

# NET ZERO CITIES



**EU MISSION PLATFORM**

**CLIMATE NEUTRAL AND SMART CITIES**



NetZeroCities has received funding from the H2020 Research and Innovation Programme under grant agreement n°101036519.



# Co-benefits for net-zero cities



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# Executive Summary



**In the sustainable transition of a city, climate solutions such as decarbonising transport and heating can provide additional value other than CO<sub>2</sub> reductions. These co-benefits are an essential part of the total economics case for city decarbonisation and support the investment case of solutions. Co-benefits also help cities prioritize and compare the value of different actions.**

**Co-benefits are additional benefits from climate actions that address some of the most pressing issues of cities, for example:**

- Improved air quality due to reduced motorized traffic
- Improved physical health from more walking/biking

**Co-benefits are mainly connected to either economic growth, health, or inclusivity.** Several co-benefits can be quantified in monetary terms and therefore be added to an investment plan and measured. From previous experience, we see that these quantified co-benefits often can turn a negative investment into a positive one, meaning they can be important to motivate and fund climate actions.

**This document is a training material about co-benefits, including the economic value of co-benefits, case examples, and a list of co-benefits for common climate actions.**





- **The economic value of co-benefits**
- Case examples
- Co-benefits per lever



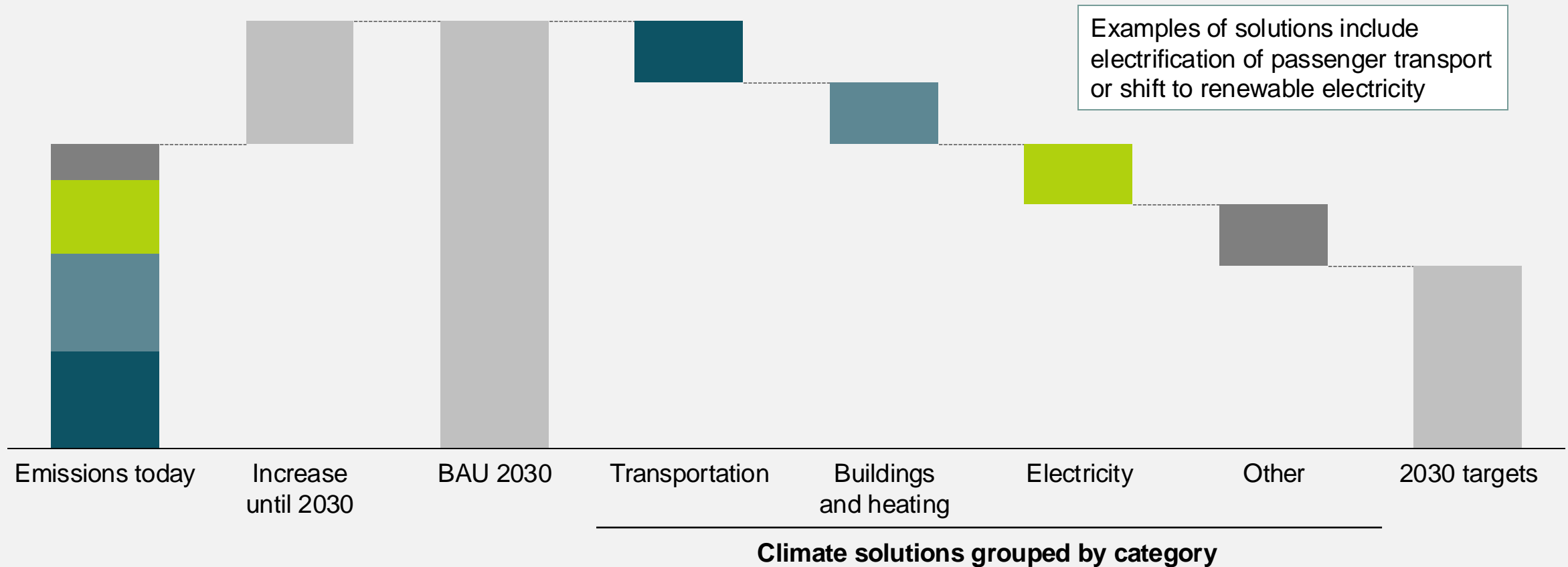
# Climate solutions can help reduce a city's CO2 emissions



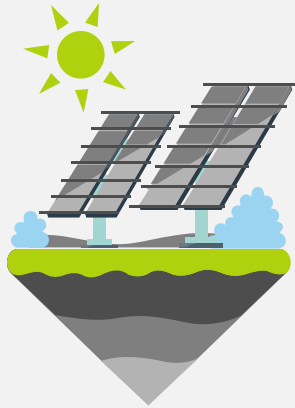
## Emissions from a city

Thousand tonnes CO<sub>2</sub> per year

Example



# Climate solutions can have a positive impact on both the climate and other co-benefits



## CO<sub>2</sub> reductions

From lower use of fossil fuels and waste incineration

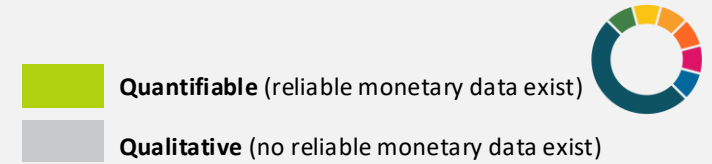


## Co-benefits

For example, improved air quality due to reduced motorised traffic or improved physical health from more walking/biking

# The co-benefits of climate solutions address the most pressing issues of cities

Co-benefits by category (not exhaustive)



Category of climate solutions	Economic growth			Health						Inclusivity		
	Employment	Time savings	Property value	Air quality	Noise	Road safety	Physical health	Well-being	Eco-system health	Water quality	Equality	Community assets
Transportation	Quantifiable	Qualitative	Qualitative	Quantifiable	Quantifiable	Quantifiable	Quantifiable	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative
Built Environment	Quantifiable	Qualitative	Qualitative	Quantifiable	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative
Energy Systems	Quantifiable	Qualitative	Qualitative	Quantifiable	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative
Green Infrastructure and Nature Based Solutions	Quantifiable	Qualitative	Quantifiable	Quantifiable	Qualitative	Qualitative	Quantifiable	Qualitative	Qualitative	Quantifiable	Qualitative	Qualitative
Waste and Circular Economy	Quantifiable	Qualitative	Qualitative	Quantifiable	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative

**Co-benefits are worth emphasising because they often add significant value** by helping to solve some of the most pressing issues for mayors.

