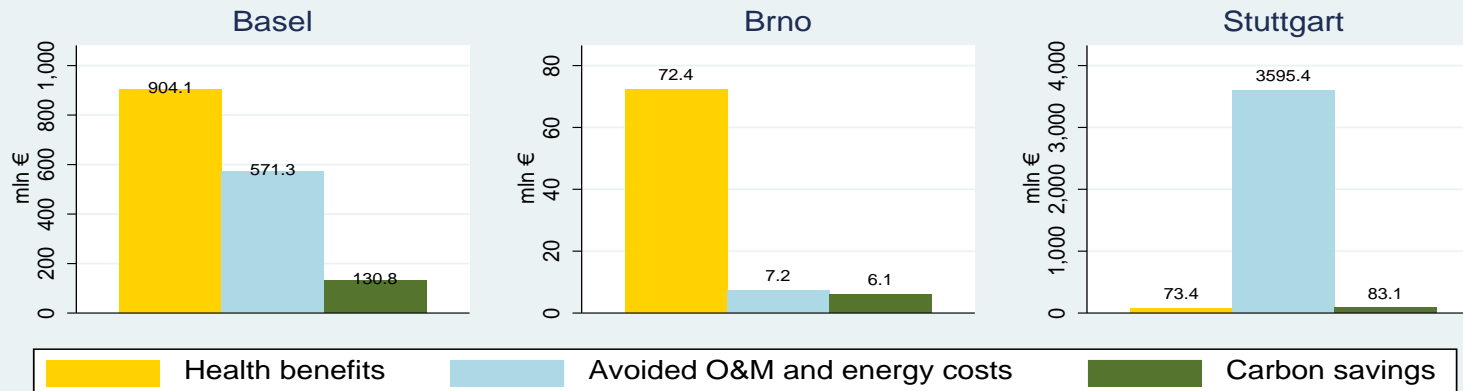
<i>Active Transport Measures</i>	
City	Description
Brno	Reduction of motorized vehicles in the city and increase of clean transportation, i.e. cycling and public transport through the creation of new cycle ways and lanes and in investments in public transport. The share of pedestrians and cyclists would increase from 12.1% in 2015 to 15.8% in 2030 with an increase in the activity of public transport of 10% during the same period. Concerning the personal cars, their share would decrease from 52.7% in 2015 to 38.5% in 2030.
Stuttgart	Promotion of walking, cycling and public transport, and decrease of individual transportation. The share of walking and cycling would increase from 10% in 2020 to 20% in 2030. This is achieved through the expansion and promotion of urban railways and cycling infrastructure, 25% tariff reduction for public transport, and awareness campaign.
Region of Attica	Promotion of walking and cycling, eco-driving and increase of public and alternative transportation. This measure aims at increasing the share of walking and cycling from 10% in 2011 to 10% in 2020 and 20% in 2030. It also promotes an awareness campaign on the citizens in eco-driving practices, with the target of reaching 10% of drivers by 2020 and 20% by 2030.

<i>Alternative Fuel Vehicles</i>	
City	Description
Brno	Increase in the share of private car vkm done by electric vehicles to 7% in 2020 and 2030, through the promotion of electric vehicles in the city of Brno and the promotion of a network of fast-charging stations through the Operational Program for Traffic of the Ministry of Transport.
Stuttgart	Increase in the share of vkm done by electric and hybrid vehicles to 7% in 2020 and 2030. This scenario includes various sub-measures like the procurement of electric and hybrid vehicles for the municipal vehicle fleet, the promotion of willingness to switch to electric vehicles in taxi companies and the construction of charging infrastructure in semi-public and non-public areas, parking fee reductions for electric vehicles.
Milan	Conversion of the entire public bus fleet to an electric fleet by 2030. This includes the purchase of 1,200 electric buses and the development of the charging infrastructure.

