MATERIAL ECONOMICS

The Economic Case for Decarbonisation in Skopje

17th of November, 2020

Climate-KIC

Climate-KIC is supported by the EIT, a body of the European Union

DISCLAIMER

This is a top down analysis based on data collected from many research papers, Skopje municipality, and various local partners as well as multiple global experts. Therefore, although the underlying figures and assumptions in this document have been taking from reputable sources and tested with various stakeholders in Skopje, they should still be considered preliminary and subject to change

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The Thriving Communities Mission and overall goals

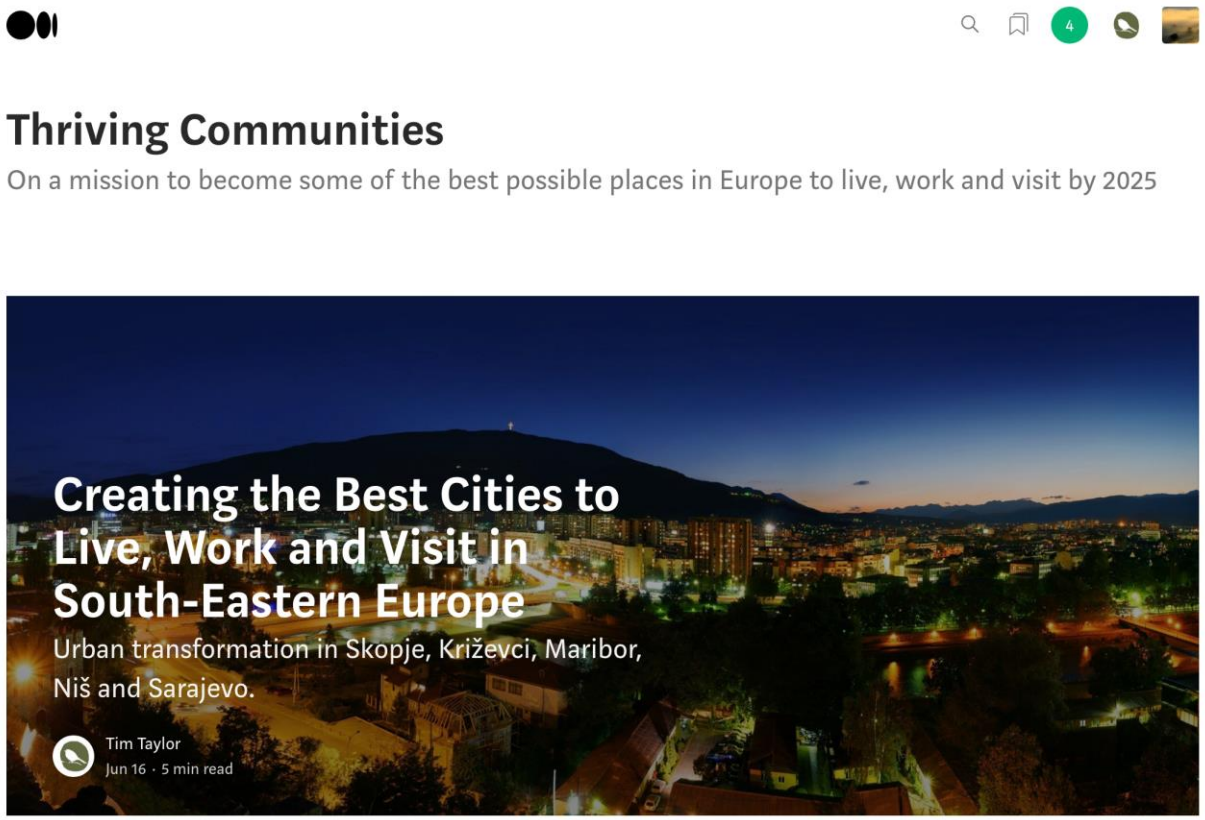
The collective Mission

"To make these cities into some of the best possible places in Europe to live, work and visit by 2025"

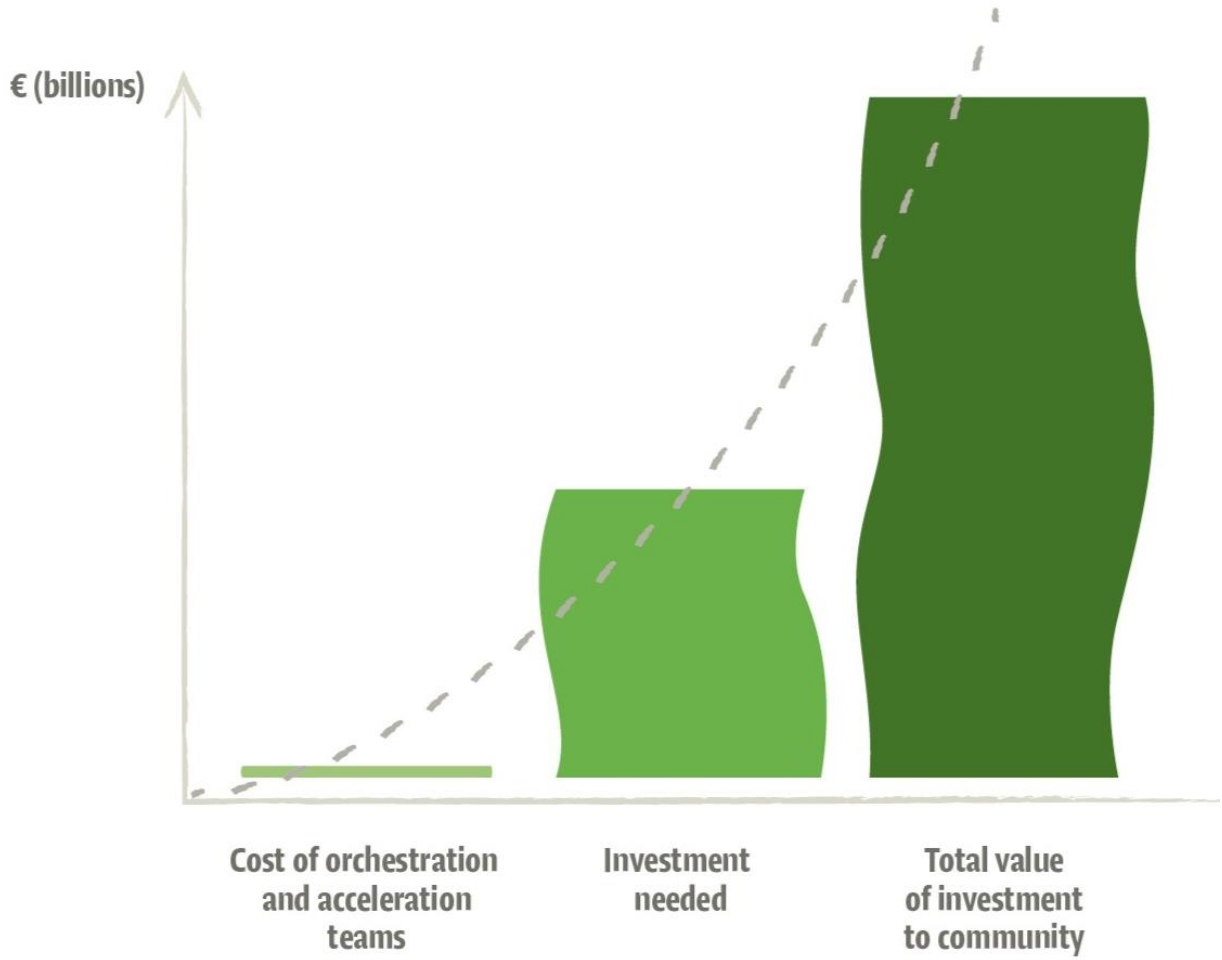
The four radical goals

1. Bring air quality in our cities to within World Health Organization recommended limits by 2023.
2. Achieve circular and net-zero greenhouse gas emission economies by 2030.
3. Ensure that by 2025 all members of our community have equitable access to the fundamentals of wellbeing: decent housing, healthcare, education, mobility, food, water, green and vibrant public spaces, security and productive work opportunities.
4. Reduce year on year the impacts of heat and flooding on our communities.

Tim Taylor - Why are we doing this?



https://medium.com/thriving-communities-of-south-eastern-europe



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Objectives for today's session

- To develop an understanding of the Economic Case and the value it can bring to the city
- To understand the Case results for Skopje and what they mean for the city's plans going forward
- To discuss policy implications and next steps for the city in its environmental transition

Introduction - Material Economics

Who we are:

- A strategy consultancy focused on the economic and strategic implications from climate change.
- Working with the public and private sector across Energy and electricity, Energy-intensive industry, Finance and Banking, Transport, Real-estate and Construction, Agriculture

Our previous work with cities:

- Deep experience around the challenges cities face from air quality issues and climate change – and the economic implications from addressing these emissions, from an economic, technology and policy perspective
- Climate-KIC Deep Demonstrations Pilot for Malmö, Milano, Madrid, Amsterdam, Copenhagen, Orléans, Leuven, Krakow, Vienna and Edinburgh

Material Economics Team

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The Economic Case approach

Purpose of the Economic Case analysis

1. Enable efficient, city-specific quantification of the economic case for a decarbonization transition
2. Build a rationale and support strategy development for ambitious climate action

Approach

1. Work together with a city partner to collect data and discuss inputs and outcomes (For Skopje, we have worked with SmartUp Social Innovation Lab and MANU)
2. Quantification of baseline emissions from key sectors until 2030
3. Analysis of emission reduction potential from 10-15 decarbonisation measures, aligned with city's current climate ambitions and targets
4. Quantification of economic case for each measure, including indirect benefits and employment effects
5. Comparison of different scenarios for decarbonization to show the economic and environmental outcomes at stake

Outcomes

1. Create rationale for change by quantifying costs and economic benefits of climate related initiatives
2. Compare the economics and effects of different measures
3. Test impact of increased ambition levels
4. Visualize & quantify the wide range of indirect benefits from climate action
5. Enabling a data-driven way of working with strategic decision-making
6. Recommendations on prioritised areas of action for the city going forward
7. Support the dialogue on climate initiatives

We have built an analysis tool that uses city data to detail the economic case for climate initiatives going forward

Inputs

City baseline data
(e.g. population, building stock, transportation system etc.)

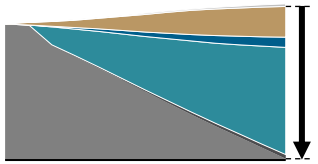
City development
going forward, incl. estimated population growth etc.

Targets and ambitions
for city climate initiatives

General assumptions
regarding technology and cost development

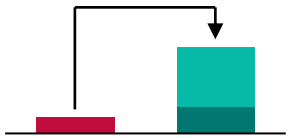
Decarbonisation potential of identified measures

- Estimated total abatement potential of each measure quantified until 2030
- Measures targeting main emission sources, i.e. transportation, buildings, heating, electricity and waste



Total economic case for decarbonisation & individual measures

- Upfront investments, direct savings and indirect benefits of realising each measure quantified until 2050 for the city



Recommendations and prioritisation of measures going forward

- Measures evaluated using the quantified economic case and decarbonisation potential
- Barriers to realisation and suggestions for how to overcome such barriers identified

For Skopje, we have analysed the economic case of different abatement measures in four sectors

Abatement measures investigated

Transportation

- Reduced passenger transportation need
- Increased car pooling
- Shift to public & non-motorised transport
- Electrification of passenger cars
- Electrification of buses
- Reduced & optimised logistics
- Electrification of freight transport

Buildings and heating

- New buildings highly energy efficient
- Building envelope renovations
- Efficient lighting & appliances
- Replace wood burning and fossil fuels in local heating
- Expand district heating network
- Replace fossil fuels in district heating

Electricity

- Rooftop solar installations
- Utility scale solar and wind generation
- *Also includes enabling investments in storage and grid infrastructure*

Waste

- Increased rate of waste collection
- Increased rate of waste sorting and recycling
- Increased rate of centralised incineration with energy recovery

In addition, we have also analysed the impact on scope 3 emissions by shift to low-CO_2 building materials, reducing food waste and a shift to low-CO_2 diets

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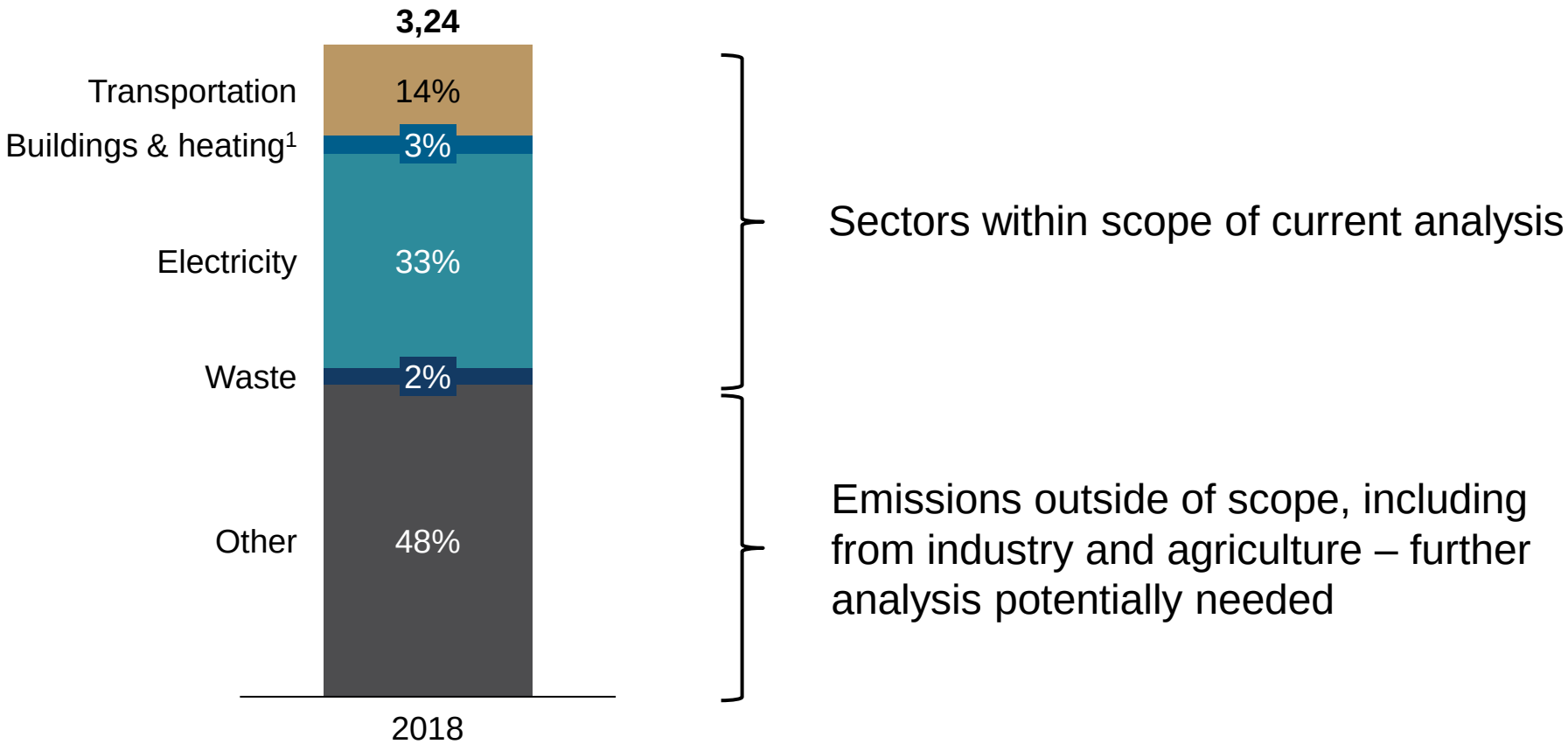
Scope of the analysis

