

The European City Calculator

CliMobCity2050

Final Dissemination Event

19, 20 & 21 June 2023

Leipzig

Dr. Luis Costa
Potsdam Institute for
Climate Impact Research (PIK)



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Introducing measures in the energy model
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Webtool

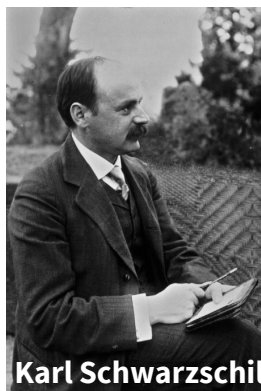
General overview
Outputs



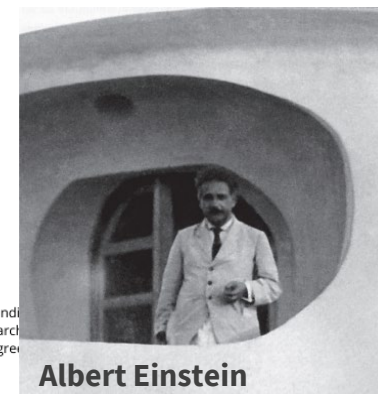
1. Introduction

Potsdam Institute for Climate Impact research (PIK)

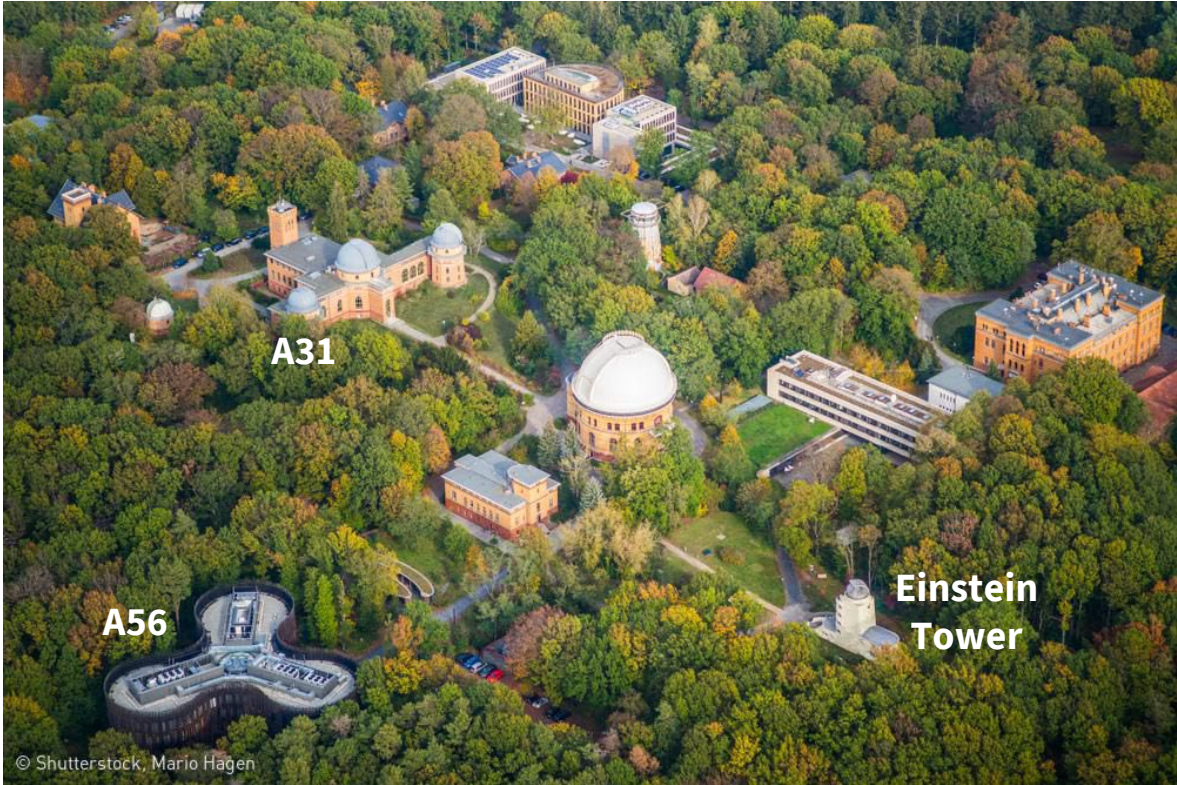
- Founded in 1992, located at the *Wissenschaftspark Albert Einstein*
 - **Currently ~400 staff (261 scientists)**
- Advancing scientific frontier on **inter-disciplinary climate impact** research for global sustainability.
- Contributing knowledge and solutions for a safe and just climate future.



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101019719.



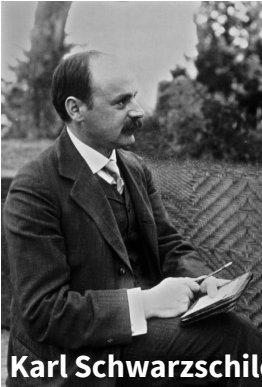
Potsdam Institute for Climate Impact research (PIK)