**Almost all solutions improve some aspect(s)** of economic growth, health, and inclusivity although some are difficult or perhaps even impossible to quantify.

**For example**, investments into the public transportation may increase property value, electrification of vehicles leads to both improved air quality and reduced noise pollution, while a shift from motorized transport to biking/walking improves physical health.



# Main co-benefits for cities can be categorised in economic growth, health, and inclusivity



NOT EXHAUSTIVE

Health	Air quality	Health improvements of citizens from cleaner air from e.g., reduced motorized transport and electrification of energy	kg pollutants (NOx, PM 2.5, and PM10)
	Noise	Health improvements of citizens from lower noise pollution from e.g., reduced motorized transport and shift to electric vehicles	km transport from ICE vehicles
	Road safety	Accidents avoided from e.g., reduced motorized transport	# of accidents
	Physical health	Health improvements of citizens from e.g., increased walking and cycling	km transport from walking and biking
	Well-being	Health improvements of citizens from e.g., renovated buildings (better living environment)	m <sup>2</sup> of insulated houses
	Ecosystem health	Ecosystems improvements in the city from e.g., reforestation	<i>Not quantified</i>
	Water quality	Water quality improvements from e.g., reforestation	# of trees planted
Economic growth	Employment	Additional jobs created in city from e.g., shift to public transport and increase in construction	# of city-jobs created
	Time savings	Time saved by citizens from e.g., reduced transport and congestion	Time saved (days)
	Property value	Increase in property value from e.g., expanded public transport and building improvements	Value of property market (EUR)
Inclusivity	Equality	Equal access to products and services from e.g., improving access to transportation	<i>Not quantified</i>
	Community assets	Publicly owned and free-to-use areas/assets by e.g., repurposing parking spaces	<i>Not quantified</i>



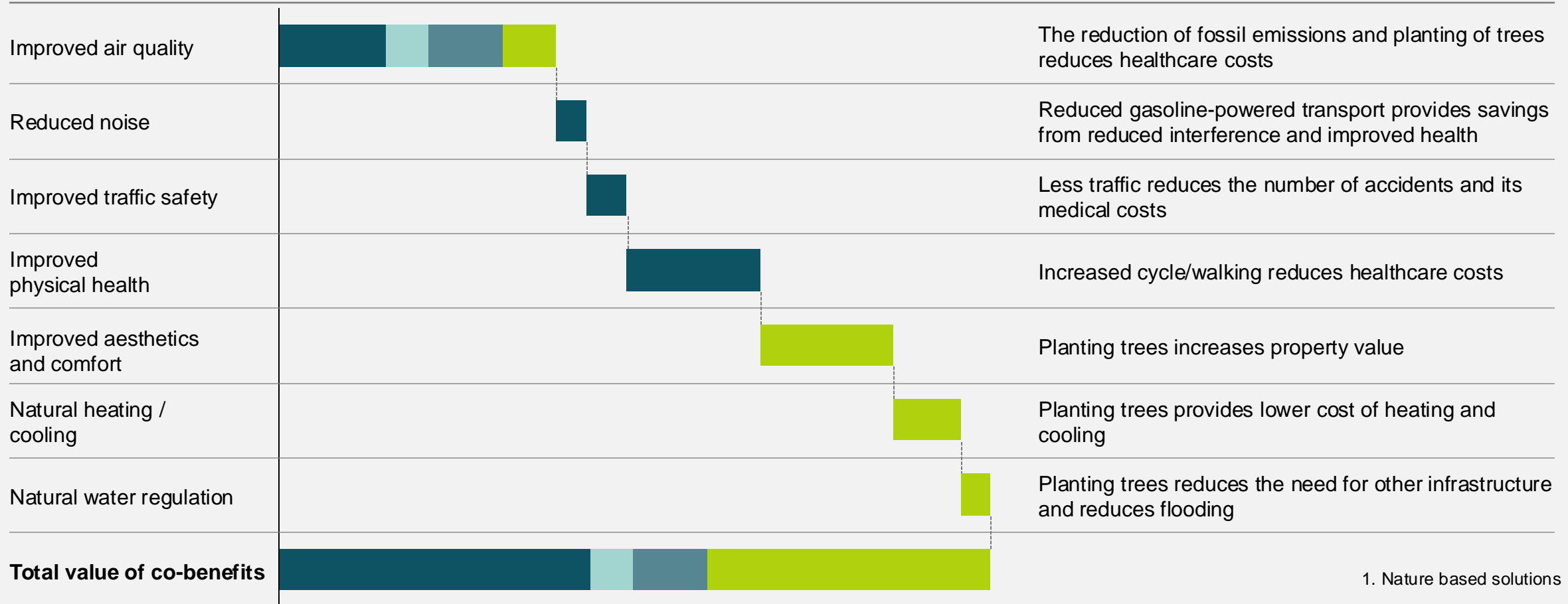


# Some co-benefits can be quantified in monetary terms



■ Green infrastructure and NBS<sup>1</sup>
■ Energy systems
 ■ Built environment
 ■ Transportation

Quantified co-benefits  
MEUR per year, 2030



1. Nature based solutions



# Backup: The economic value of co-benefits are based on literature review



Category	Value of co-benefits
<b>Particles</b>	<p><b>NOx:</b> 12.6 EUR/kg fuel (within city) &amp; 21.3 EUR/kg (outside city)<sup>1</sup></p> <p><b>PM 2.5:</b> 252 EUR/kg (within city) &amp; 70 EUR/kg (outside city)<sup>1</sup></p> <p><b>PM 10:</b> 22.3 EUR/kg<sup>1</sup></p> <p><b>Air quality:</b> 6 EUR/tree<sup>2</sup></p>
<b>Accident reduction</b>	<p><b>Cars:</b> 0.014 EUR/pkm<sup>1</sup></p> <p><b>Buses:</b> 0.008 EUR/pkm<sup>1</sup></p> <p><b>Light trucks:</b> 0.046 EUR/pkm<sup>1</sup></p> <p><b>Heavy trucks:</b> 0.010 EUR/pkm<sup>1</sup></p>
<b>Noise reduction</b>	<p><b>Cars:</b> 0.006 EUR/pkm<sup>1</sup></p> <p><b>Buses:</b> 0.004 EUR/pkm<sup>1</sup></p> <p><b>Trains:</b> 0.008 EUR/pkm<sup>1</sup></p> <p><b>Light trucks:</b> 0.016 EUR/tonnekm<sup>1</sup></p> <p><b>Heavy trucks:</b> 0.008 EUR/tonnekm<sup>1</sup></p>
<b>Others</b>	<p><b>Water regulations:</b> 9 EUR/tree<sup>2</sup></p> <p><b>Shading benefits:</b> 22 EUR/tree<sup>2</sup></p> <p><b>Property value:</b> 43 EUR/tree<sup>2</sup> <span style="border: 1px solid black; padding: 2px; display: inline-block;">Property value may or may not be considered a societal benefit</span></p> <p><b>Health co-benefits from walking/cycling:</b> 0.3 EUR/pkm<sup>3</sup></p>

1. Essen et. al. (2019). Handbook on the external costs of transport. For European Commission Directorate-General for Mobility, 2. Song et al (2018) - The economic benefits and costs of trees in urban forest stewardship: A systematic review, 3. Victoria Transport Policy Institute (2019). Evaluating Active Transport Benefits and Costs.