Carbon emissions in Skopje
Mton CO_2 per year, 2018

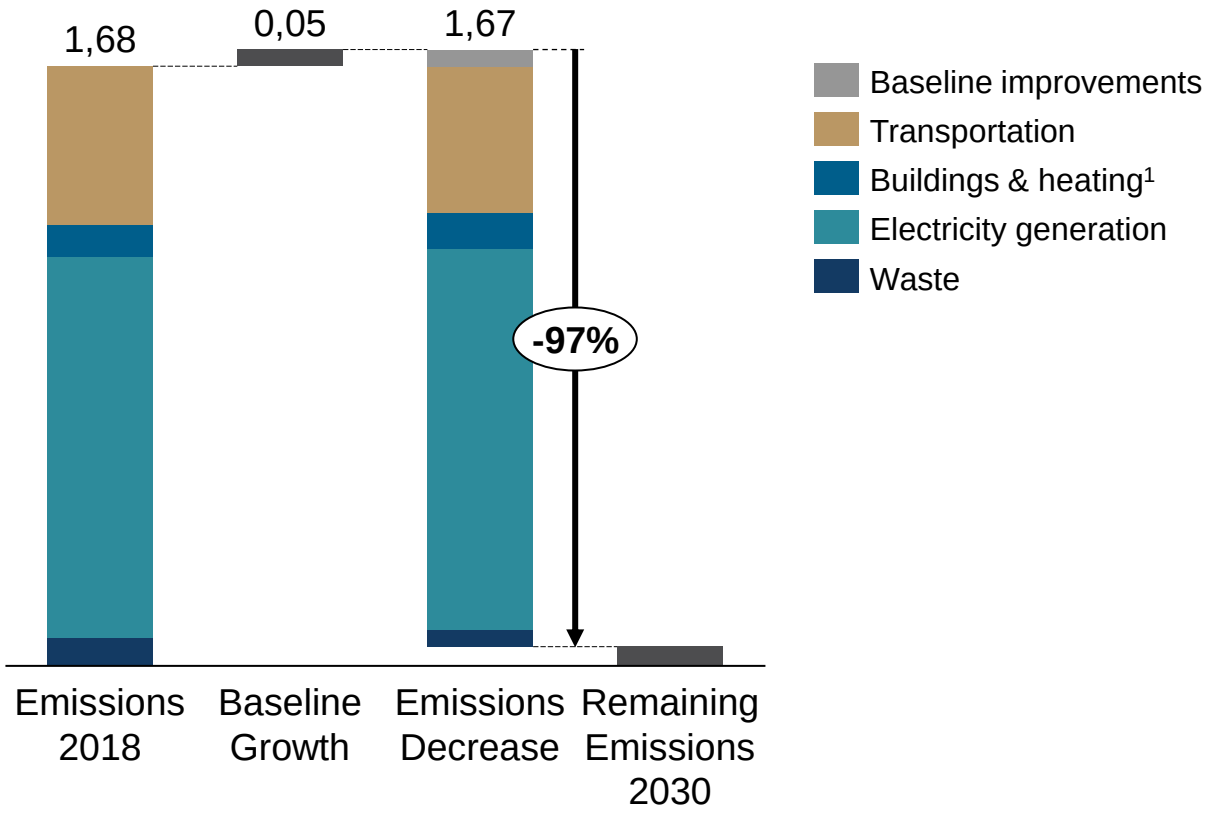


1. Emissions from electricity used for heating are accounted for under the “electricity” sector

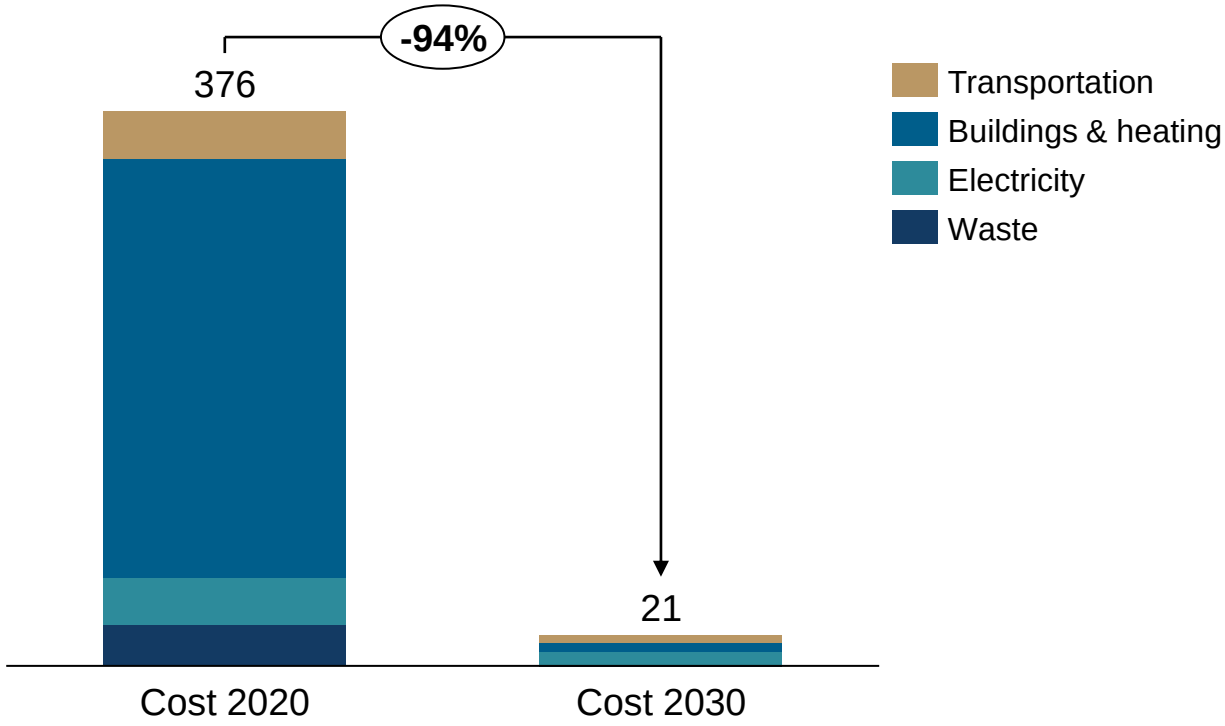
Source: Material Economics analysis

In the "Net-zero Skopje" scenario, nearly all of the city's emissions of CO_2 and air pollutants in scope of the study are removed until 2030

CO_2 abatement for Skopje total emissions in scope
Mton CO_2 per year



Health impact of air pollution[2] generated in Skopje
M€ per year, impact of NOx and PM

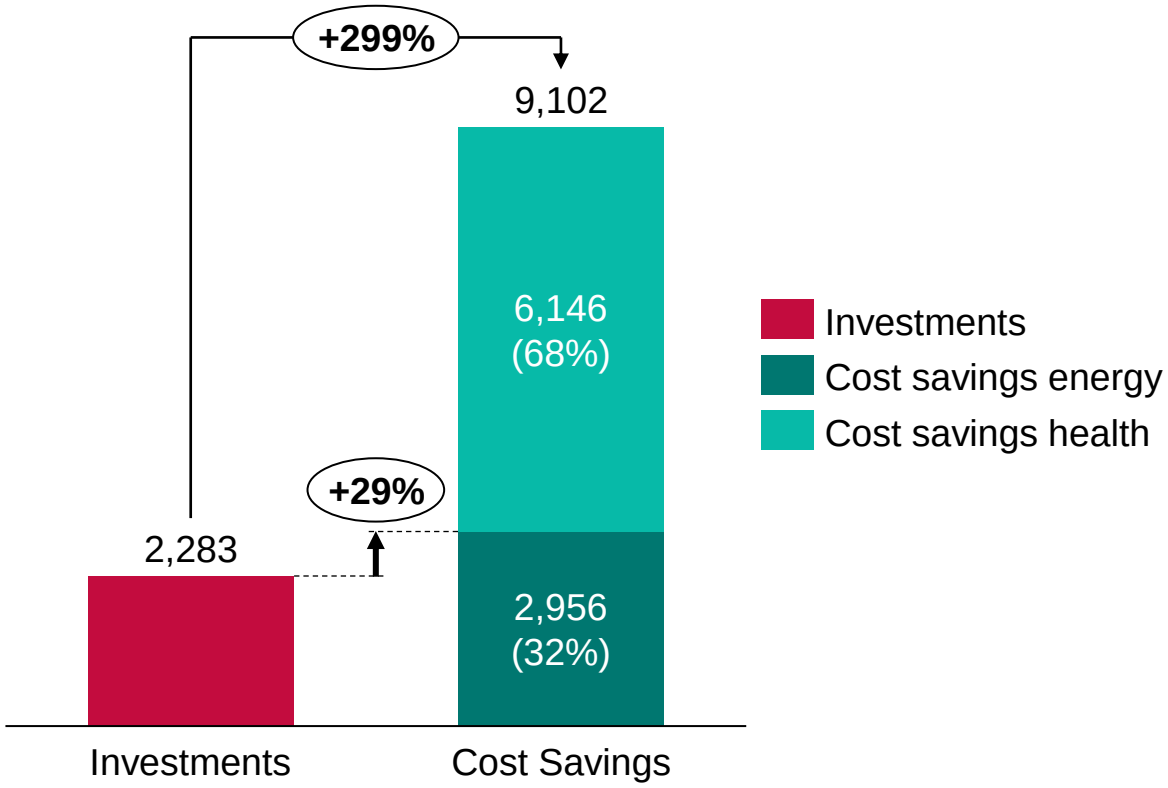


1. Emissions from electricity used for heating are accounted for under the "electricity" sector
2. Includes air pollution from road transport (incl. wear & tear), heat generation, electricity production and waste handling in or related to the city. Does not include effects of air pollutants entering the city from external sources

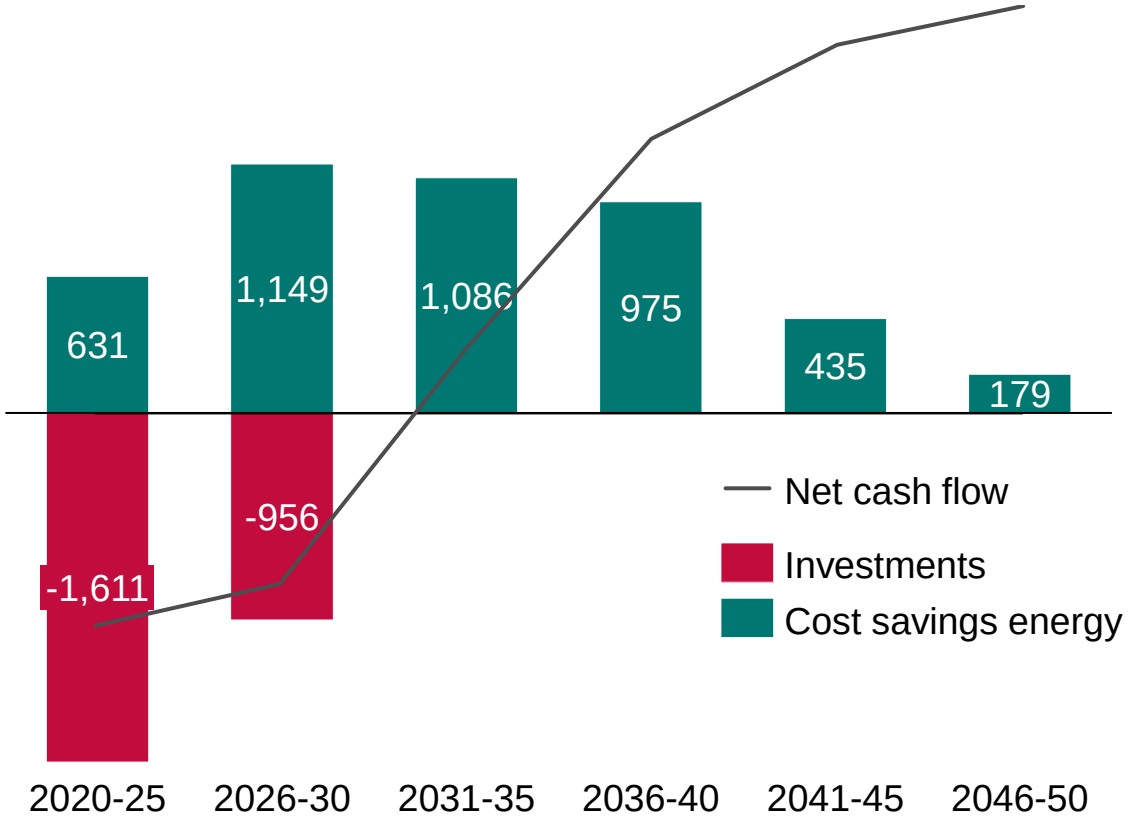
Source: Material Economics analysis

The economic case for the transition breaks even with only direct cost savings, and is highly positive when also considering health benefits (1/2)

Total economic case for all measures,
M€, NPV investments (2020-2030) and benefits (2020-2050)