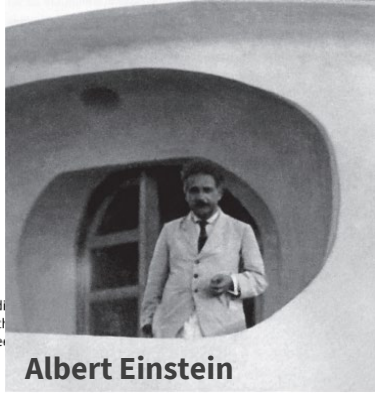
Climate and resilience



© Shutterstock, Mario Hagen



Karl Schwarzschild



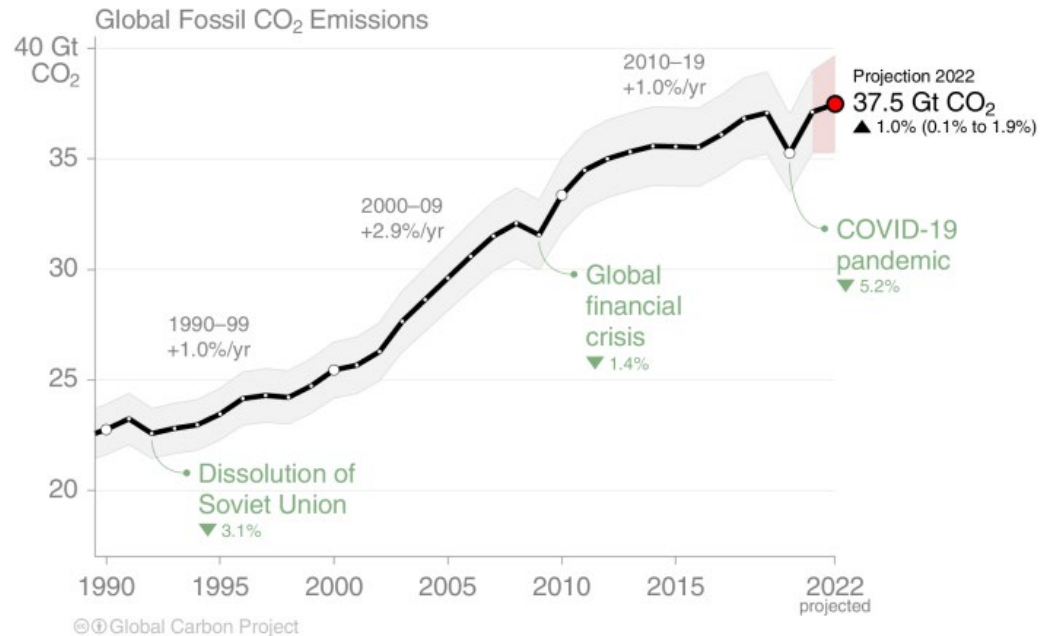
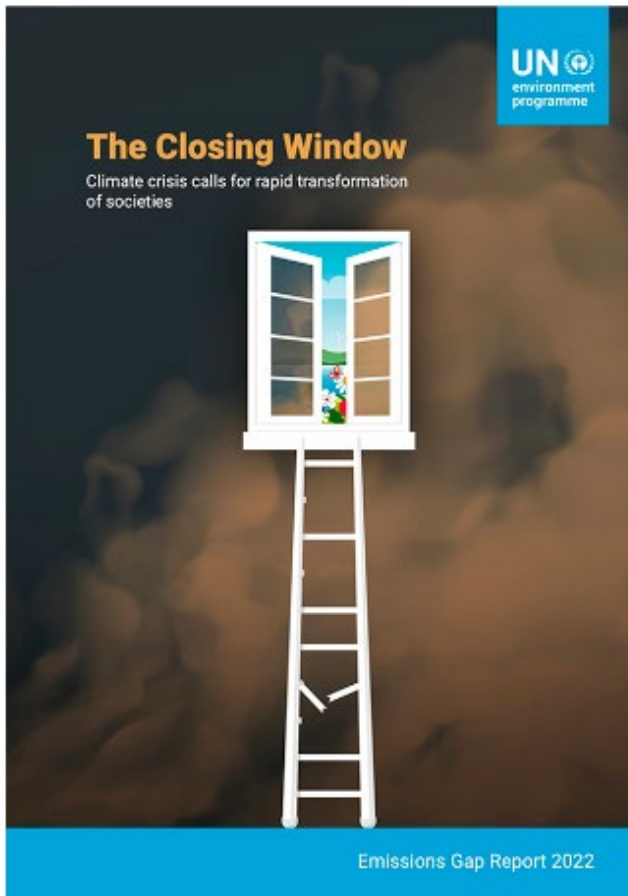
Albert Einstein



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101019718

Global mitigation goes slow...

“Despite a call for strengthened **Nationally Determined Contributions (NDCs)** for 2030, **progress since COP26 in Glasgow has been woefully inadequate**”.