# Co-benefits are an essential part of the total economics case for city decarbonisation

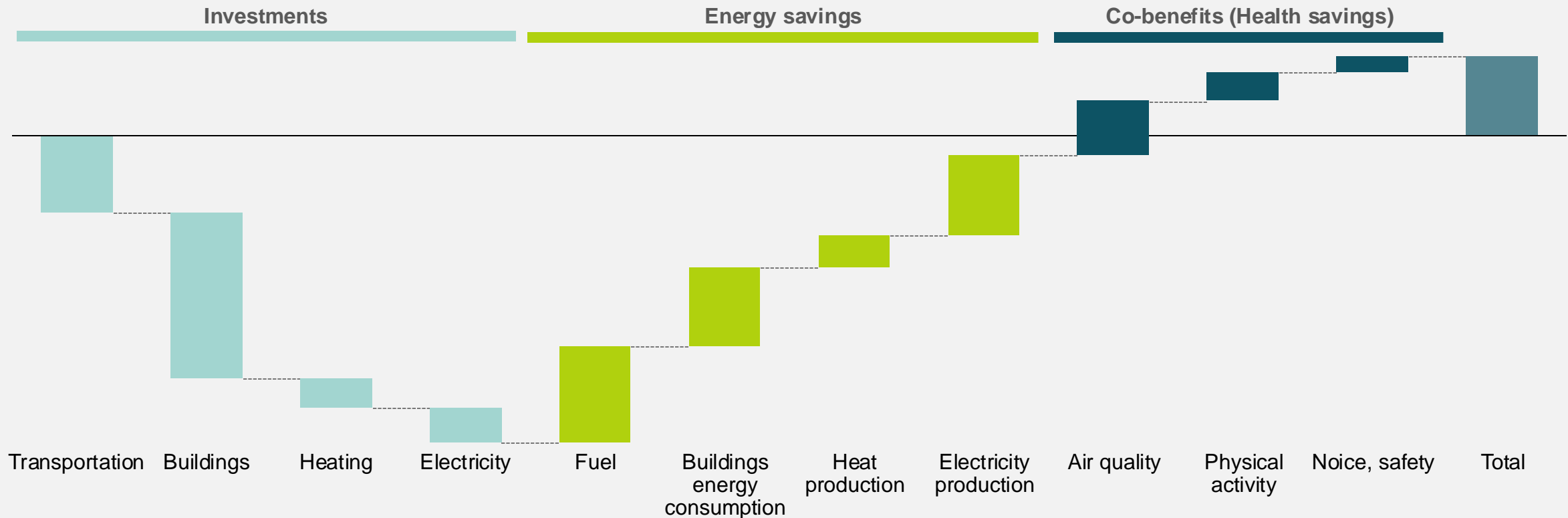


ILLUSTRATIVE

Total investments and savings for the climate transition

MEUR, 2020-2030 for investments, 2020-2050 for savings

**Additional benefits arising from actions to reduce greenhouse gas emissions** (e.g., better air quality from electrification of vehicles).



# Each climate solution has its own economic case including the value of co-benefits



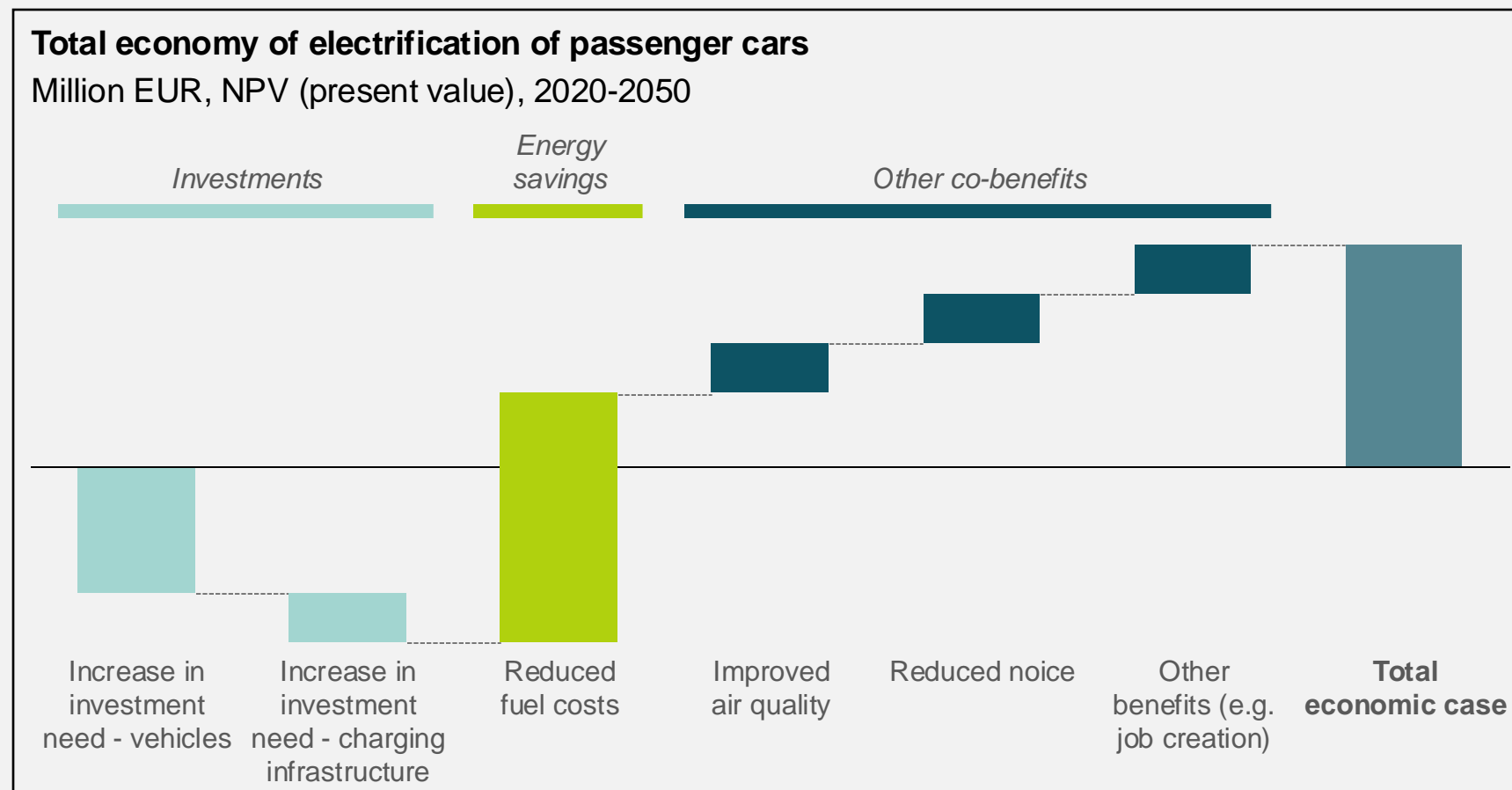
What new investments or adjustment of planned investments<sup>1</sup> are required to reach the climate goals, according to the climate roadmap?