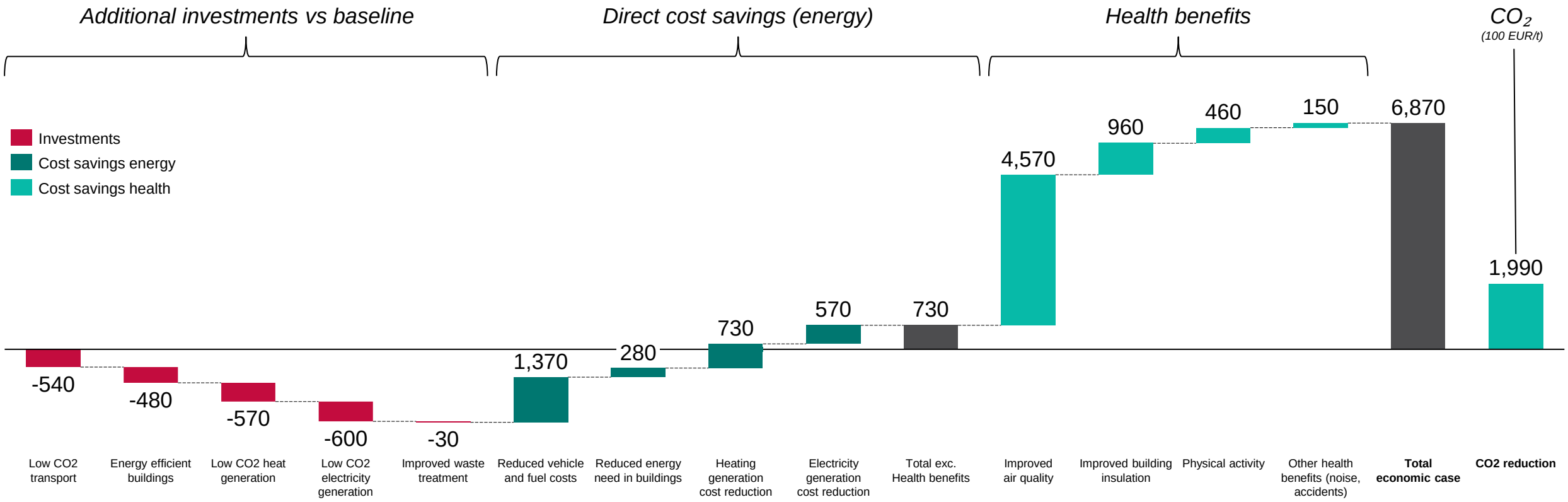
Cash-flow analysis
M€, Absolute numbers, 2020-2050



Source: Material Economics analysis

The economic case for the transition breaks even with only direct cost savings, and is highly positive when also considering health benefits (2/2)

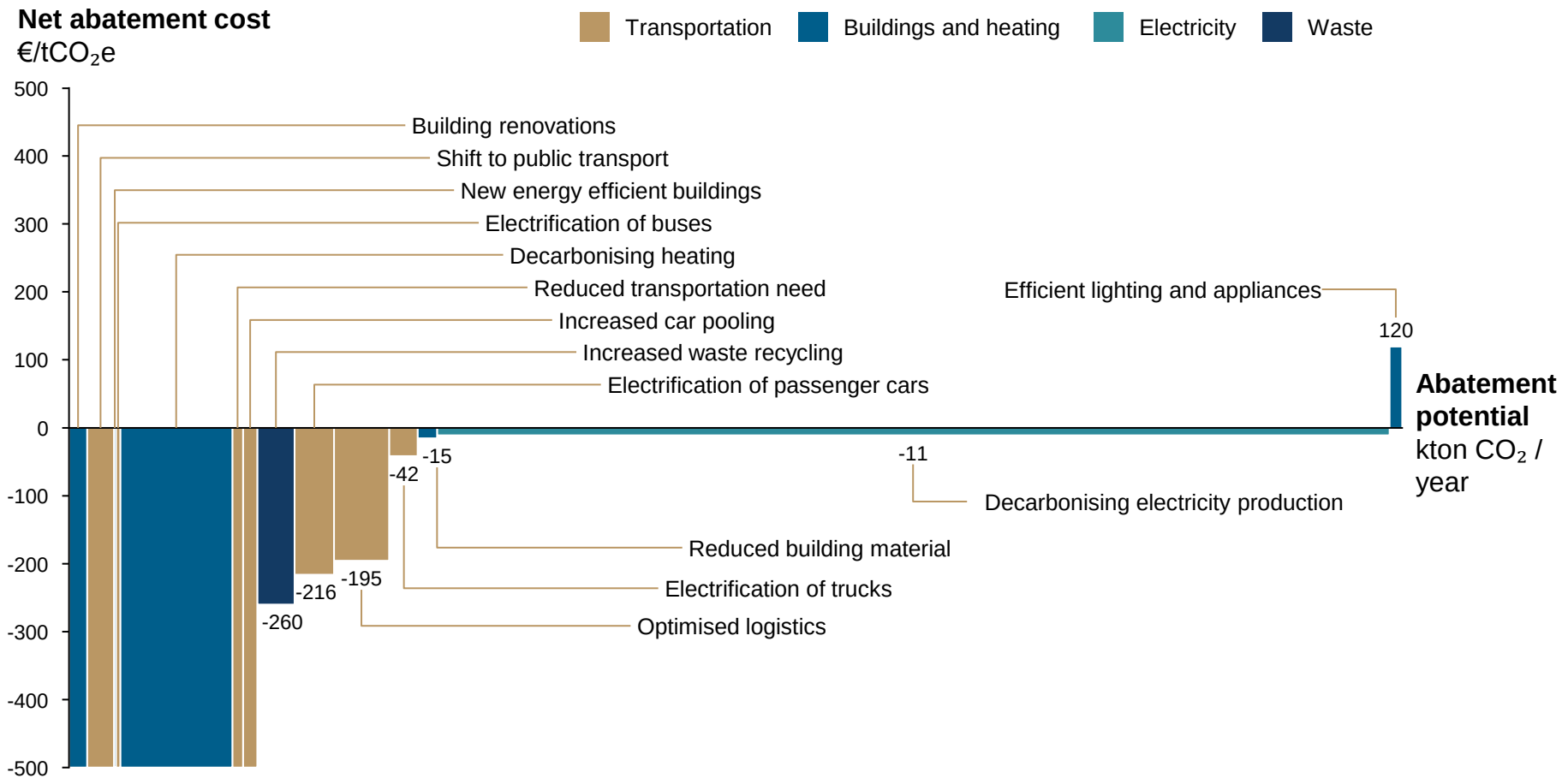
Total economic case for all measures (detailed),
M€, NPV investments (2020-2030) and benefits (2020-2050)



Source: Material Economics analysis

A large majority of the individual decarbonisation measures show positive individual economic cases

Skopje abatement cost curve
kton CO_2e emissions in 2030, abatement costs and benefits annualised based on investments in 2020-2030, and recurring costs/savings and co-benefits in 2020-2050

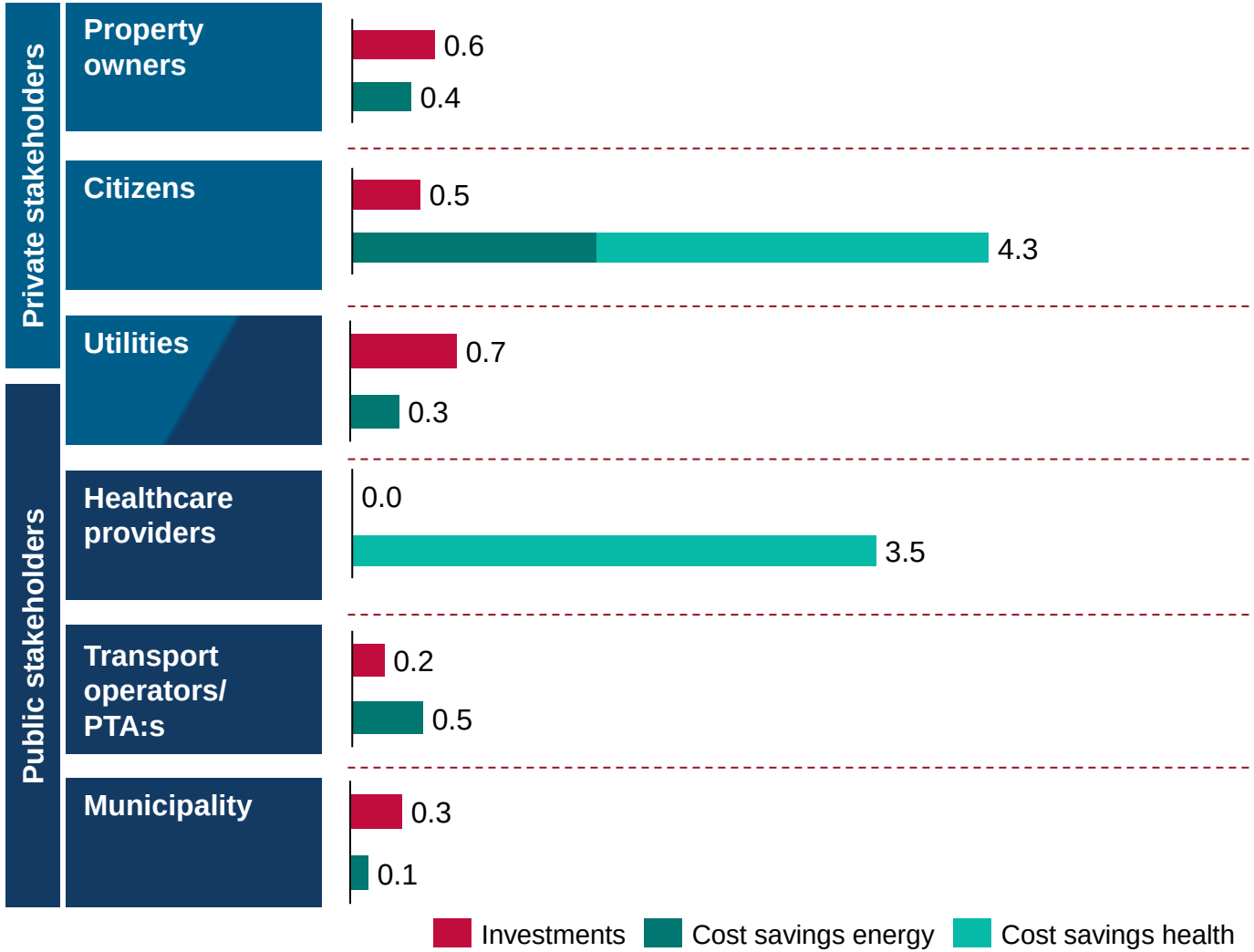


- The cost curve showcases the individual economic case per abated tonne of CO_2 for all measures, in combination with the total CO_2 abatement potential for each measure
- On the vertical axis, we can see that almost all measures have a negative cost per abated tonne, meaning that they are overall economically profitable for the community
- The graph shows how some actions have a strongly positive financial business case while others do not. Yet with a mission-led approach all of these things must be done. Investment in only the 'highly profitable' measures in isolation does nothing to support delivery of the 'less attractive' yet highly important measures such as the decarbonization of electricity production. This shows how strategic aggregation of investments is essential

Source: Material Economics analysis

Costs and benefits from the transition are not evenly distributed between stakeholder groups

Total economic case by stakeholder
B€, NPV investments (2020-2030) and benefits (2020-2050)



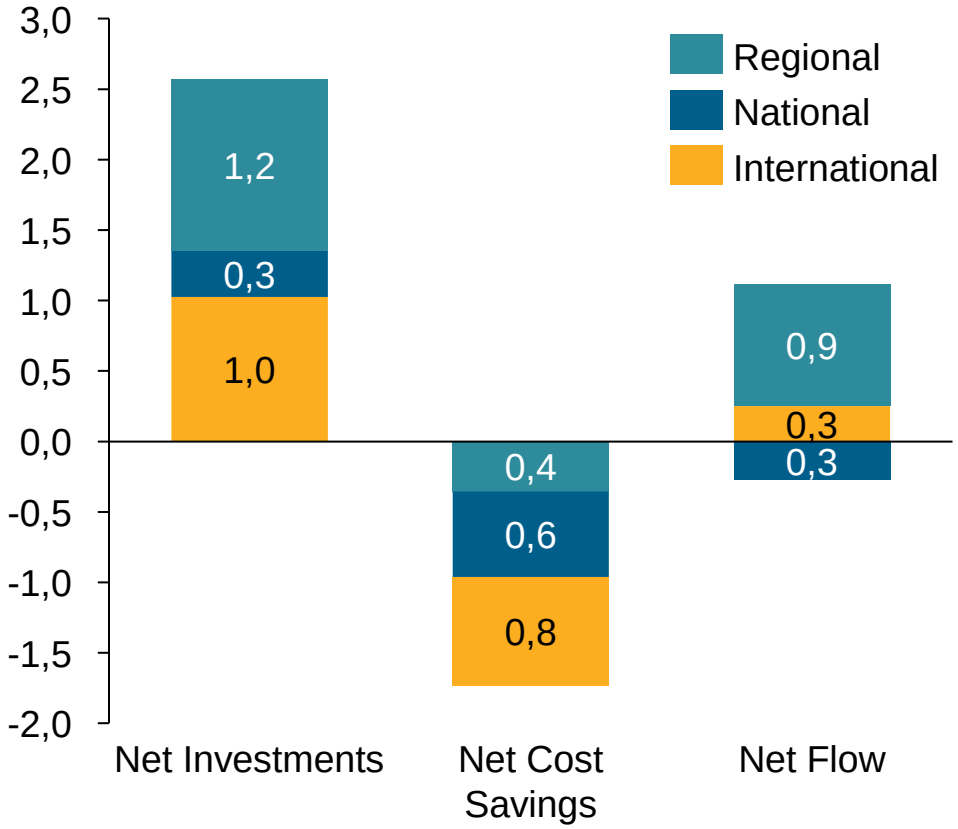
Comments

- Property owners are significant investors, but also yield some benefits from decarbonising local heating and electricity (e.g. through rooftop solar)
- Citizens receive benefits from the investments they make, investments in infrastructure made by property owners & the city, as well as health benefits from better air quality and increased walking/cycling
- Utilities in Skopje will need to pay for investments in the city's energy systems, but also receive the benefits of lower operational costs from renewable energy sources
- Healthcare providers receive indirect benefits from a healthier population without requiring any specific investments other than in renovations of their own properties
- Transport operators reduce costs through optimised logistics and reduced transportation need, but must invest in/maintain new vehicles and an expanded public transport system
- Municipalities typically cover costs for expanding transport infrastructure, lower land costs for developers building energy efficiently, and retrofits of publicly owned buildings