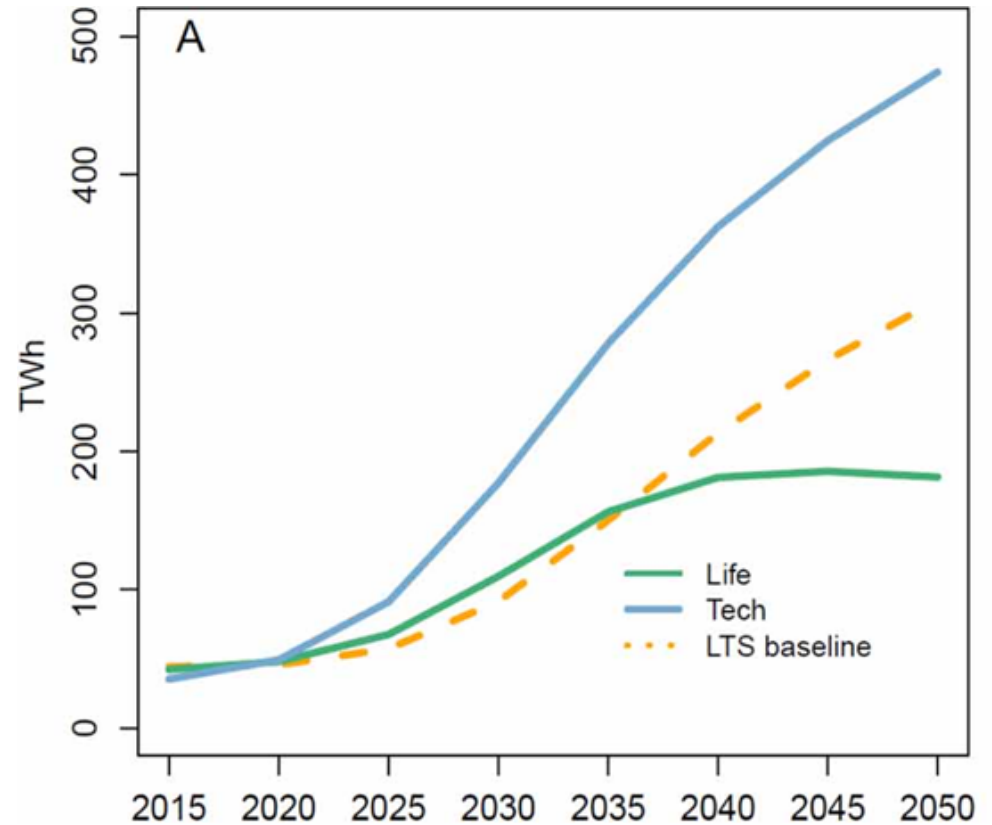
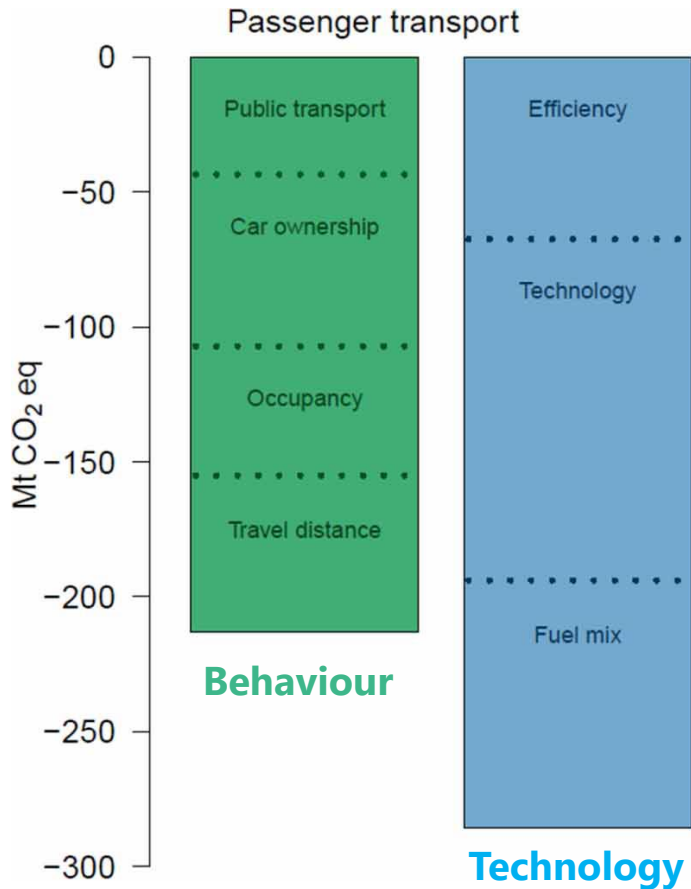
+1% emissions growth in 2022.

- › **India +6.0%**
- › **USA +1.5%**
- › **EU -0.8%**
- › **China -0.9%**

Insights from EU/national energy modelling...

GHG savings from EU's passenger transport (2050 vs 2015)

Electricity demand from EU's transport sector





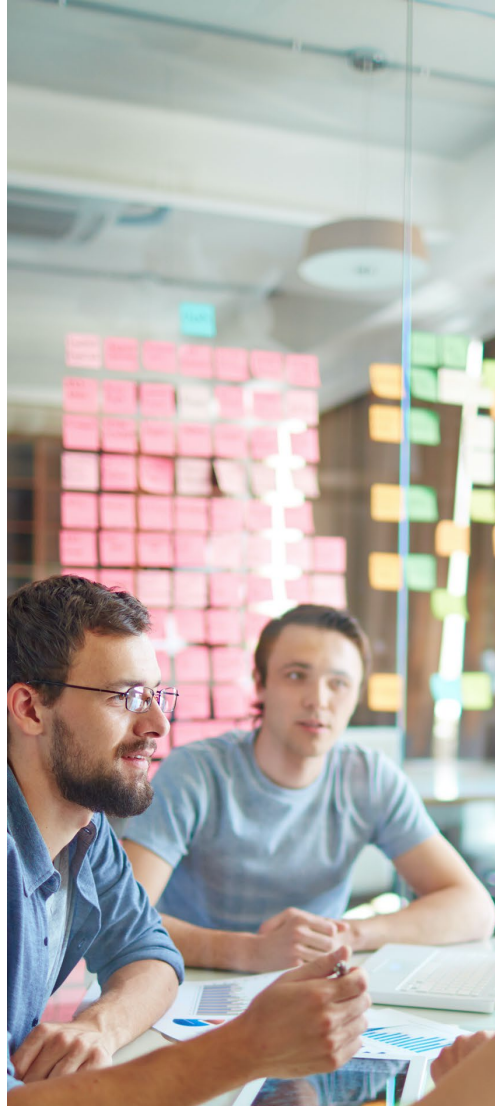
EuCityCalculator supports cities creating their climate strategy

Bring integrated energy-modelling capacities to small and medium-sized cities.

Allow cities to independently test the CO2 reductions associated with specific measures.

Facilitate the elaboration of Sustainable Energy and Climate Action Plans of cities (SECAPs).

Track city-progress to Net-Zero and other National targets.