How do the investments affect ongoing energy and other costs for each area?

What other savings are created?

Which need owners need to invest in what?

## EXAMPLE



1. Investments can include either completely new investments or making existing investments in a climate-smart way (which can give rise to an increased investment), e.g. new construction or the purchase of a new car



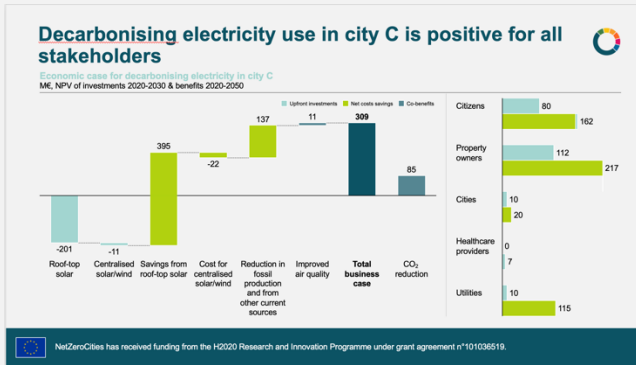
- The economic value of co-benefits
- **Case examples**
- Co-benefits per lever



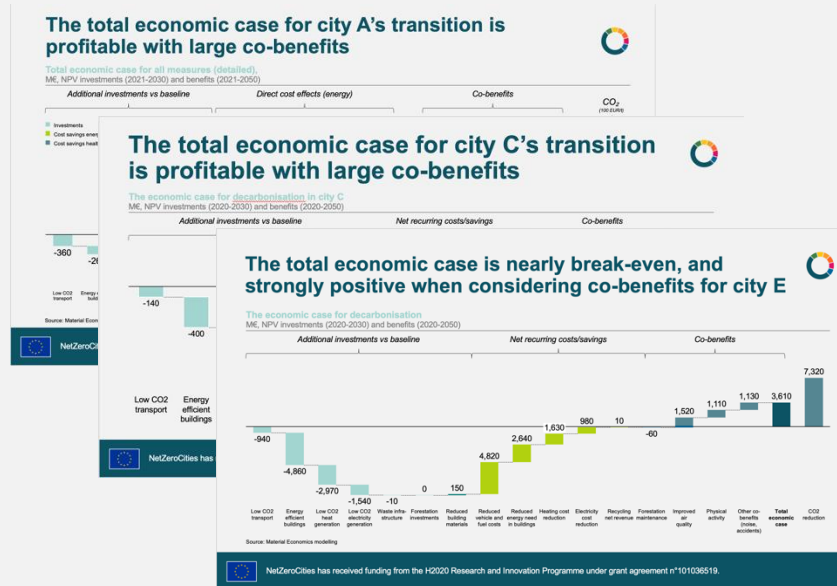


# Overview of case examples

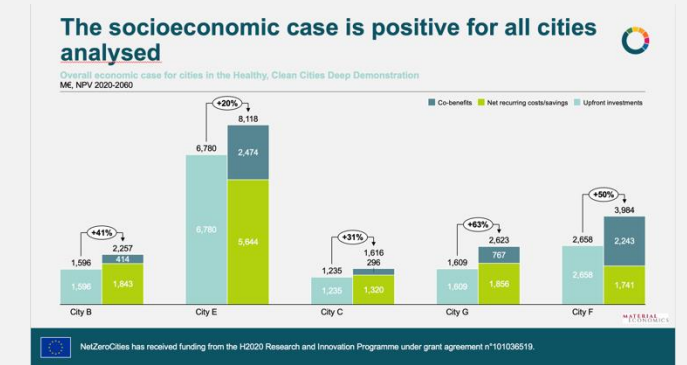
## Lever impact



## Total economic case



## City comparison



# The investment need for different types of cities

## - examples

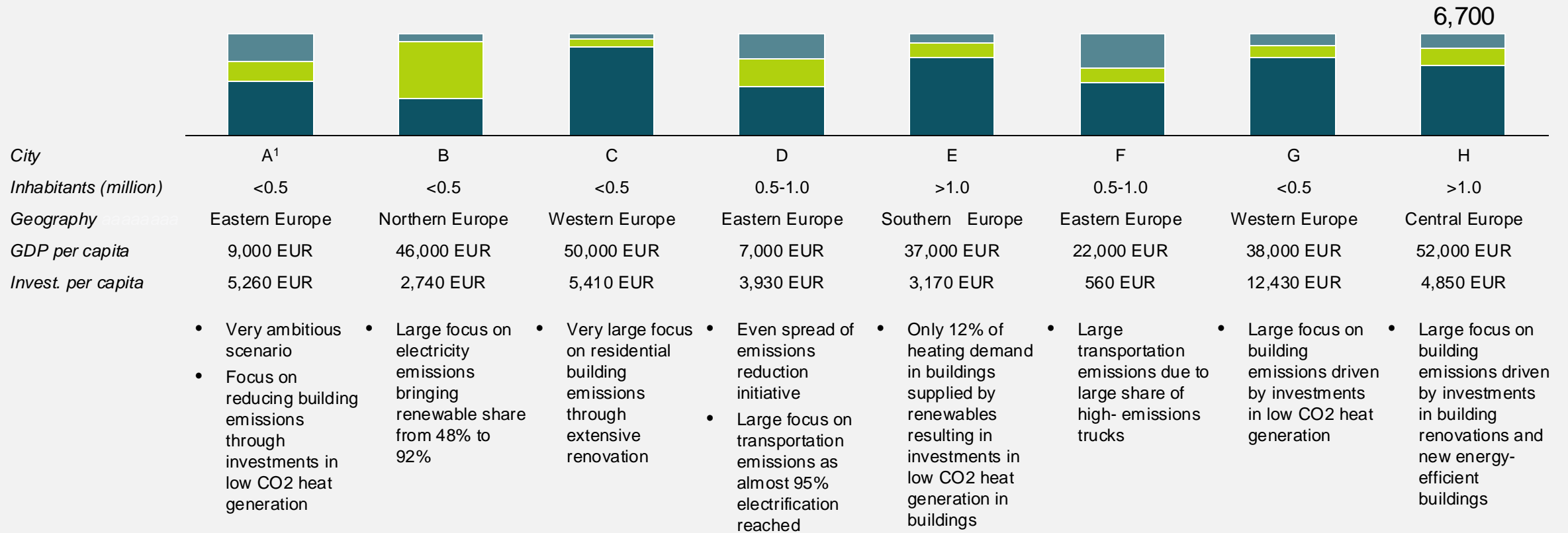


Investments, Million EUR, NPV 2020-2030

■ Transportation

■ Electricity

■ Buildings



1) City A exemplifies a very ambitious decarbonisation scenario (vehicle electrification is almost 100% in 2030 for passenger cars, truck and buses and renewable share in electricity and heat generation also almost reaches 100% in 2030. This scenario should therefore be interpreted as a theoretical "visionary" pathway where deep decarbonisation is carried out in all sectors.