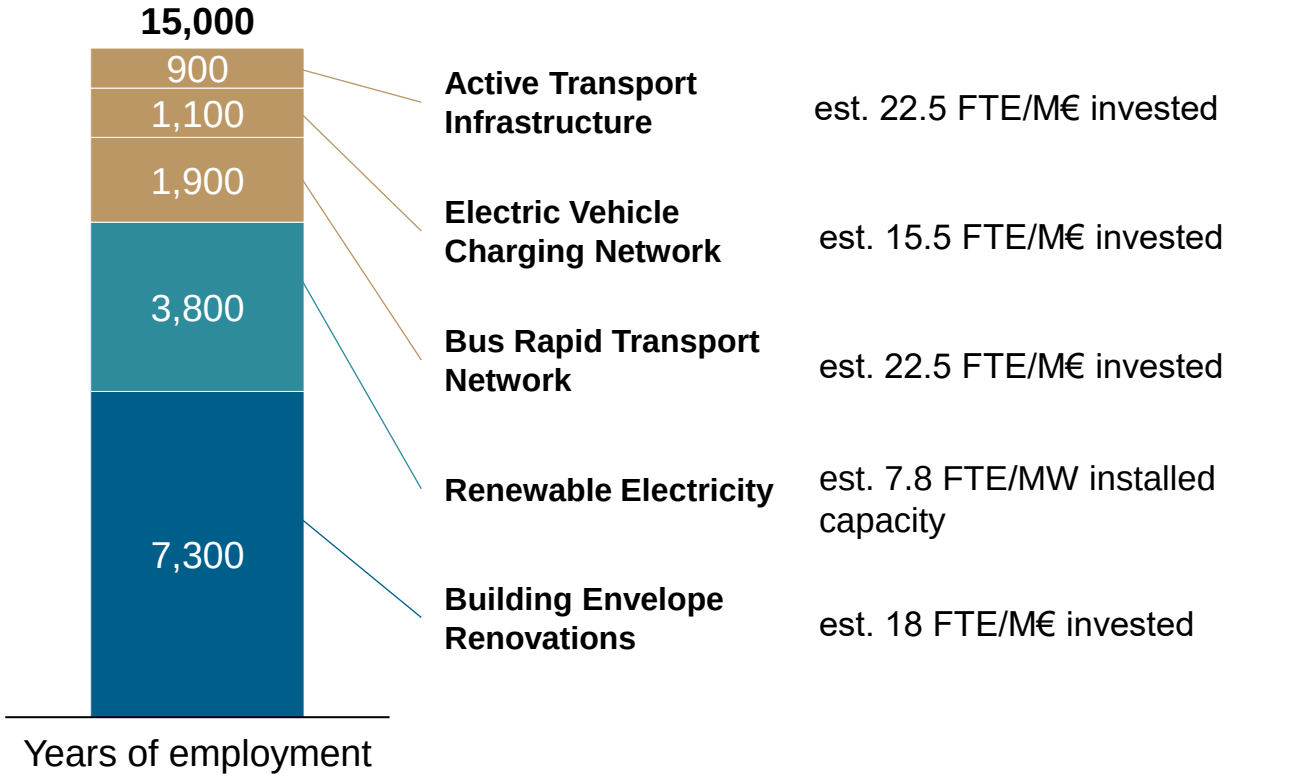
Source: Material Economics analysis

The transition results in a net flow of almost 1B€ to the region, and has the potential to create approximately 15,000 job-years over the ten year period

Net monetary flows resulting from decarbonization investments
B€, undiscounted, 2020-2030



Estimated job creation potential[1]
Years of employment created 2020-2030



1. Includes estimated job creation from energy efficiency retrofits and solar PV installation & maintenance, does NOT include any potential lost jobs in e.g. fossil generation

Sources: European Parliament (2016) - Boosting Building Renovation: What Potential and value for Europe?, Dvorak, et. al. (2017) - Renewable energy investment and job creation; a cross-sectoral assessment for the Czech Republic with reference to EU benchmarks, Cuchi & Sweatman (2011) - A national perspective on Spain's buildings sector a roadmap for a new housing sector, Material Economics modelling. McKinsey (2020) - How a post-pandemic stimulus can both create jobs and help the climate.

Our recommended top five measures for Skopje to implement in the short term

Transportation sector

1. **Shift from car-based transport to public transport and walking/cycling**
   - Very cost-effective with high health benefits, especially when switching to active mobility (walking/cycling), however requires behavioural change along with some investments in transport infrastructure
2. **Electrify passenger cars**
   - Good potential to abate emissions of CO_2 and air pollutants by 2030 – increasing further with a decarbonized electricity grid
   - Requires innovative methods for financing of initial vehicle purchase, however pays off over car lifetime given low electricity prices

Buildings and heating

1. **Large-scale building envelope renovation program across Skopje**
   - Improved insulation reduces heating need and improves health and quality of life for citizens
   - Positive economics when considering massive health benefits – requires innovative financing solutions to monetize health cost savings
2. **Decarbonize Skopje's heating systems**
   - Expanding the district heating system and switching remaining households to modern heating systems would create billions of euros of health benefits from reducing the air pollution generated by current heating practices
   - Largest barrier is financing the required capital investments to e.g. expand the district heating network, and replace existing residential heating systems and practices, e.g. wood burning in local stoves

Electricity

1. **Decarbonize Skopje's electricity production**
   - Key measure to enable the transition of transportation and heating sectors
   - Huge abatement potential – abating up to 1,180 kton CO_2 per year by 2030
   - Break-even investment when only considering direct savings, and produces large health improvements for citizens
   - Likely additional investments required in electricity grid capacity to enable e.g. heat pumps and electrification of transportation – need for further investigations to assess needs and feasibility

The continued work going forward

- This analysis is a good initial step towards defining a clear and ambitious vision for Skopje going forward, but further work is required
- This work will be continued by the Skopje Yes Team, MANU and the other Thriving Communities Design Partners, pending continued funding currently being investigated
- The Economic Case model and tool will be handed over to MANU – reach out to them for further questions on the modelling or results
- For other questions, contact the SmartUp Social Innovation Lab coordinator

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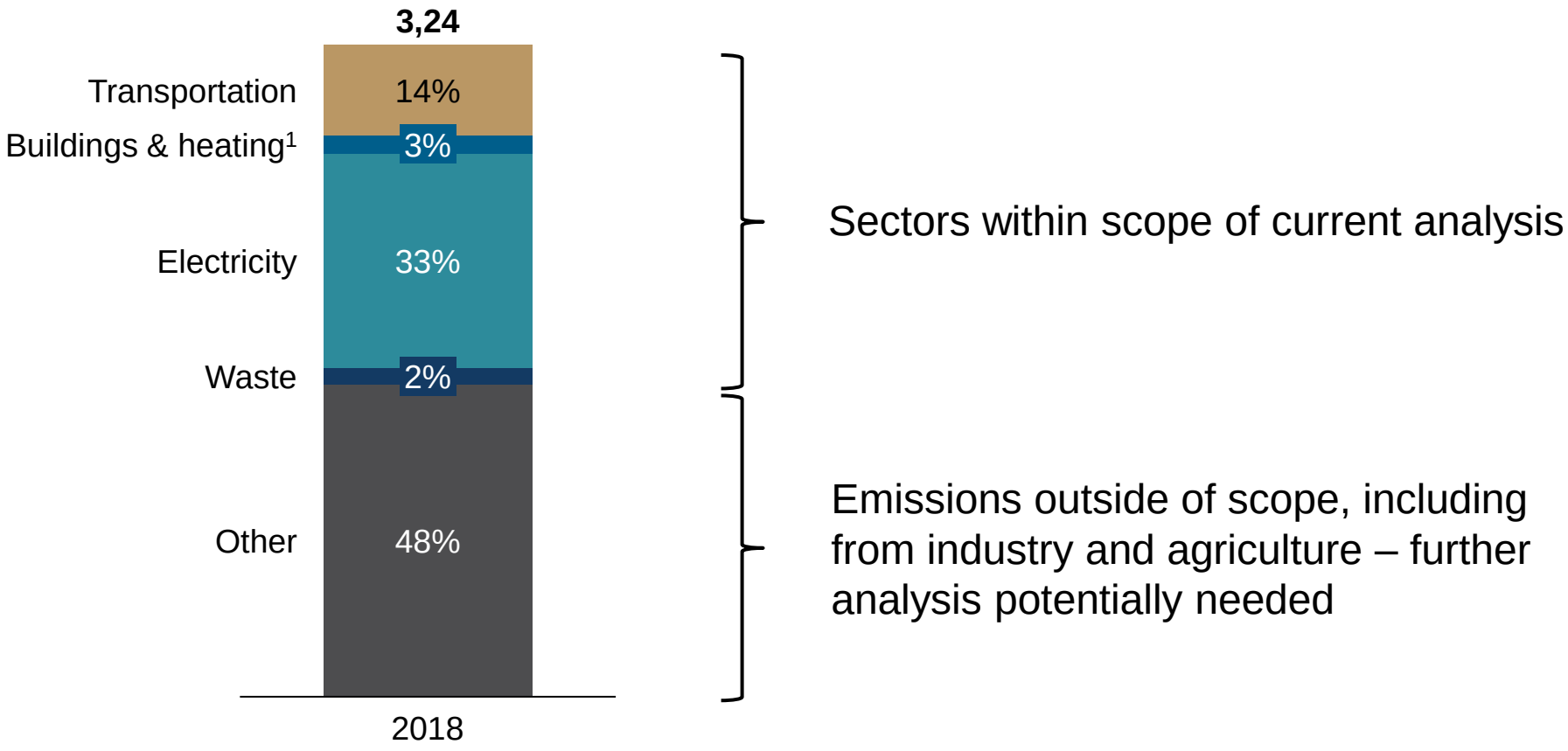
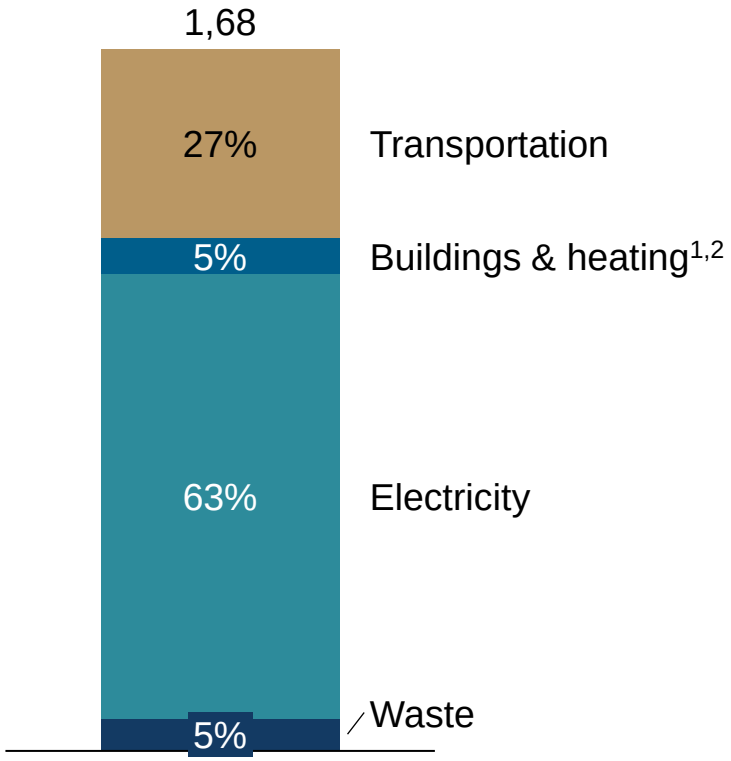
Mton CO_2 per year, 2018



1. Emissions from electricity used for heating are accounted for under the “electricity” sector
Source: Material Economics analysis

The current energy and transport systems in Skopje are associated with large emissions and have negative health impacts for citizens

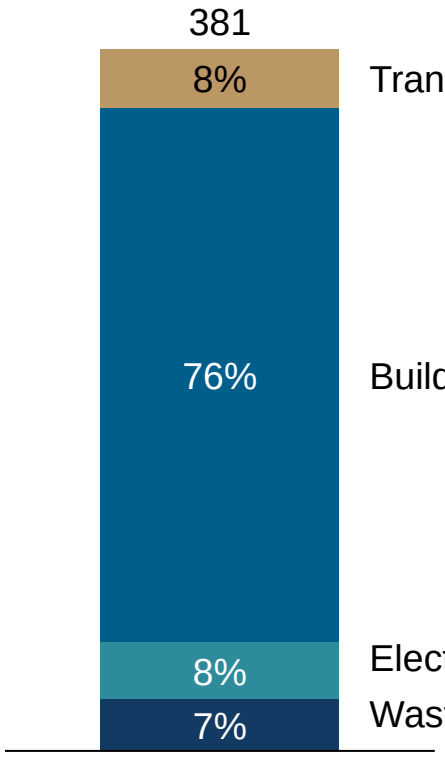
Carbon emissions in Skopje
Mton CO_2 per year, 2018



Large emissions associated with city electricity consumption, as well as current transportation systems

Current heating practices not highly carbon intensive given high use of wood incineration, though the "carbon neutrality" of this practice can be questioned[2]

Health costs from air pollution[3] generated in Skopje
M€ per year, impact of NOx and PM, 2018



Majority of air pollutants come from the incineration of wood for local heating – shifting to cleaner heating practices has a massive potential impact on citizen health of approximately ~290M€ per year, or ~600 € per citizen per year

Emissions generated in other sectors have not been analysed, but will need to be tackled

1. Emissions from electricity used for heating are accounted for under the "electricity" sector
2. Wood incineration generates an additional 230kton (14%) of emissions of biogenic CO_2
3. Includes air pollution from road transport (incl. wear & tear), heat generation, electricity production and waste handling in or related to the city. Does not include effects of air pollutants entering the city from external sources
4. 96% of costs for heating-generated emissions come from current wood incineration practices

Source: Material Economics analysis

We have compared two different scenarios for the future of Skopje

"Current targets"

- Scenario based on targets and ambitions defined in Skopje today
- For measures with no defined targets, assumptions are based on work with previously analysed cities similar to Skopje

"Net-zero Skopje"

- Scenario based on the level of changes required to reach zero carbon emissions for Skopje by 2030
- Represents one (but not the only) possible pathway for reducing city-related emissions to zero by 2030
- Heavy focus on electrification of transport and heating systems along with rapid expansion of renewable electricity generation

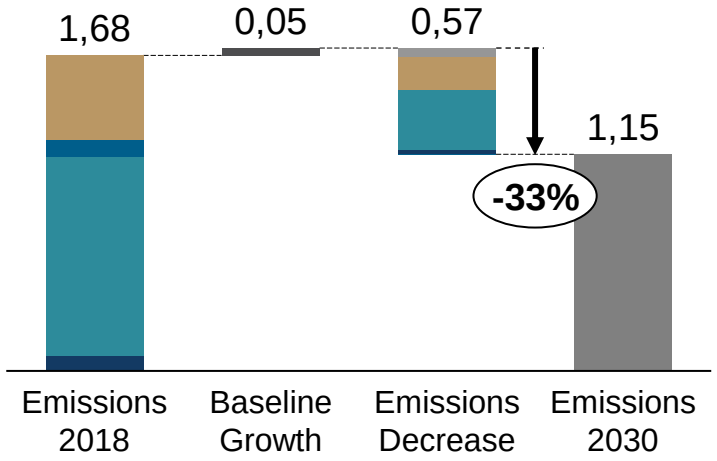
We have compared two different scenarios for the future of Skopje