User oriented

Easy-to-use interface with step-by-step guidance



Robust

Energetic model approach more than 10 years

EU City Calc is being developed in close interaction with pilot cities

9 Pilot cities

Setúbal 2022



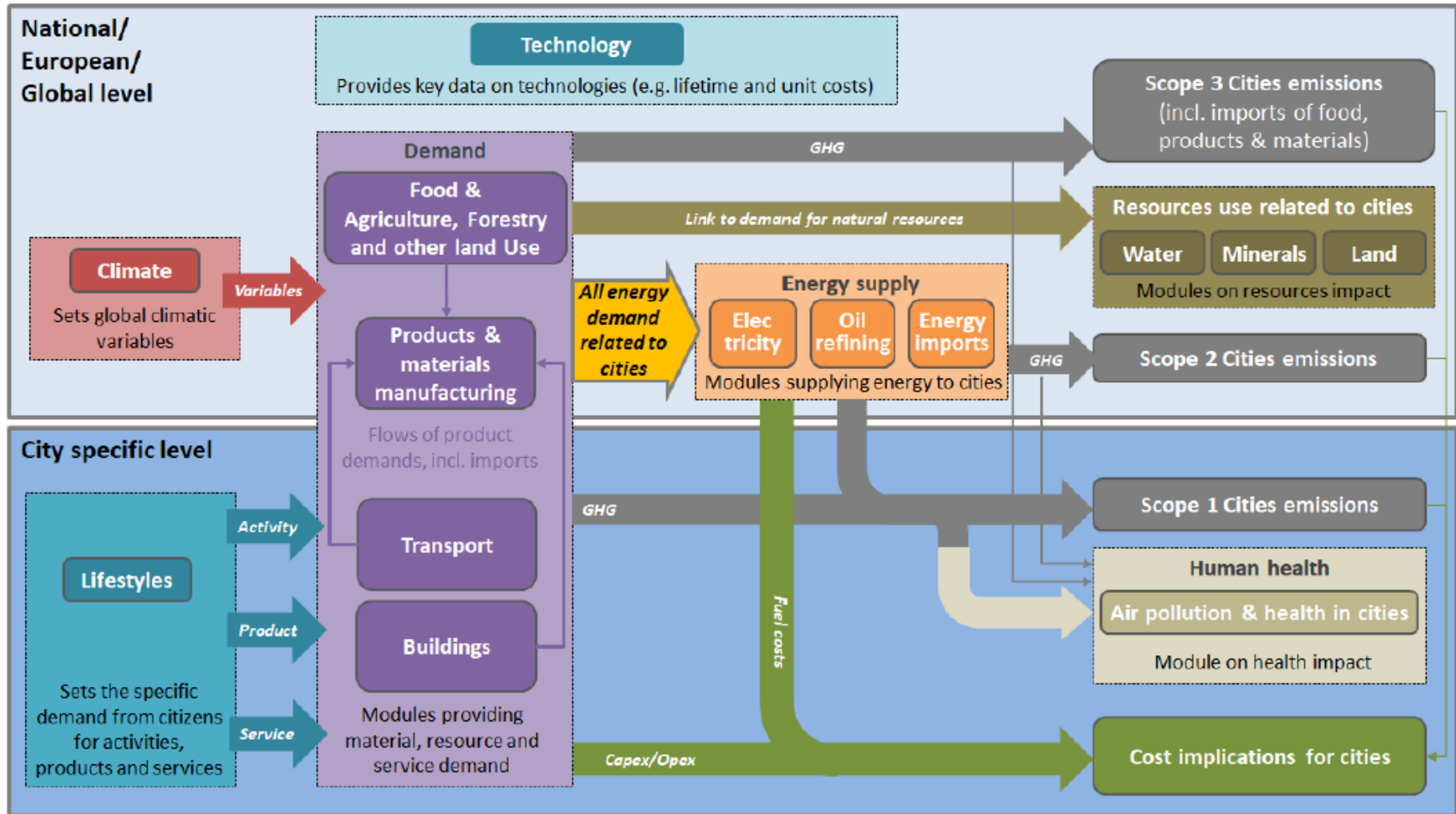
EU CityCalc is being developed in close interaction with pilot cities