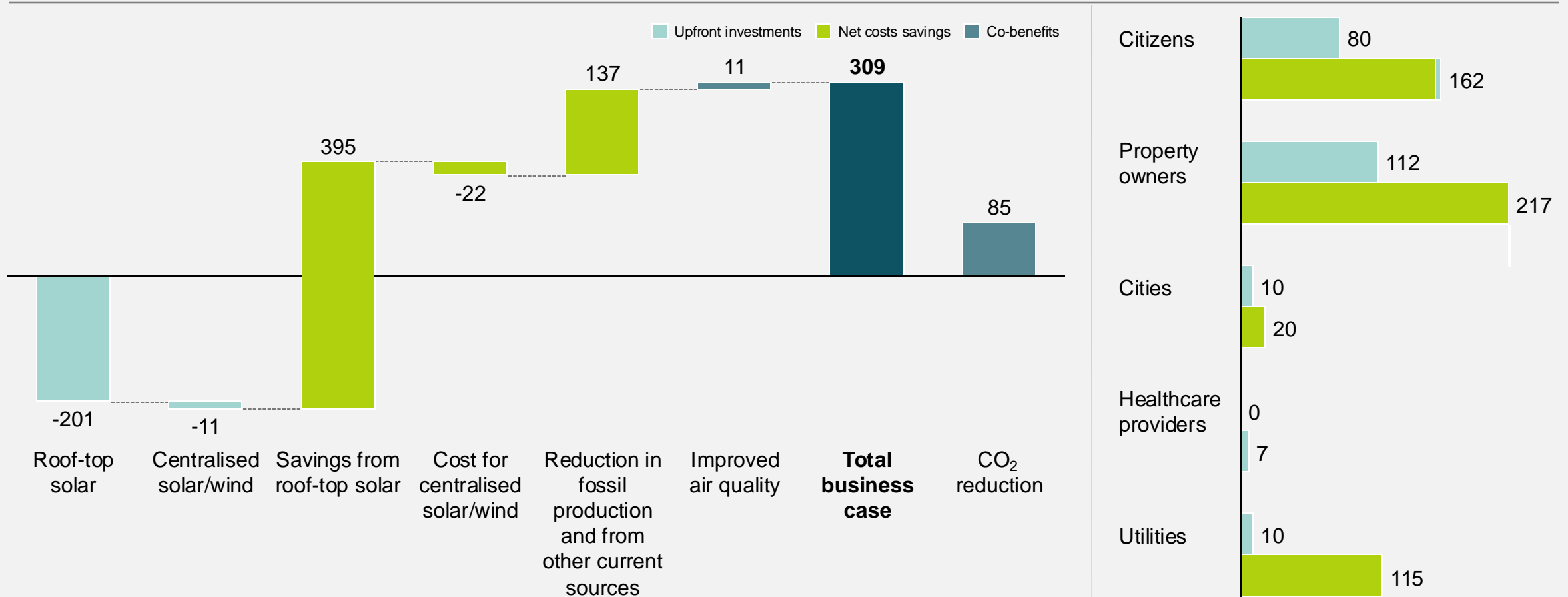


# Decarbonising electricity use in city C is positive for all stakeholders



## Economic case for decarbonising electricity in city C

M€, NPV of investments 2020-2030 & benefits 2020-2050

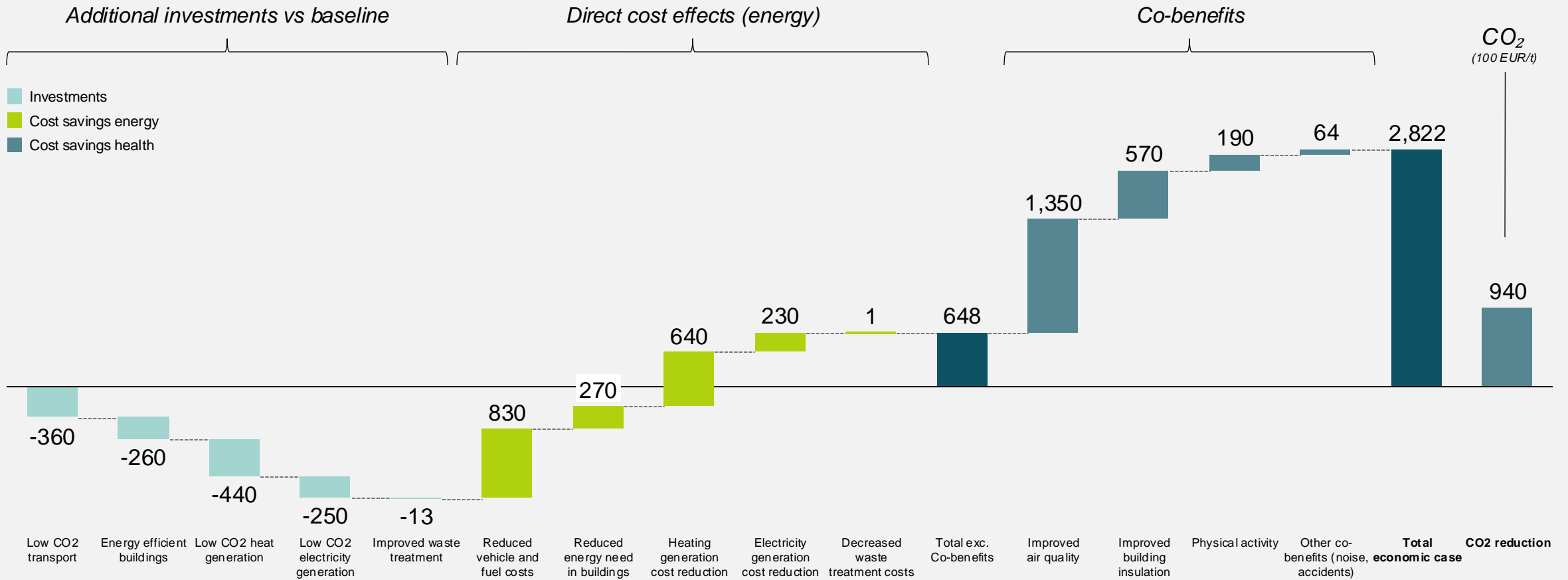




# The total economic case for city A's transition is profitable with large co-benefits



Total economic case for all measures (detailed),  