a) Energy efficiency measures: costs



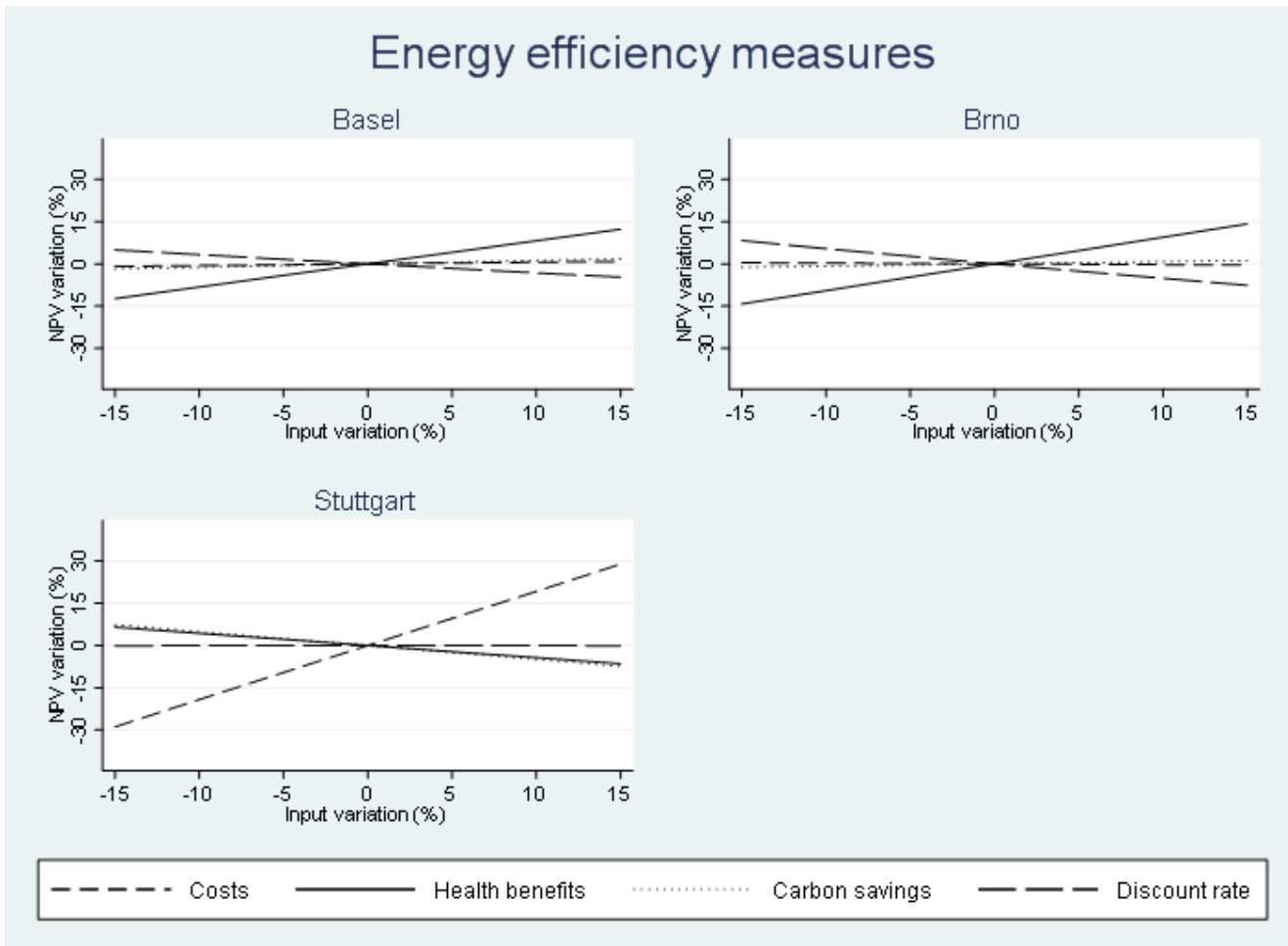
b) Energy efficiency measures: benefits



	Energy efficiency measures		
	Basel	Brno	Stuttgart
NPV	1,099,028,950	76,430,727	- 169,202,216
BCR	3.17	9.27	0.96
FICOSTEF	245.09	98.72	3,040.36
FUCOSTEF	- 468.00	- 751.72	195.64
	Active transport measures		
	Brno	Stuttgart	Attica
NPV	1,232,049,120	797,854,411	9,150,683,828
BCR	15.10	2.39	3.61
FICOSTEF	70.68	712.63	332.64
FUCOSTEF	- 935.95	- 925.09	- 801.90
	Alternative fuel vehicles		
	Brno	Milan	Stuttgart
NPV	167,356,472	2,602,853,918	- 14,259,324
BCR	2.33	4.01	0.99
FICOSTEF	226.55	10,457.19	2,372.45
FUCOSTEF	- 238.67	- 31,383.55	82.43

FICOSTEF –
Financial
cost
effectiveness
(€/t)

FUCOSTEF
– Full
economic
cost
effectiveness
(€/t)



Sensitivity of results to changes in different key variables tested.

Only the case of Stuttgart is shown to be particularly sensitive to one attribute – that of cost,

- Our results suggest that benefits of air quality measures outweigh the costs, with seven out of nine measures achieving a positive NPV. The inclusion of health benefits is an important factor explaining high levels of the BCR, although for none of these seven measures the inclusion of health benefits was essential to reach a positive NPV.
- Our analysis shows the importance of the inclusion of health co-benefits in cost-effectiveness analysis of carbon mitigation strategies. Options that may appear costly in terms of the financial cost per ton of carbon reduced become viable in many cases when co-benefits are considered.
- Differences between cities – need for subsidiarity in defining policy.