11 partners

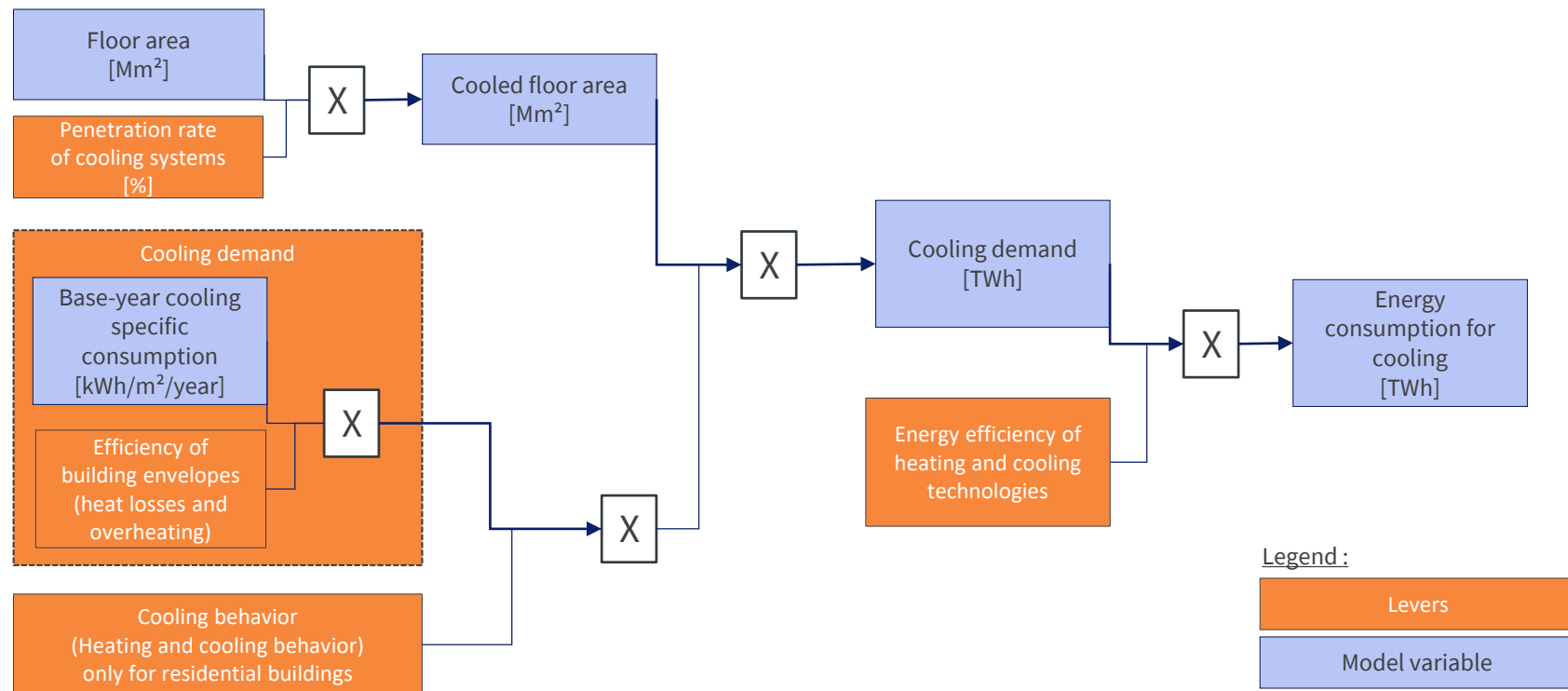


2. Model architecture

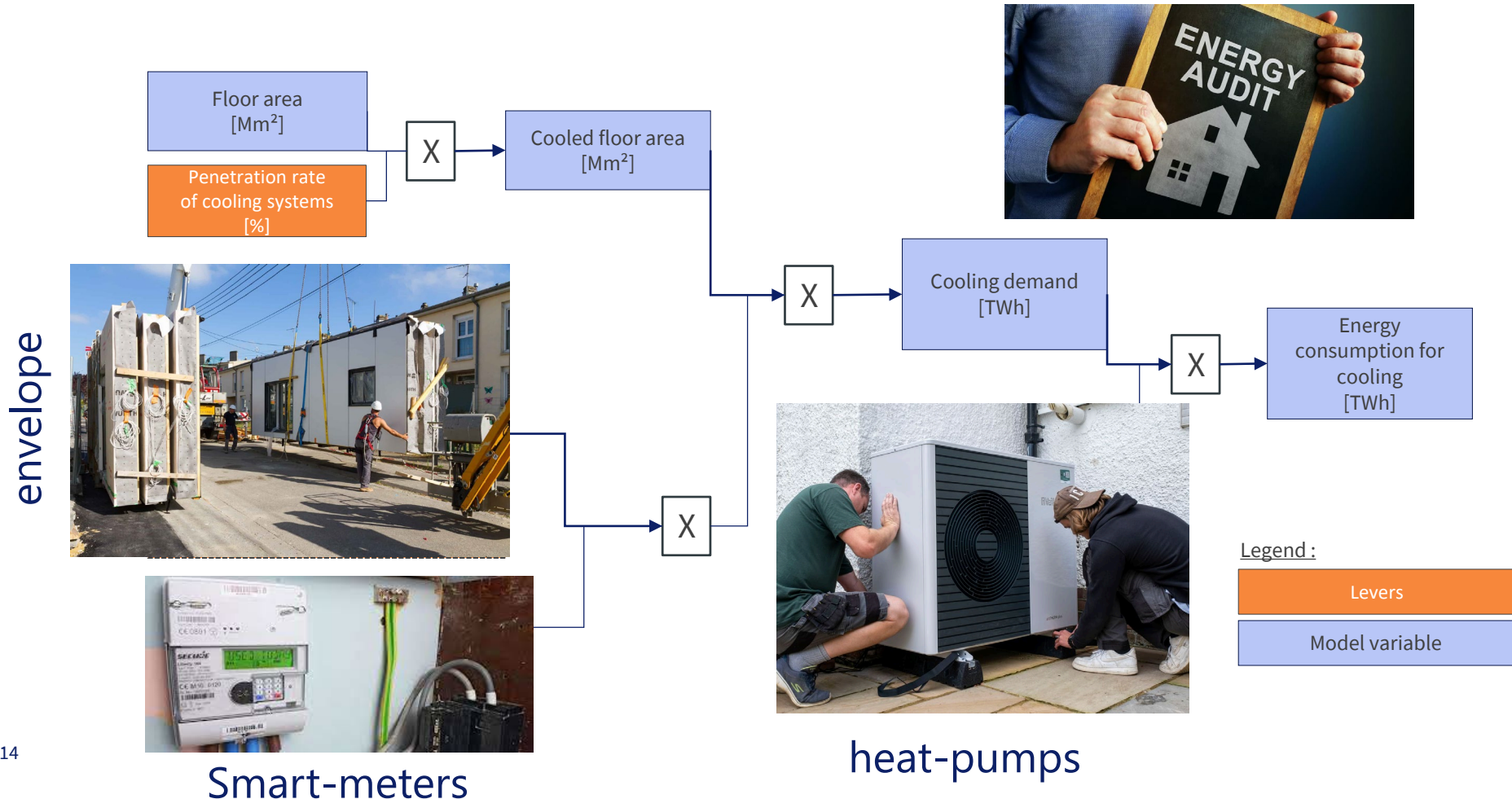
EUCityCalculator model: interactions between sectors & scales.