M€, NPV investments (2021-2030) and benefits (2021-2050)



Source: Material Economics analysis

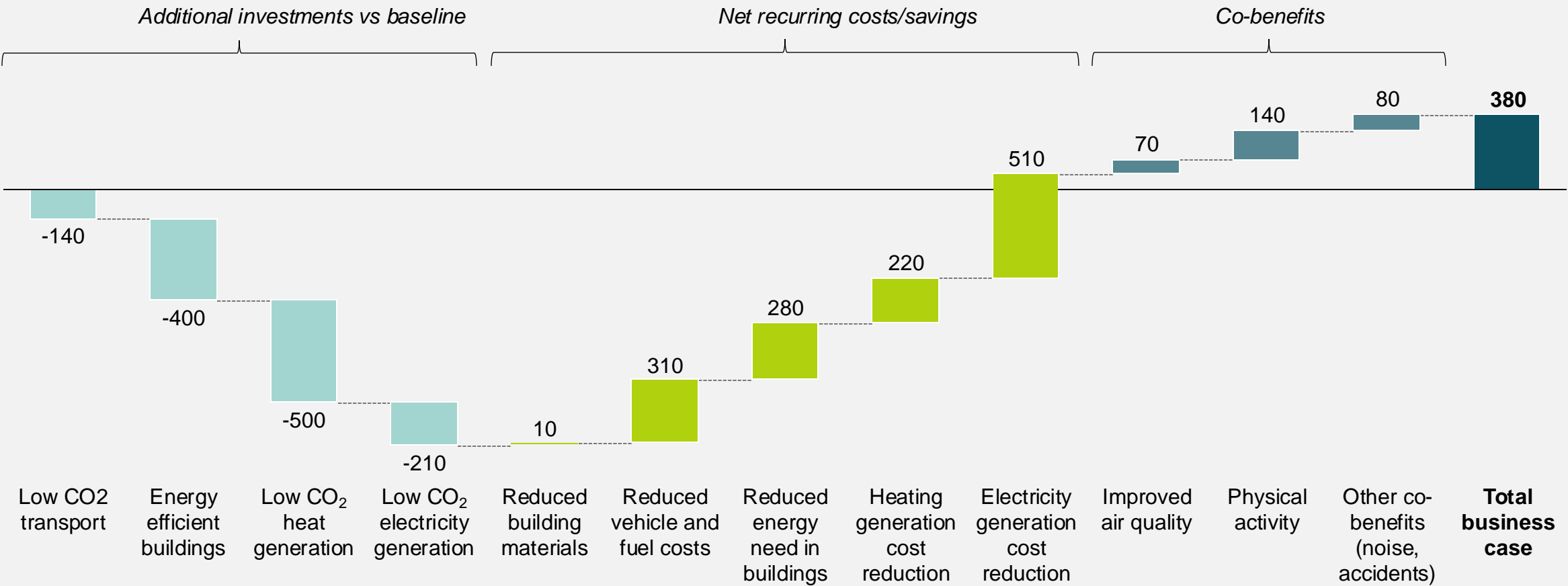


# The total economic case for city C's transition is profitable with large co-benefits



## The economic case for decarbonisation in city C

M€, NPV investments (2020-2030) and benefits (2020-2050)