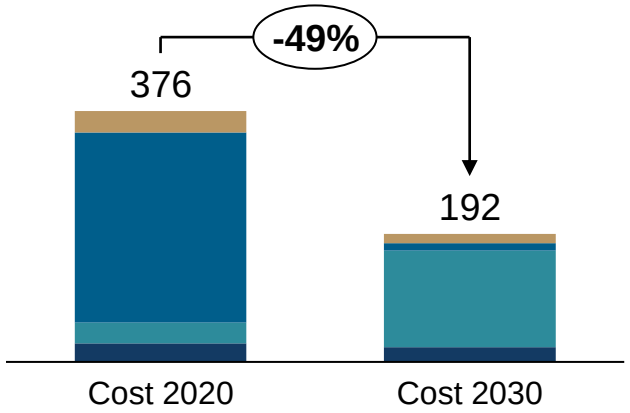
Scenario

CO_2 abatement for Skopje total emissions in scope[1]
Mton CO_2 per year

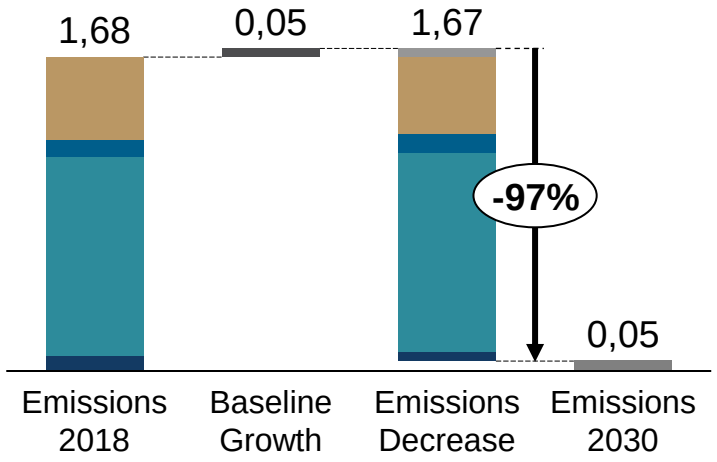
Health impact of air pollution[2] generated in Skopje
M€ per year, impact of NOx and PM

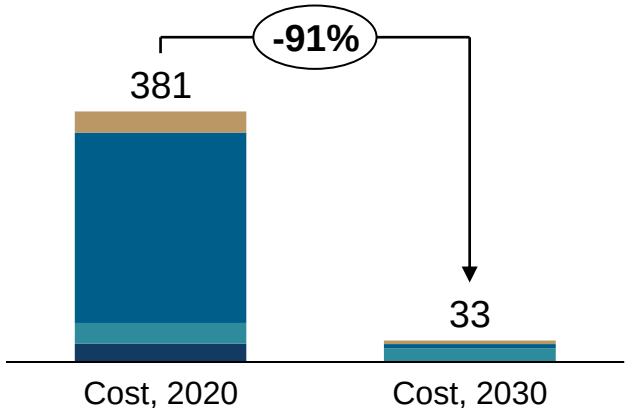
"Current targets"

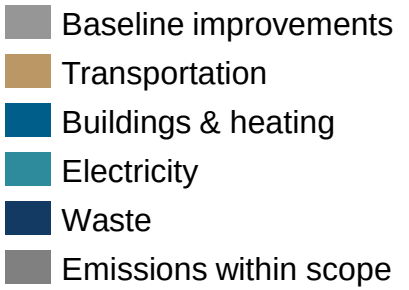




"Net-zero Skopje"







1. Transport, buildings and heating, electricity generation and waste. Remaining emissions mainly from industrial and agricultural sectors
2. Includes air pollution from road transport (incl. wear & tear), heat generation, electricity production and waste handling in or related to the city. Does not include effects of air pollutants entering the city from external sources.

Source: Material Economics analysis

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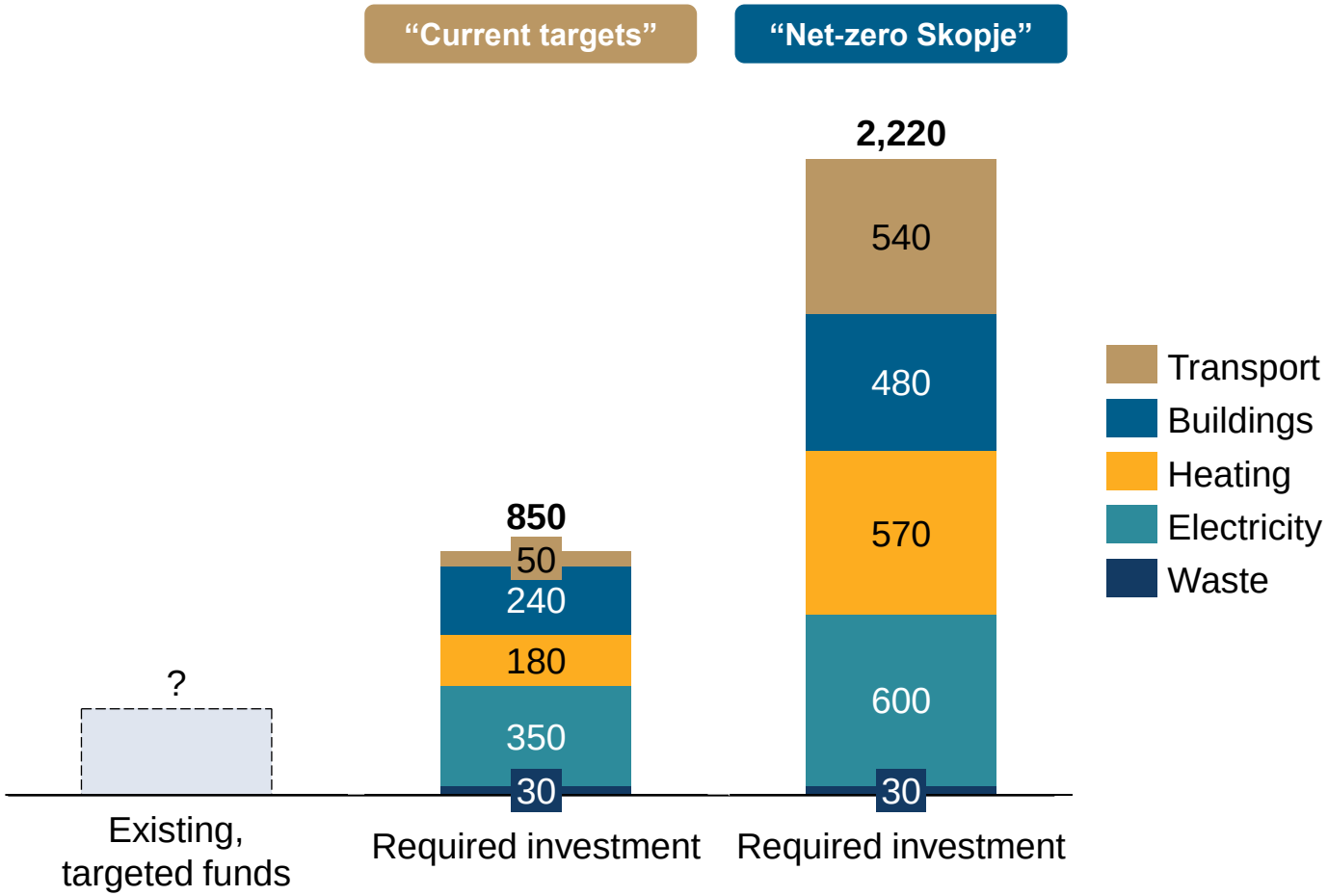
Large investments needed to reach current goals, and even more so for total decarbonization

Investments needed for decarbonizing Skopje, different ambition levels
M€ total investments, rounded numbers, NPV 2020-2030

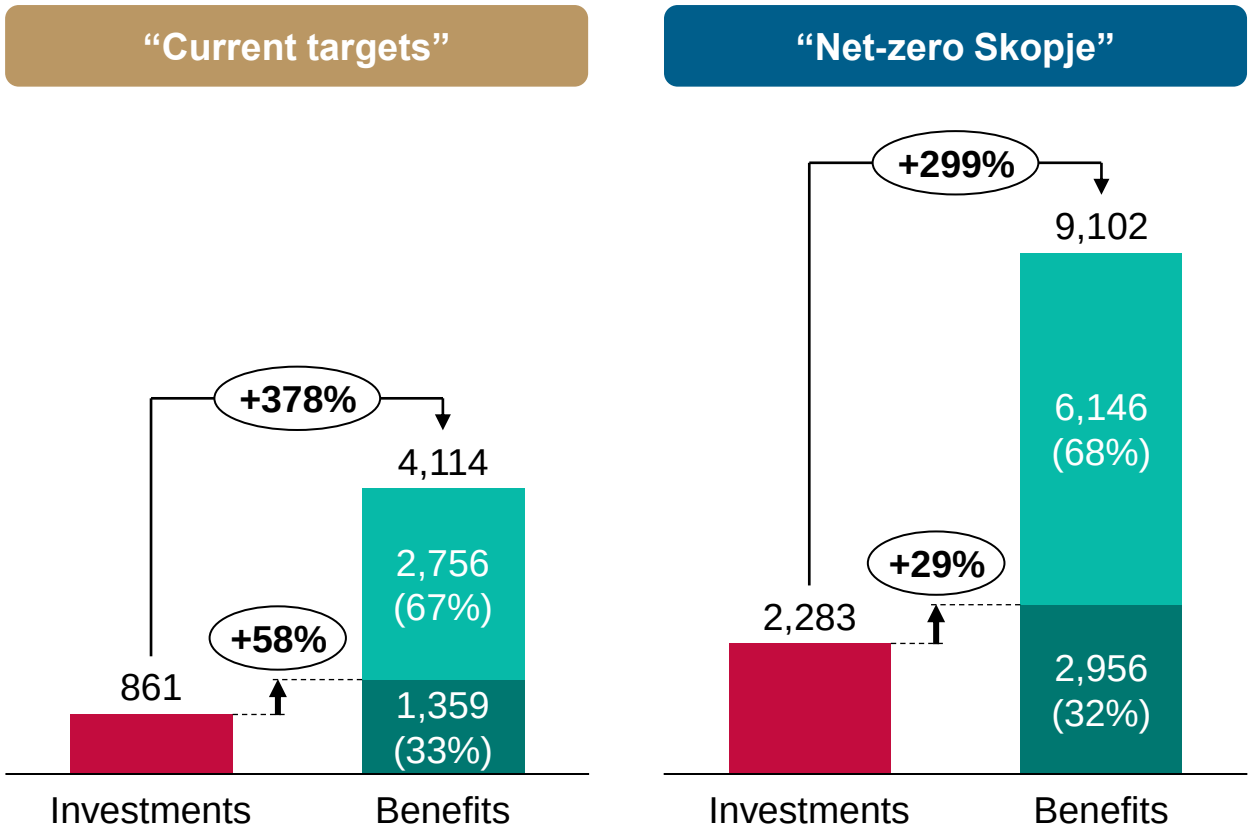


- Massive new investments beyond existing targeted sources will be needed to achieve the full potential of decarbonization in Skopje
- The majority of this money will not come from the municipality itself but from other stakeholders and investors, including citizens and companies within the city itself as well as state and union funding - The municipality mainly takes an enabler role in driving and directing these investments
- Identifying and securing new and innovative financing solutions, together with e.g. Bankers without Boundaries, will thus be crucial in successfully driving the sustainable transition for Skopje

Source: Material Economics analysis

However, investments pay off in massive cost reductions and health improvements for citizens

Total economic case for all measures, per scenario
M€, NPV investments (2020-2030) and benefits (2020-2050)

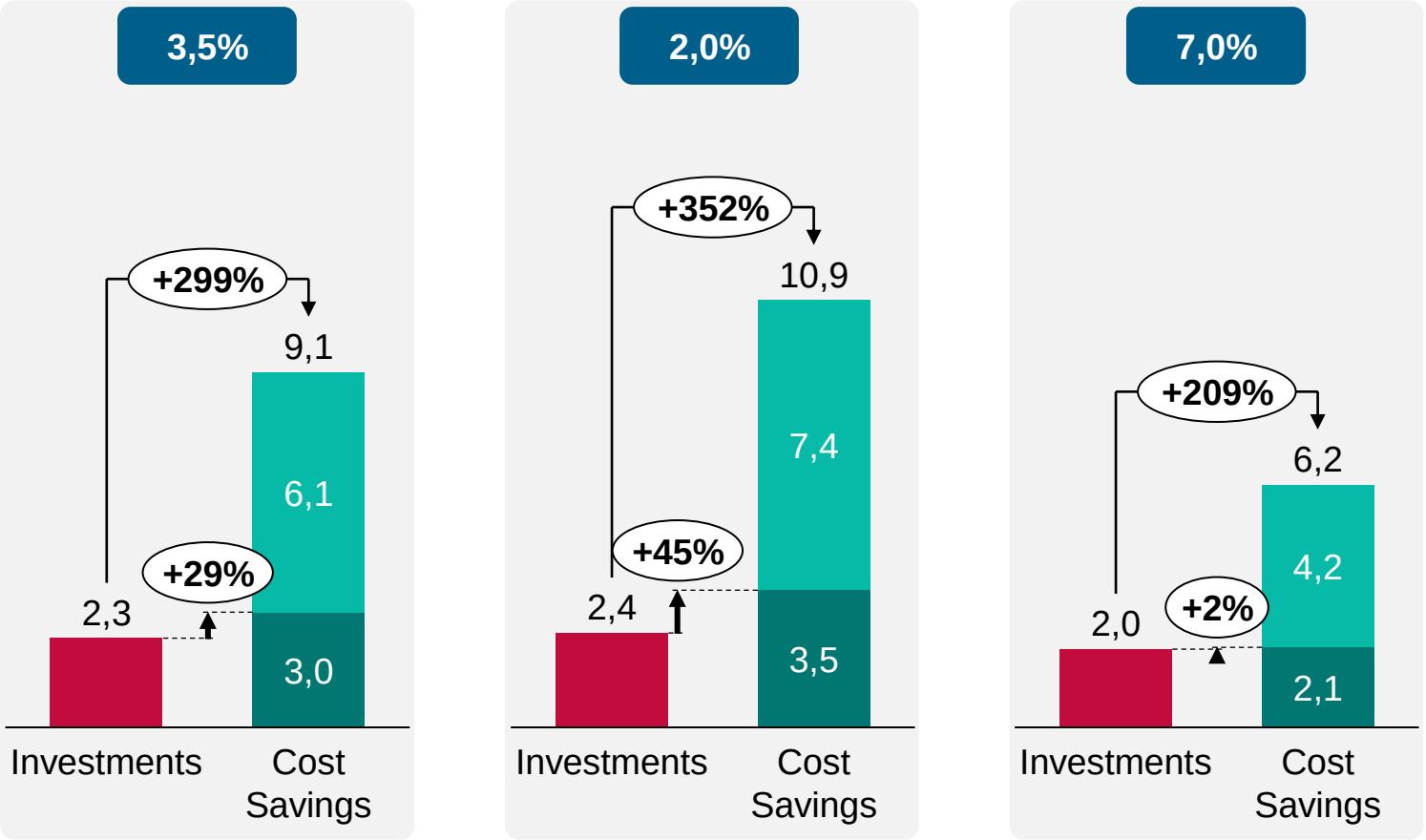


- In both scenarios, the total programme has a positive return on investment even without considering indirect benefits in health improvements, and so constitutes a rational investment decision purely on economical grounds.
- When health impacts are included, the returns reach levels several times higher then initial investments – these benefits are very real in the long-term, however can be more difficult to monetize to finance investments than direct cost savings.
- Each measure may or may not have a positive economic case on an individual basis, meaning bundling measures together into a larger programme is important to make sure everything gets done (i.e. avoiding "cherry-picking" only the most profitable investments)