Example of calculation tree for energy consumption on residential buildings – related to cooling demand

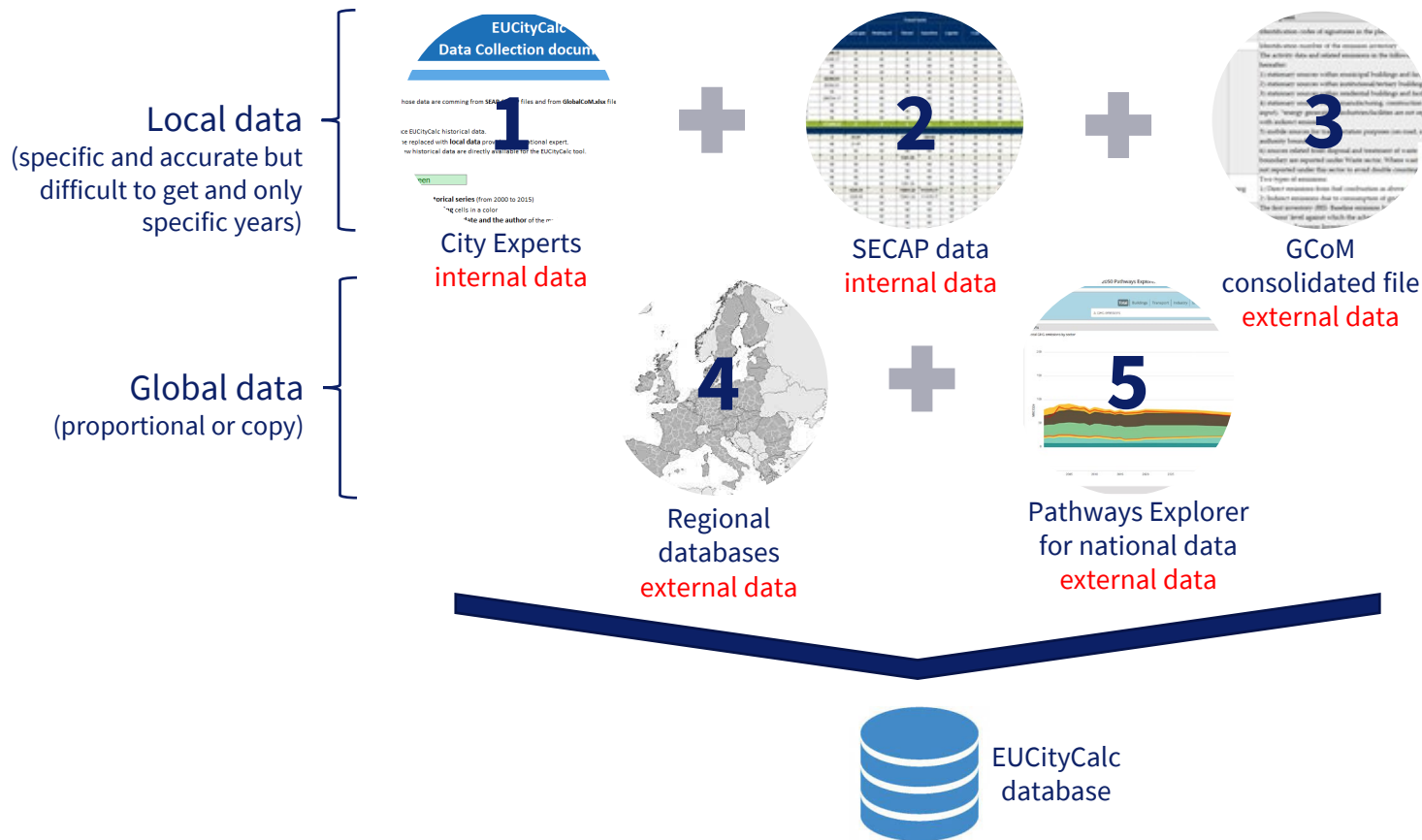


Example of calculation tree for energy consumption on residential buildings – related to cooling demand