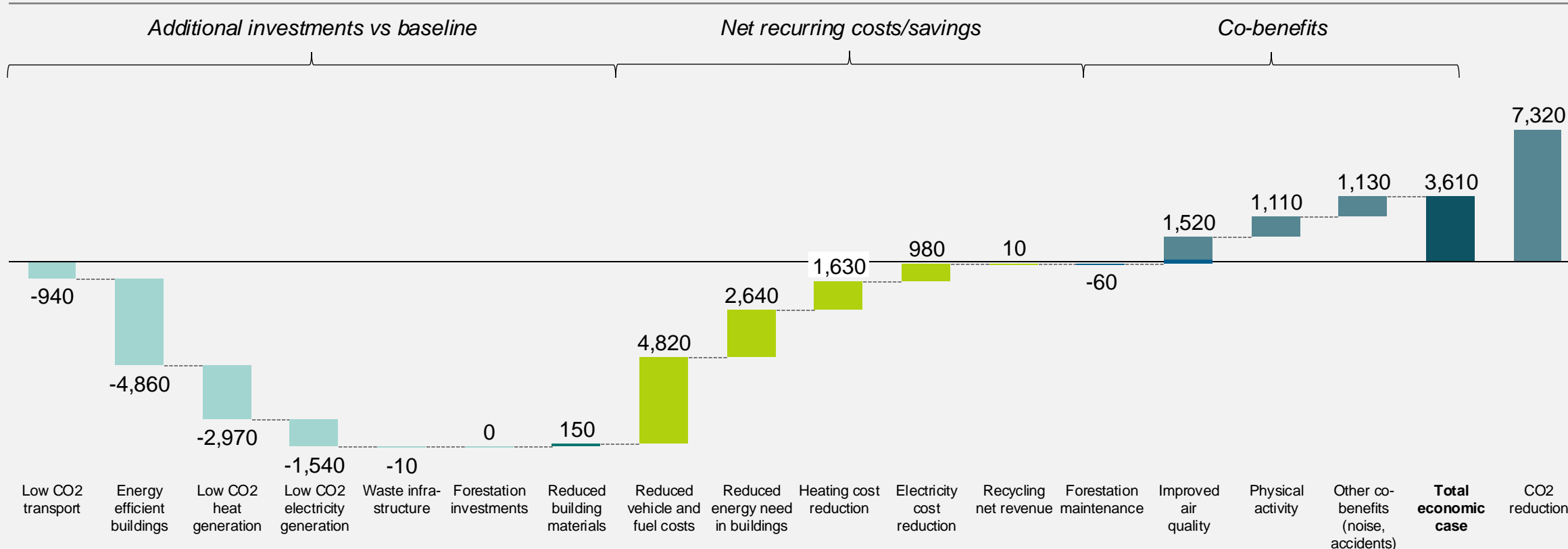


# The total economic case is nearly break-even, and strongly positive when considering co-benefits for city E



## The economic case for decarbonisation

M€, NPV investments (2020-2030) and benefits (2020-2050)



Source: Material Economics modelling

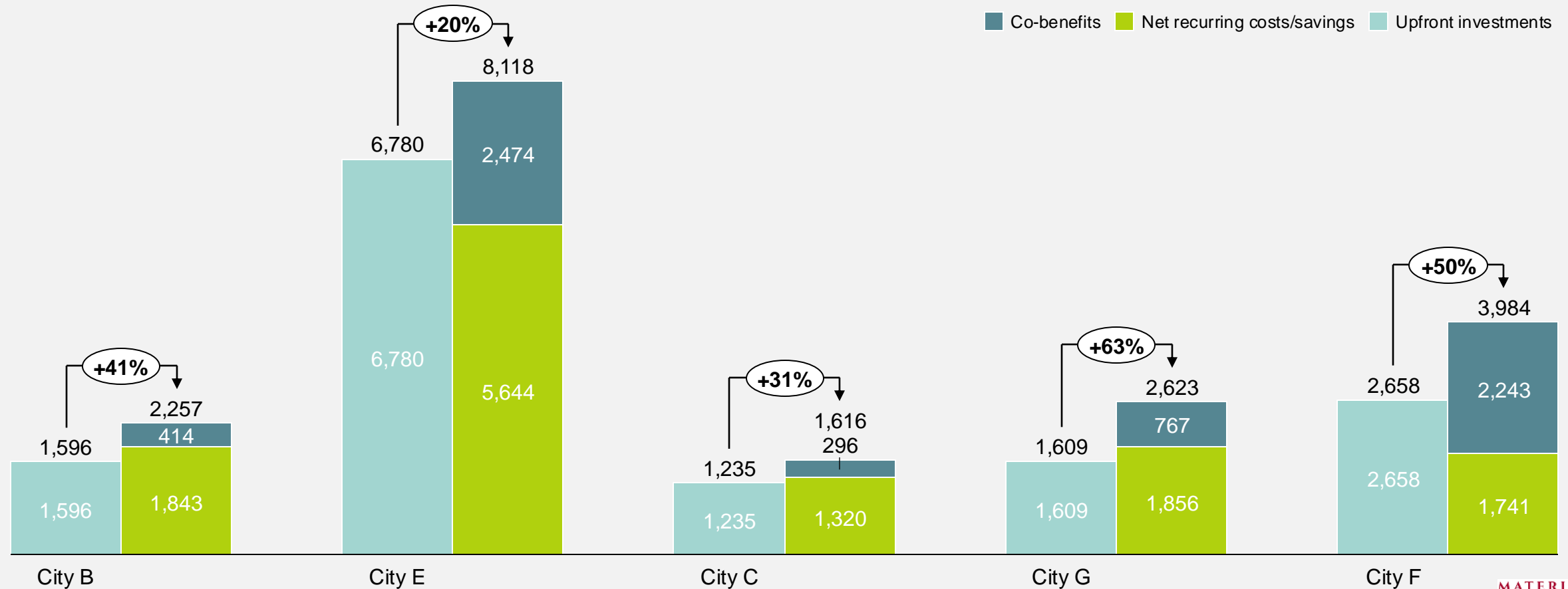


# The socioeconomic case is positive for all cities analysed



Overall economic case for cities in the Healthy, Clean Cities Deep Demonstration

M€, NPV 2020-2060



MATERIAL ECONOMICS





- The economic value of co-benefits
- Case examples
- **Co-benefits per lever**



# Overview of levers (not exhaustive)



## 1. Passenger transport

1. Reduced motorised transport
2. Shift to public & non-motorised transport
3. Increased car pooling
4. Electrification of passenger cars
5. Electrification of buses



## 2. Freight transport

1. Optimised logistics
2. Electrification of trucks



## 3. Built environment

1. Building renovations
2. New energy efficient buildings
3. Efficient lighting and appliances
4. Decarbonising heating
5. Expanded district heating network\*



## 4. Energy systems

1. Decarbonising electricity
2. Rooftop solar installations\*
3. Utility-scale solar and wind generation\*
4. Electrified machinery\*



## 5. Waste

1. CCS on heat and power plants
2. Increased rates of waste collection, sorting and recycling
3. Increased rate of centralised incineration with energy recovery



## 6. Nature based solutions

1. Planting trees

Deepdives for levers on following pages

Without deepdives

\* = Without deepdive



# 1.1 Reduced motorised transportation



ILLUSTRATIVE EXAMPLE

**Legend**

- Limited +/- effect
- Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	<b>Air quality</b> Reduced motorised transportation reduces emissions of air pollutants such as NOx, PM 2.5, and PM 10.	
	<b>Road safety</b> Reduced motorised transport decreases the number of road accidents	
	<b>Noise</b> Reduced buses and cars on the road reduces noise pollution and related health issues	
Economic growth	<b>Employment</b> Could potentially have negative consequences on employment, since jobs within public transport would likely decrease	
	<b>Time savings</b> Reduced time spent for people travelling and vehicles on the road could reducing congestion	