1. Transport, buildings and heating, electricity generation and waste.
Source: Material Economics analysis

Backup – ROI is robust against changes in discounting rate

Total economic case for all measures, net-zero scenario, for different discounting rates
B€, NPV investments (2020-2030) and benefits (2020-2050)

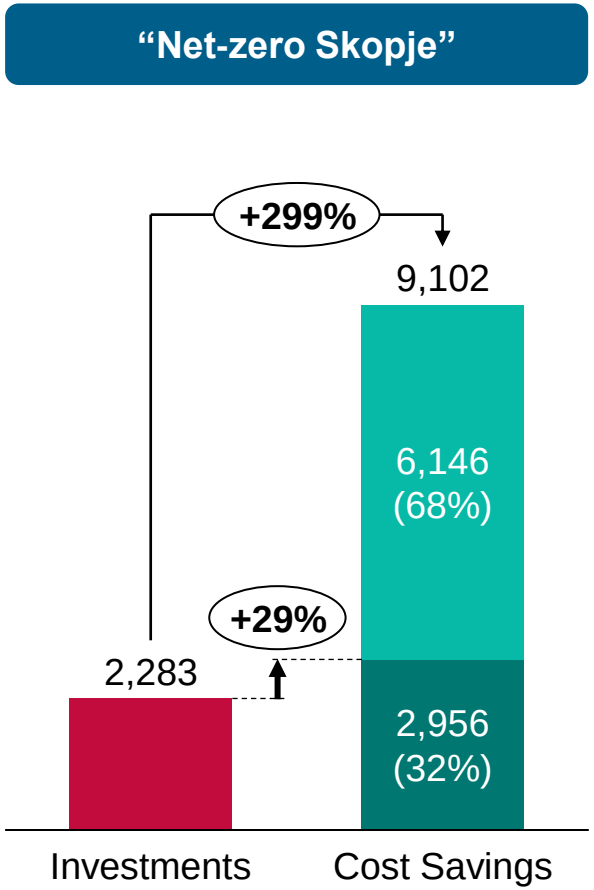


- Choice of discounting rate has a large impact on total programme ROI
- However, the programme breaks even with only direct cost savings even with very high discounting rates, and total ROI when including health benefits is consistently very high

Source: Material Economics analysis

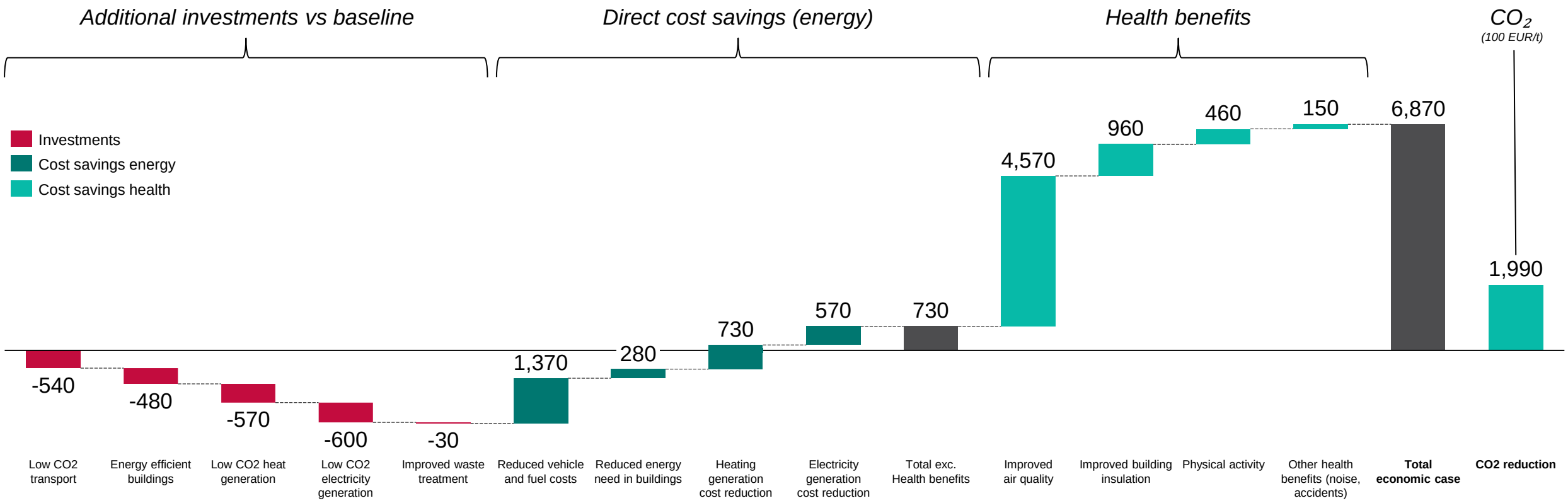
The “Net-zero Skopje” scenario will be the focus for the rest of this presentation

- We will now focus on the “Net-zero Skopje” scenario for the rest of this presentation



The economic case for the transition breaks even with only direct cost savings, and is highly positive when also considering health benefits

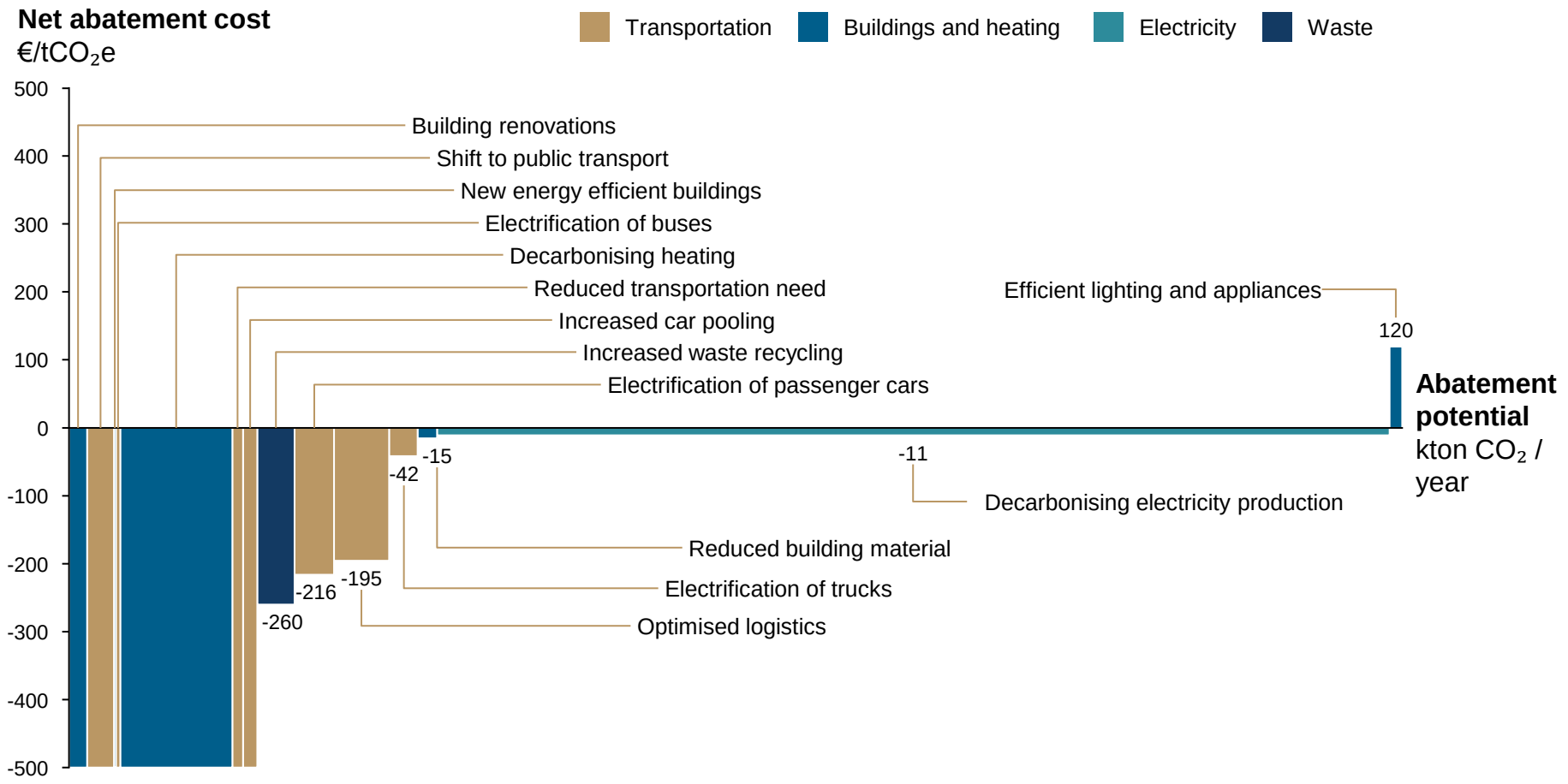
Total economic case for all measures (detailed),
M€, NPV investments (2020-2030) and benefits (2020-2050)



Source: Material Economics analysis

A large majority of the individual decarbonisation measures show positive individual economic cases

Skopje abatement cost curve
kton CO_2e emissions in 2030, abatement costs and benefits annualised based on investments in 2020-2030, and recurring costs/savings and co-benefits in 2020-2050

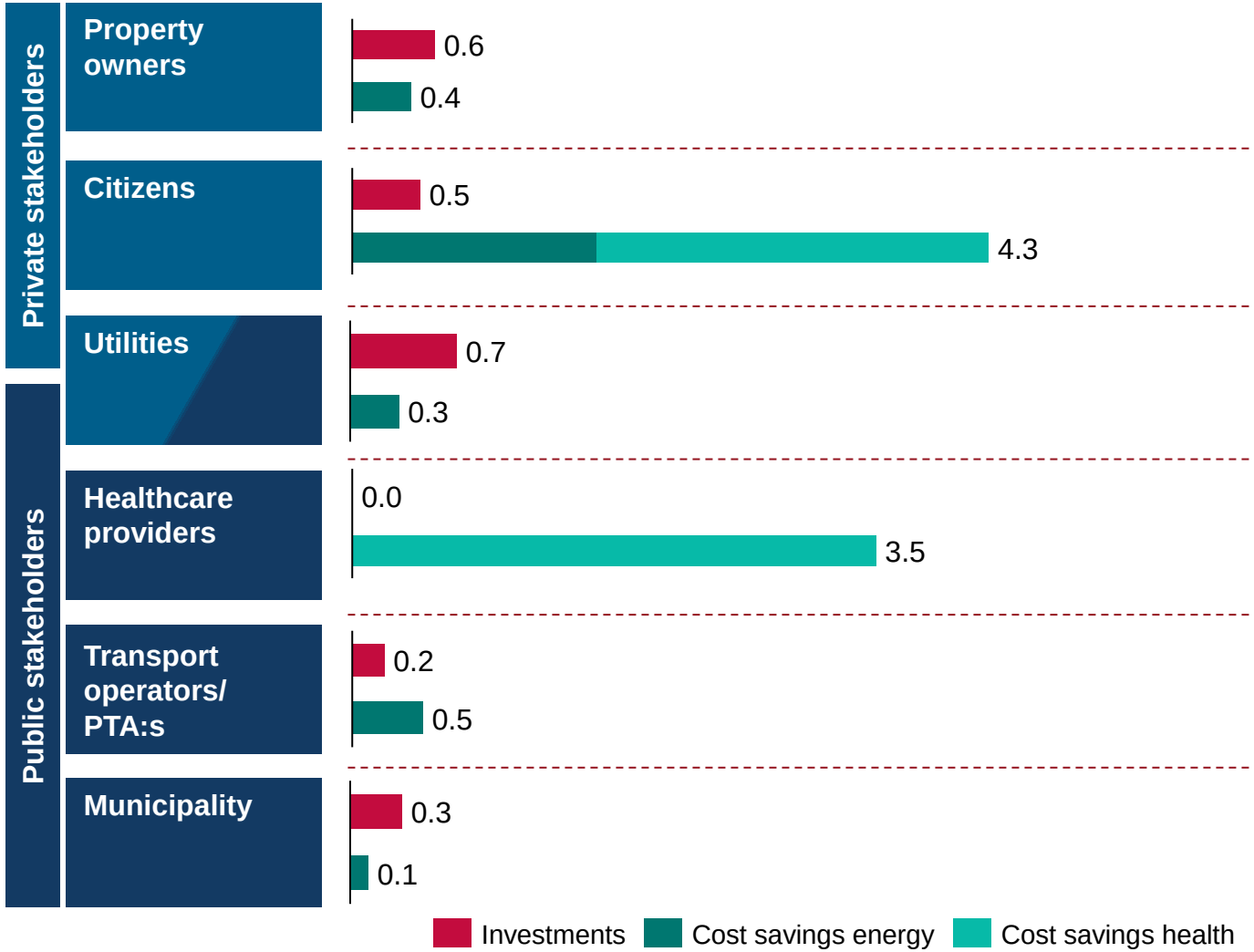


- The cost curve showcases the individual economic case per abated tonne of CO_2 for all measures, in combination with the total CO_2 abatement potential for each measure
- On the vertical axis, we can see that almost all measures have a negative cost per abated tonne, meaning that they are overall economically profitable for the community
- The graph shows how some actions have a strongly positive financial business case while others do not. Yet with a mission-led approach all of these things must be done. Investment in only the 'highly profitable' measures in isolation does nothing to support delivery of the 'less attractive' yet highly important measures such as the decarbonization of electricity production. This shows how strategic aggregation of investments is essential

Source: Material Economics analysis

Costs and benefits from the transition are not evenly distributed between stakeholder groups

Total economic case by stakeholder
B€, NPV investments (2020-2030) and benefits (2020-2050)



Comments

- Property owners are significant investors, but also yield some benefits from decarbonising local heating and electricity (e.g. through rooftop solar)
- Citizens receive benefits from the investments they make, investments in infrastructure made by property owners & the city, as well as health benefits from better air quality and increased walking/cycling
- Utilities in Skopje will need to pay for investments in the city's energy systems, but also receive the benefits of lower operational costs from renewable energy sources
- Healthcare providers receive indirect benefits from a healthier population without requiring any specific investments other than in renovations of their own properties
- Transport operators reduce costs through optimised logistics and reduced transportation need, but must invest in/maintain new vehicles and an expanded public transport system
- Municipalities typically cover costs for expanding transport infrastructure, lower land costs for developers building energy efficiently, and retrofits of publicly owned buildings

Source: Material Economics analysis

There are three main ways for decarbonization investments to create economic stimulus effects

1

Creation of local jobs

~15,000 jobs created

Investments and economic activities that utilize resources which would otherwise have been unused