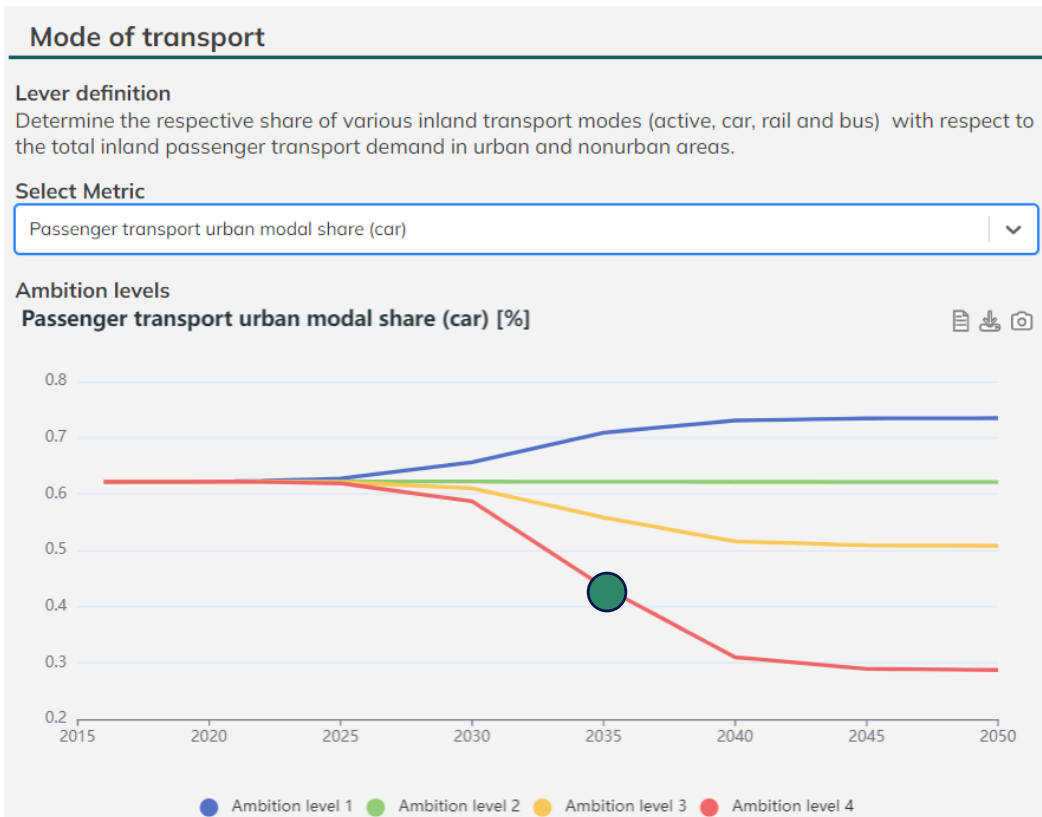
Data crawling

Our heritage, a hierarchy of data



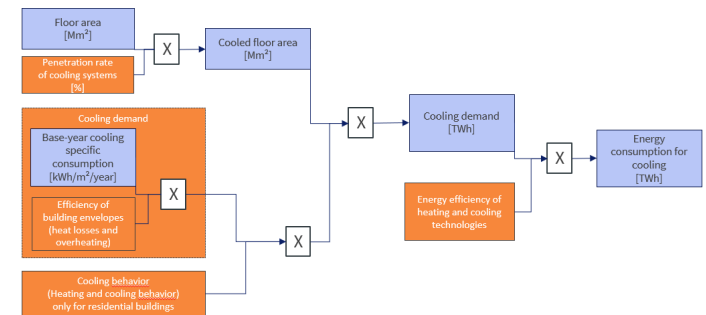
3. Implementing measures in the energy model

Introducing city measures in the energy model

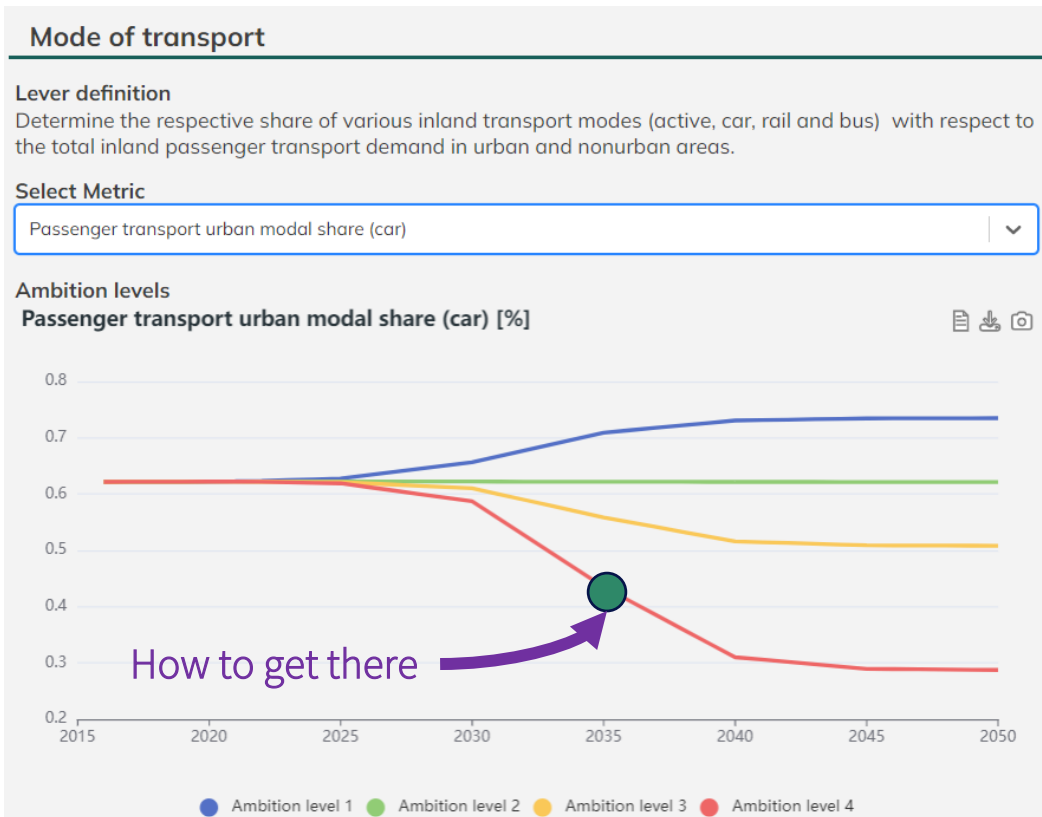


Changes in energy and GHG in the transport sectors (and others...)

- **Simulation model** that converts changes in a lever into savings of energy and emissions