# 1.2 Shift to public & non-motorised transport



ILLUSTRATIVE EXAMPLE

**Legend**

Limited -/+ effect  
 Significantly -/+ effect

Category	Effect of lever on co-benefits	Scale of effect	
Health	Air quality	Reduced motorised transportation reduces emissions of air pollutants such as NOx, PM 2.5, and PM 10	
	Road safety	Reduced motorised transport decreases the number of road accidents	
	Noise	Reduced vehicles on the road reduces noise pollution and related health effects	
	Physical health	Significant health benefits from increased walking and cycling	
Economic growth	Employment	A shift to more public transport could create more job opportunities within the transportation sector in the city	
	Time savings	Reduced vehicles on the road reduces congestion and thereby time spent on transportation	
	Property value	Expanding public transport to new areas of the city often increases the property value in those areas	
Inclusivity	Equality	Increased public transport can increase equality in a city, since it can increase everyone's access to transportation	
	Community assets	Promotes development of community assets such as repurposing parking spaces and building out the public transport infrastructure	





# 1.2 Shift to public & non-motorised transport



ILLUSTRATIVE EXAMPLE

**Legend**

Limited +/- effect  
 Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	<b>Air quality</b> Reduced motorised transportation reduces emissions of air pollutants such as NOx, PM 2.5, and PM 10	
	<b>Road safety</b> Reduced motorised transport decreases the number of road accidents	
	<b>Noise</b> Reduced vehicles on the road reduces noise pollution and related health effects	
	<b>Physical health</b> Significant health benefits from increased walking and cycling	
Economic growth	<b>Employment</b> A shift to more public transport could create more job opportunities within the transportation sector in the city	
	<b>Time savings</b> Reduced vehicles on the road reduces congestion and thereby time spent on transportation	
	<b>Property value</b> Expanding public transport to new areas of the city often increases the property value in those areas	
Inclusivity	<b>Equality</b> Increased public transport can increase equality in a city, since it can increase everyone's access to transportation	
	<b>Community assets</b> Promotes development of community assets such as repurposing parking spaces and building out the public transport infrastructure	



# 1.3 Increased car pooling



ILLUSTRATIVE EXAMPLE

**Legend**

- Limited +/- effect
- Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	Air quality Air pollution decreases when vehicle kilometres in the cities are reduced	
	Road safety Road accidents decrease when vehicle kilometres are reduced	
	Noise Reduced vehicles on the road reduces noise pollution and related health effects	
Economic growth	Time savings Reduced vehicles on the road could reduce queues and thereby time spent on transportation	



# 1.4 Electrification of passenger cars



ILLUSTRATIVE EXAMPLE

**Legend**

- Limited +/- effect
- Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	<p><b>Air quality</b></p> <p>A reduced number of ICE cars leads to reduced emissions of air pollutants such as NOx, PM 2.5, and PM10</p>	
Inclusivity	<p><b>Equality</b></p> <p>Promoting the use of private vehicles can be seen as socially inequal given that it is typically wealthier citizens who use private cars</p>	









# 1.5 Electrification of buses

ILLUSTRATIVE EXAMPLE

### Legend

-  Limited +/- effect
-  Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	Air quality	
	Noise	



# 2.1 Optimised logistics



**Legend**

- Limited +/- effect
- Significantly +/- effect

ILLUSTRATIVE EXAMPLE

Category	Effect of lever on co-benefits	Scale of effect
Health	Air quality Air pollution decreases when vehicle kilometres in the cities are reduced	
	Road safety Road accidents decrease when vehicle kilometres are reduced	
	Noise Noise related health problems decrease when vehicle kilometres are reduced	
Economic growth	Employment Employment within sector may decrease due to reduced vehicle kilometres. However, employment at loading stations might increase	
	Time savings Reduced vehicles on the road could reduce queues and thereby time spent on transportation	





# 2.2 Electrification of trucks

ILLUSTRATIVE EXAMPLE

**Legend**

- Limited +/- effect
- Significantly +/- effect

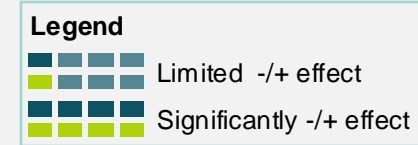
Category	Effect of lever on co-benefits	Scale of effect
Health	<b>Air quality</b> A reduced number of ICE trucks leads to reduced emissions of air pollutants such as NOx, PM 2.5, and PM10	
	<b>Road safety</b> Electric trucks generate less noise than ICE trucks. Therefore, noise related health issues decrease when the truck fleet is electrified.	



# 3.1 Building renovations



ILLUSTRATIVE EXAMPLE



Category	Effect of lever on co-benefits	Scale of effect
Health	Air quality Air pollution decreases when energy consumption decreases	
	Well-being More energy efficient buildings are often better isolated, which could lead to less temperature fluctuations and a better living environment	
Economic growth	Employment Increased renovations has a positive effect on employment in construction sector	
	Time savings Property value increases when buildings are renovated to become more energy efficient	

1. European Parliament "Boosting Building Renovation: What potential and value for Europe?"



# 3.2 New energy efficient buildings



ILLUSTRATIVE EXAMPLE

**Legend**

- Limited +/- effect
- Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	Air quality Air pollution decreases when energy consumption decreases	
	Well-being More energy efficient buildings are often better isolated, which could lead to less temperature fluctuations and a better living environment	
Economic growth	Property value Property value increases for more energy efficient buildings.	





# 3.3 Efficient lighting & appliances



ILLUSTRATIVE EXAMPLE

**Legend**

- Limited +/- effect
- Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	<p><b>Air quality</b></p> <p>Air pollution decreases when energy consumption decreases</p>	
Economic growth	<p><b>Property value</b></p> <p>Property value increases for more energy efficient buildings.</p>	



# 3.4 Decarbonising heating



ILLUSTRATIVE EXAMPLE

**Legend**

- Limited +/- effect
- Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	<b>Air quality</b> Decarbonised heating sources decrease the emissions of air pollutants such as NOx, PM 2.5 and PM10	
Economic growth	<b>Employment</b> Some additional employment for installation of heat pumps and construction of renewable district heating	
	<b>Property value</b> Increases value of buildings given lower running costs and more pleasant environment	








# 4.1 Decarbonising electricity



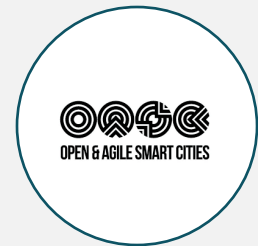
ILLUSTRATIVE EXAMPLE

**Legend**

 Limited +/- effect  
 Significantly +/- effect

Category	Effect of lever on co-benefits	Scale of effect
Health	<b>Air quality</b> Decarbonised electricity decreases the emissions of air pollutants such as NOx, PM 2.5 and PM10	
Economic growth	<b>Employment</b> Installation of rooftop PVs and construction of energy community utility solar and wind could create full-time job-years	
	<b>Property value</b> Increases value of buildings given installation of rooftop PVs	





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