2

Net cost savings

Total cost savings of ~1,8B€ by 2030

Stakeholders with higher net disposable income spend part of that money on regional products and services

3

Increased regional spending

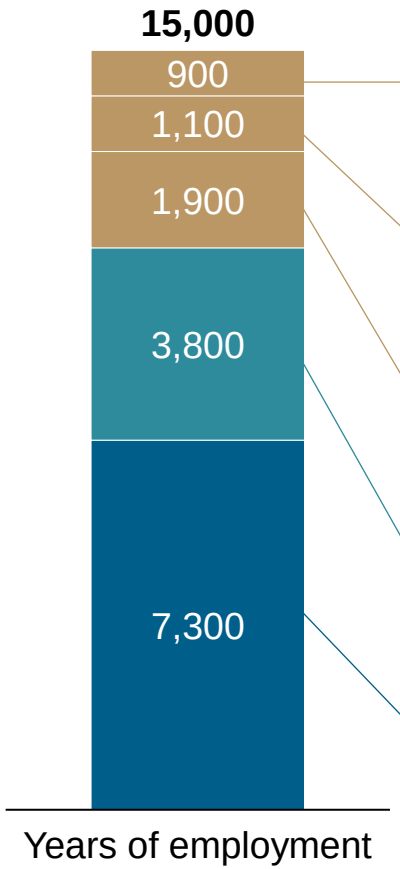
Net flow of close to 1B€ to the regional economy by 2030

Transitioning to a system where a higher share of total spending flows to the regional economy rather than out of the country (e.g. solar panel installation rather than oil purchasing)

An ambitious decarbonisation programme could potentially generate 15,000 jobs in and around the city until 2030

1 Creation of local jobs

Estimated job creation potential[1]
Years of employment created 2020-2030



		Example jobs descriptions and characteristics
Active Transport Infrastructure	est. 22.5 FTE/M€ invested	Construction of bicycle lanes and walking pathways. Mobilization of regional construction worker force.
Electric Vehicle Charging Network	est. 15.5 FTE/M€ invested	Installation of electric vehicle charging stations. Requires specially trained electro technicians and coordination with charging equipment suppliers.
Bus Rapid Transport Network	est. 22.5 FTE/M€ spent	Optimize and expand public transport network (mainly buses).
Renewable Electricity	est. 7.8 FTE/MW installed capacity	Installation of wind turbines and rooftop/centralised solar. Requires a combination of local worker force training and coordination with external suppliers (e.g. solar panel producers).
Building Envelope Renovations	est. 18 FTE/M€ invested	Renovation of buildings to decrease heating energy consumption. Increased renovation projects enhances the resilience of the construction sector.

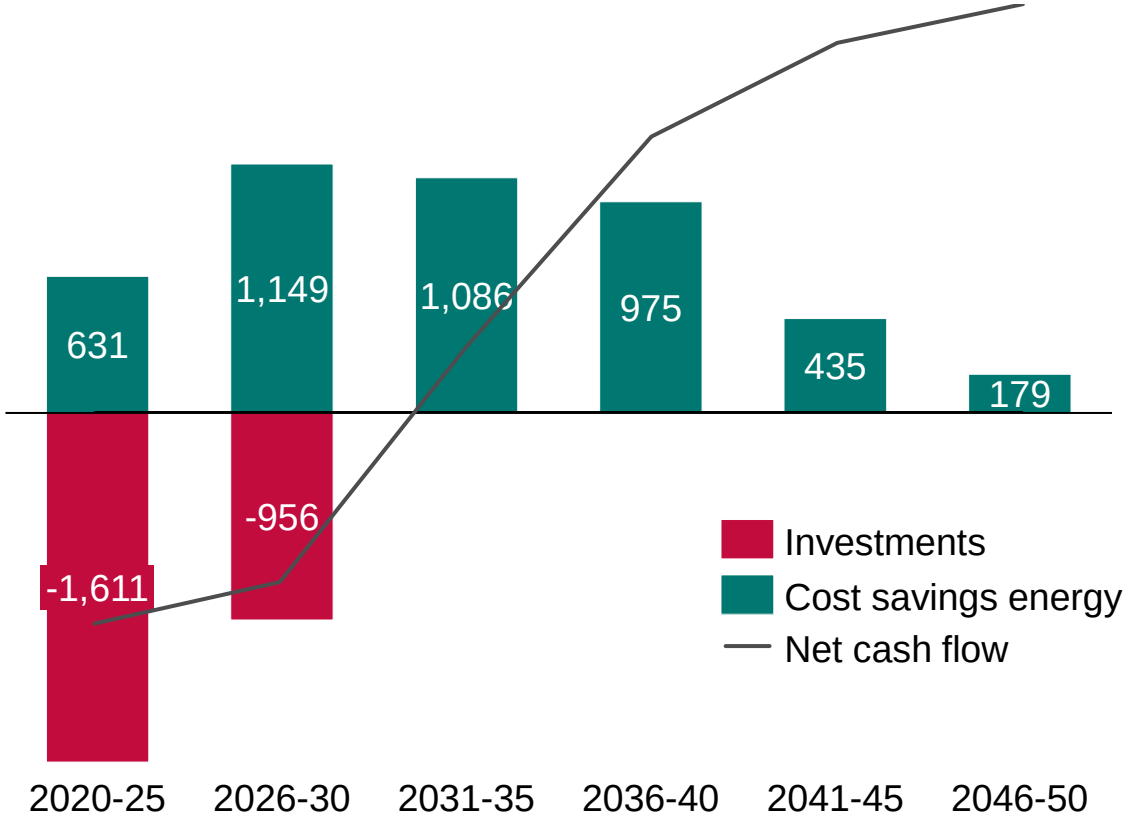
1. Includes estimated job creation from energy efficiency retrofits and solar PV installation & maintenance, does NOT include any potential lost jobs in e.g. fossil generation

Sources: European Parliament (2016) - Boosting Building Renovation: What Potential and value for Europe?, Dvorak, et. al. (2017) - Renewable energy investment and job creation; a cross-sectoral assessment for the Czech Republic with reference to EU benchmarks, Cuchi & Sweatman (2011) - A national perspective on Spain's buildings sector a roadmap for a new housing sector, Material Economics modelling. McKinsey (2020) - How a post-pandemic stimulus can both create jobs and help the climate.

Cash-flow for the total programme breaks even within 20 years, with measures in the transportation sector giving the highest short-term benefits

2 Net cost savings

Cash-flow analysis
M€, Absolute numbers, 2020-2050



Individual measures with positive ROI within first 5 years

Reduced passenger transportation need
Potential net cash flow until 2025: **+34M€**

Shift to public & non-motorized transport
Potential net cash flow until 2025: **+9M€**

Increased car pooling and sharing
Potential net cash flow until 2025: **+9M€**

Optimized freight logistics
Potential net cash flow until 2025: **+43M€**

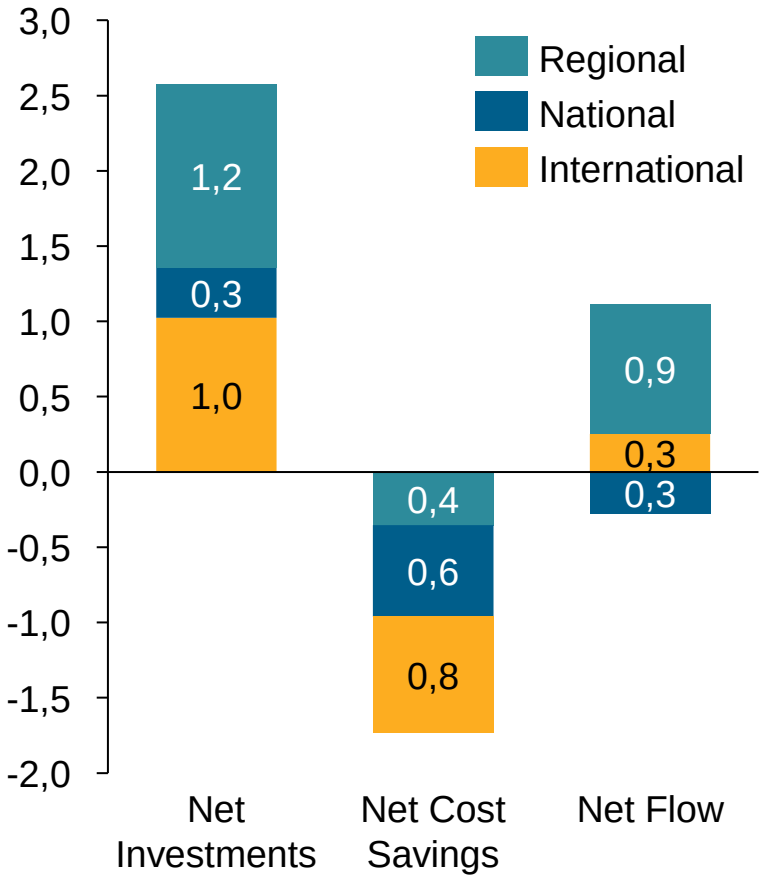
Measures within the transportation sector often rely more on behavioural change and optimization rather than large investments (with the exception of electrification) and thus exhibit large cost savings potential even in the short term

Source: Material Economics analysis

Skopje's sustainability transition means more funds stay within city limits, further stimulating the local economy within the next 10 years

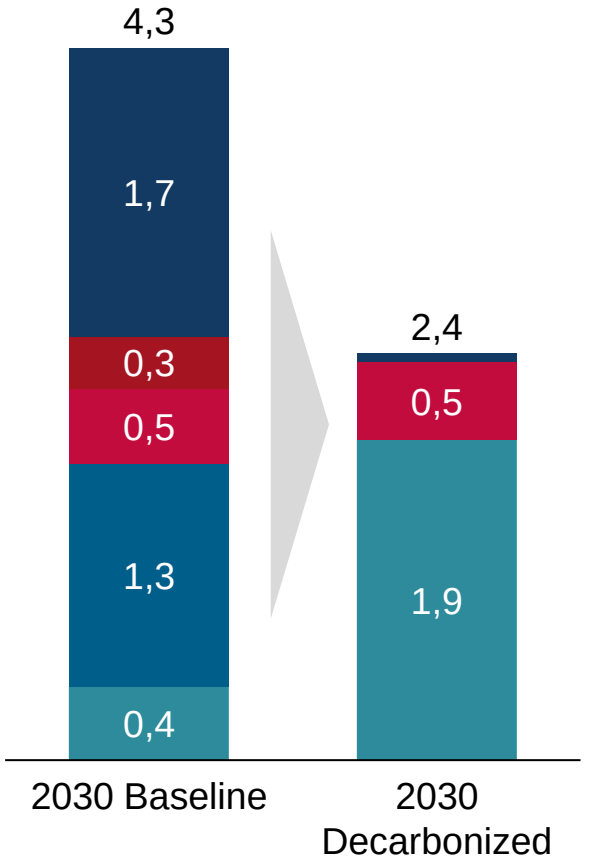
3 Increased regional spending

Net monetary flows resulting from decarbonization investments
B€, undiscounted, 2020-2030

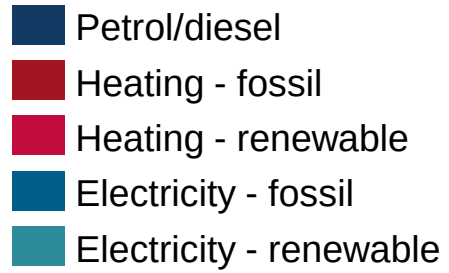


- A majority of investments for the transition fall to regional and national businesses and development
- Meanwhile, roughly 45% of net cost savings resulting from these investments would otherwise have been used to pay for imported goods and services
- On the net, this means almost a billion euros is retained within the regional economy.
- Even larger share of investment could be regional long-term if Skopje develops its industry in these areas (EVs, Solar PV etc.)

Shifting energy use in Skopje contributes to local spending
TWh total energy use for transport, heating, electricity, 2030



- The transition means shifting fossil fuels, which are often to a large extent (by value) imported, to electricity, generated nationally or even regionally



Source: Material Economics analysis

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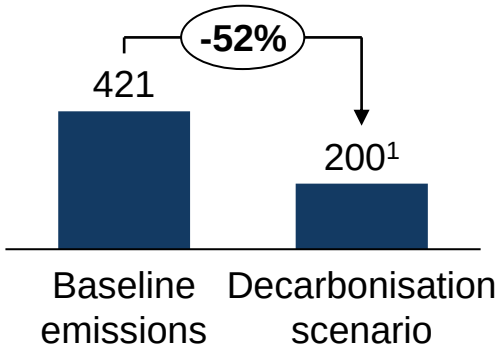
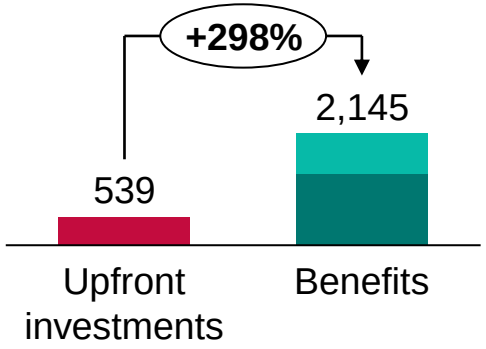
Skopje's transportation sector has great potential for costs savings combined with significant sustainability gains

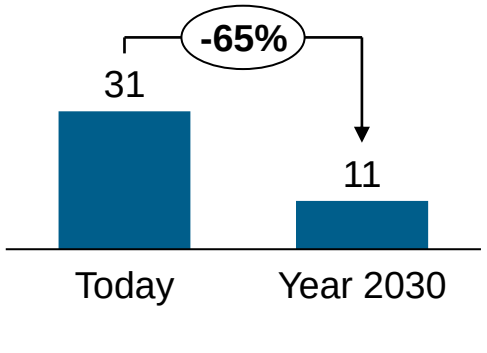
Abatement potential
kton CO_2e, 2030



Economic case
M€, NPV



Air pollution costs
M€ per year



Most promising measures within sector

1. Shifting to public transport and walking/cycling
   - Very cost-effective with high health benefits, especially when switching to active mobility (walking/cycling), however requires behavioural change along with some investments in transport infrastructure
2. Electrification of passenger cars
   - Good potential to abate emissions of CO_2 and air pollutants by 2030 – increasing further with a decarbonized electricity grid
   - Requires innovative methods of supporting the financing of initial vehicle purchase, however pays off quickly given low electricity prices

Key Actions:

- **Explore options to support financing of private electric vehicles**
- **Expand EV charging infrastructure**
  - Secure financing and plan roll-out
- **Expand alternative transport options**
  - Continue current plans to expand bus rapid-transit system and consider further public transport projects
  - Expand bicycle and walking paths throughout the city
- **Explore policy and other options to reduce car usage and encourage alternative transport use**

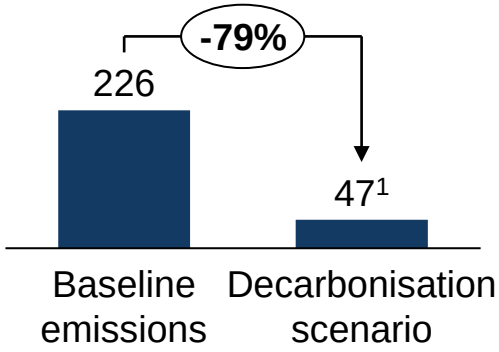
Key insights:

- **Behavioural change** will be key to reduce and shift transport use, which requires **efficient policy design** and strong **stakeholder- and citizen engagement**
- Very **large economic benefits** can be gained by **reducing car-based mobility**- by improving physical health as well as reduced air and noise pollution
- **Electrification** is generally **economically attractive**, however **unlocking financing** to invest in electric vehicles & charging infrastructure will be crucial
- **EVs shift emissions to electricity** use – must be tackled by also **decarbonizing the electricity system**

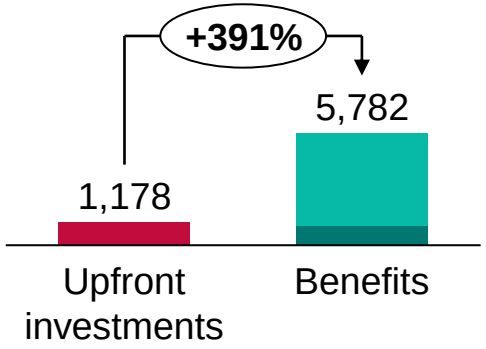
1. Given current electricity emissions – further reductions are had when also decarbonizing the electricity supply
Source: Material Economics analysis

Skopje's buildings and heating sector is the largest source of air pollution - large health gains can be made from energy efficiency and a switch away from firewood

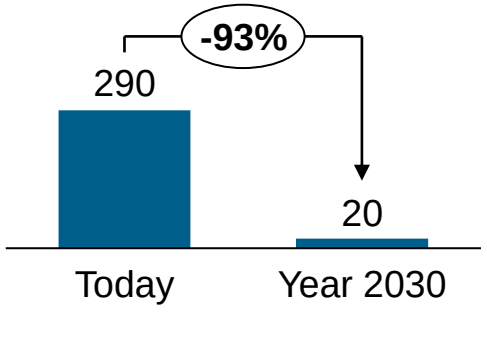
Abatement potential
kton CO_2e, 2030



Economic case
M€, NPV



Air pollution costs
M€ per year



Most promising measures within sector

1. Building envelope renovations
   - Improved insulation reduces heating need and improves health and quality of life for citizens
   - Only cost positive when considering the massive health benefits – requires innovative financing solutions to monetize large health cost savings
2. Decarbonising the heating system
   - Expanding the district heating system and switching remaining households to modern heating systems would create billions of euros of health benefits from reducing the air pollution generated by current heating practices
   - Largest barrier is financing the required capital investments to e.g. expand the district heating network

Key Actions:

- **Create a plan for the heating transition**
  - Expanding district heating network to cost-effective areas of the city
  - Start programme to upgrade or replace local heating systems in remaining areas
- **Explore innovative financing and monetization solutions to capture large indirect benefits**
  - Heating measures are highly beneficial on a societal level, yet do not create large direct returns on investment, requiring innovative solutions for financing

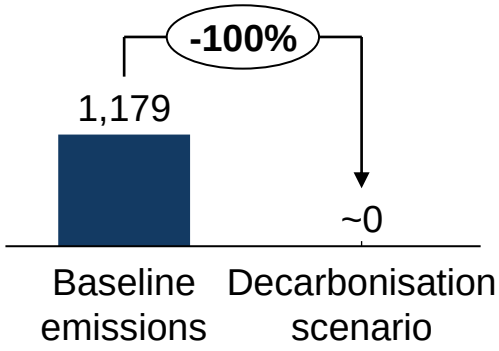
Key insights:

- **Bundling renovation measures** (envelope renovations, heat pumps, lighting & appl.) into one program can create an **attractive total investment case**
- Improving **local heating** generally has a **better case** than expanding **district heating**
- **Behavioural change** may be needed to transition from current local heating practices based on wood and waste incineration

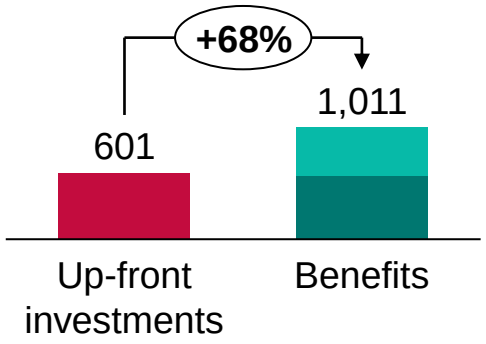
1. Given current electricity emissions – further reductions are had when also decarbonizing the electricity supply
Source: Material Economics analysis

Transitioning Skopje's electricity supply is a key enabler for the transition, providing the energy for tomorrow's heating and transport systems

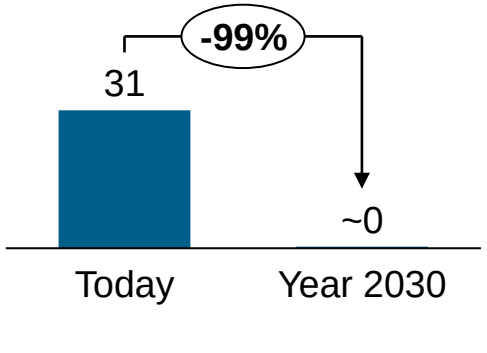
Abatement potential
kton CO_2e, 2030



Economic case
M€, NPV



Air pollution costs
M€ per year



Most promising measures within sector

1. Decarbonizing electricity production
   - Key measure to enable the transition of transportation and heating sectors
   - Huge abatement potential – abating almost to 1,2 Mton CO_2 per year by 2030
   - Break-even investment when only considering direct savings, and produces large health improvements for citizens
   - Likely additional investments required in electricity grid capacity to enable e.g. heat pumps and electrification of transportation – need for further investigations to assess needs and feasibility

Key Actions:

- **Begin planning and secure financing** for a major expansion of renewable generation capacity, storage and grid infrastructure
- **Determine target mix for renewables**
  - Local solar panel installation is more expensive and requires coordination on the house-hold level, but creates citizen engagement and local jobs
  - Utility scale construction is more efficient but may require national coordination

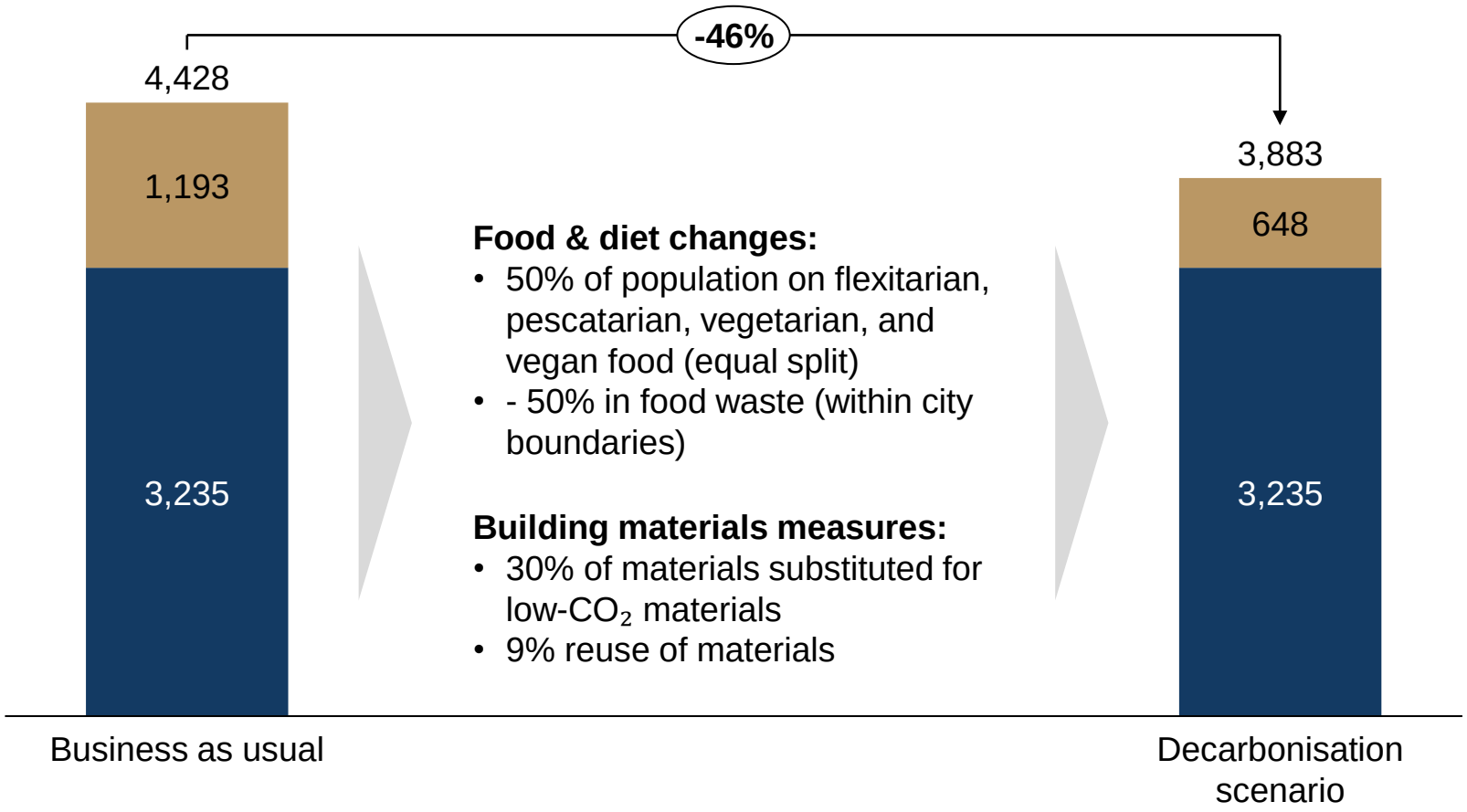
Key insights:

- Electricity **demand will significantly increase** until 2030, mainly driven by **electrification** of the mobility and heating sector
- There is a strong case for aggressively pursuing both **local and utility-scale solar/wind** on a large scale, however **utility-scale generation** is **more cost-effective** in terms of EUR/kW installed
- Economic case **sensitive** to pace of **cost reduction for solar PV** generation (currently assuming decrease of 1.7% p.a.)

1. Given current electricity emissions – further reductions are had when also decarbonizing the electricity supply
Source: Material Economics analysis

Scope 3 emissions also an important factor in total city emissions, with promising initiatives in the areas of building materials and food

Total estimated CO_2 emissions generated in Skopje
kton CO_2 per year, 2030



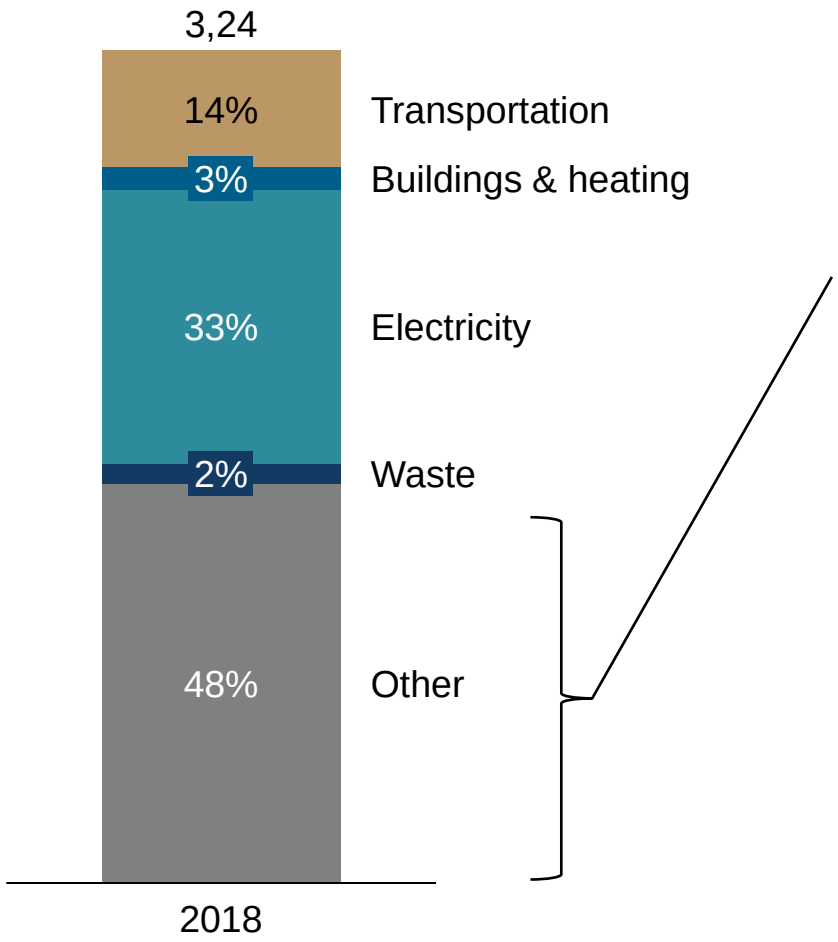
Scope 1 and 2 emissions
Scope 3 emissions

- Scope 3 emissions are an important driver of city emissions, with large impacts attributed to consumption of food and building materials
- The municipality has some ability to influence these areas through e.g. building codes, educational programmes, subsidies, and support for low-carbon diets
- Modelled interventions in the two areas show the potential to reduce Scope 3 emissions by close to 50%, equivalent to roughly 12% of total city emissions

Source: Material Economics analysis

There are several sectors and potential measures left which require further analysis

Carbon emissions in Skopje
Mton CO_2 per year, 2018



Roughly **1,5 Mton CO_2 per year** in 2018 have not been analysed in the current model. These emissions mainly come from;

- **Industry**
- **Agriculture**
- **Product use and other minor emission sources**

On top of this, **Scope 3** (consumption-based) emissions must also be analysed to cover the full range of emissions from the city

A good first step to addressing these measures would be to expand the model to quantify current emissions and model additional measures to address them, including e.g. electrifying industrial processes, more efficient agricultural practices, and an expansion of circular economy practices.

The continued work going forward

- This analysis is a good initial step towards defining a clear and ambitious vision for Skopje going forward, but further work is required
- This work will be continued by the Skopje Yes Team, MANU and the other Thriving Communities Design Partners, pending continued funding currently being investigated
- The Economic Case model and tool will be handed over to MANU – reach out to them for further questions on the modelling or results
- For other questions, contact the SmartUp Social Innovation Lab coordinator

Thank you for your time!

Please reach out with any additional questions or comments

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Appendix - References

This slide provides references to a selection of key sources used in the development of the analysis methodology and results.

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