Introducing city measures in the energy model

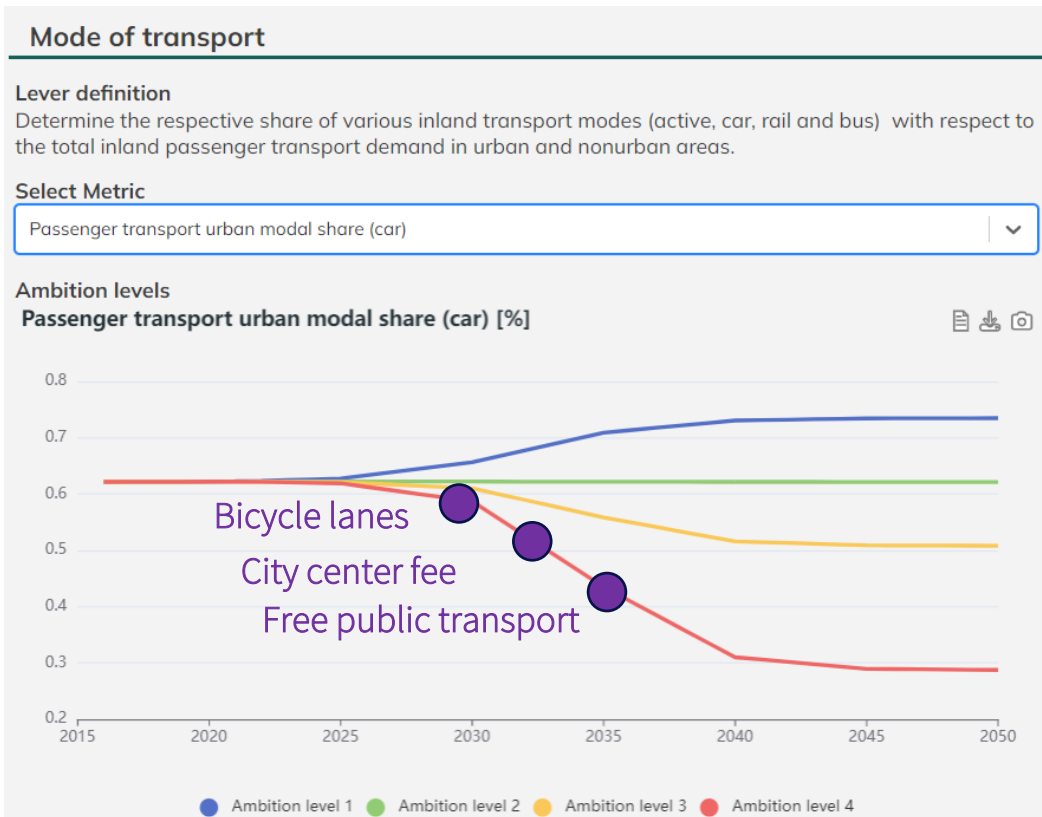


- **Simulation model** that converts changes in a lever into savings of energy and emissions
- It is **not a policy model**, that is, it does not inform what policies/measures may help you to achieve the goal.



Changes in energy and GHG in the transport sectors (and others...)

Introducing city measures in the energy model



Changes in energy and GHG in the transport sectors (and others...)

- **Simulation model** that converts changes in a lever into savings of energy and emissions
- It is **not a policy model**, that is, it does not inform what policies/measures may help you to achieve the goal.
- Translating the effect of concrete **measures** into changes in levers.
 - As far as possible based on real-world examples.
 - Not always possible for all measures.

Introducing city measures in the energy model

Matrix to convert measures into changes in levers

| Measure | City/panning specificities | Time | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 | L9 | L10 | L11 | L12 | L13 | L14 | L15 |
|--|--|------|----|----|----|----|----|-----|-----|----|----|-----|-----|-----|-----|-----|-----|
| Free public transport | 70% of public transport is provided by buses | 2 | 0 | 0 | 0 | 0 | 0 | -6 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| Low emission zones | Ban on ICE with standards lower than EURO4 | 3 | 5 | 54 | 1 | 3 | -1 | -17 | 4 | 12 | 5 | 5 | 21 | -4 | 0 | 4 | 0 |
| Congestion charges (City-center fee) | NA | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10 | 0 | 0 | 0 |
| Cycle lanes | NA | 14.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 136 | 0 | 0 | 74 | 0 | 0 |
| Cycling systems | 4000 hab/km2 | 7.7 | 0 | 0 | 0 | 0 | 0 | -5 | -11 | 0 | -6 | 18 | 0 | 0 | 0 | 0 | 0 |
| Charging stations | 500 charges/million habitants | 0.8 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mobility services (Maas) - ridesharing | Ride sharing | 5 | 0 | 0 | 0 | 0 | 0 | 2 | -5 | 0 | -5 | -5 | 0 | 0 | 0 | 0 | 8 |
| Compact city | Increasing city density by 50% | 20 | 0 | 0 | 0 | 0 | 0 | -14 | 0 | 0 | 0 | 0 | 0 | -15 | 0 | 7 | 0 |
| Establishing new eco-districts | 10 % of building stock constructed as <u>Ecodistrict</u> | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |

Levers

Measures



Introducing city measures in the energy model

Matrix to convert measures into changes in levers

| Measure | City/planning specificities | Time | Levers | | | | | | | | | | | | | | | | |
|--|--|------|--------|----|----|----|----|-----|-----|----|----|-----|-----|-----|-----|-----|-----|---|---|
| | | | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 | L9 | L10 | L11 | L12 | L13 | L14 | L15 | | |
| Free public transport | 70% of public transport is provided by buses | 2 | 0 | 0 | 0 | 0 | 0 | 0 | -6 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| Low emission zones | Ban on ICE with standards lower than EURO4 | 3 | 5 | 54 | 1 | 3 | -1 | -17 | 4 | 12 | 5 | 5 | 21 | -4 | 0 | 4 | 0 | 0 | 0 |
| Congestion charges (City-center fee) | NA | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10 | 0 | 0 | 0 | 0 | 0 |
| Cycle lanes | NA | 14.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 136 | 0 | 0 | 74 | 0 | 0 | 0 | 0 |
| Cycling systems | 4000 hab/km2 | 7.7 | 0 | 0 | 0 | 0 | 0 | -5 | -11 | 0 | -6 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Charging stations | 500 charges/million habitants | 0.8 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mobility services (Maas) - ridesharing | Ride sharing | 5 | 0 | 0 | 0 | 0 | 0 | 2 | -5 | 0 | -5 | -5 | 0 | 0 | 0 | 0 | 0 | 8 | 0 |
| Compact city | Increasing city density by 50% | 20 | 0 | 0 | 0 | 0 | 0 | -14 | 0 | 0 | 0 | 0 | 0 | -15 | 0 | 7 | 0 | 0 | 0 |
| Establishing new eco-districts | 10 % of building stock constructed as <u>Ecodistrict</u> | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

passenger transport urban modal share (LDV)
 passenger transport urban modal share (bus)
 passenger transport urban modal share (rail)
 passenger transport occupancy (bus)

Levers

Measures



23 measures have already been quantified (1/2)

| | Measure | Description | Sector | Type |
|----|--|---|-----------|-----------------|
| 1 | Free public transport | Provision of free public transport | Transport | Regulatory |
| 2 | Low emission zones | Implement a Low Emission Zone (LEZ) in the city center | Transport | Regulatory |
| 3 | City-center fee | Implement a city-center entry fee | Transport | Regulatory |
| 4 | Cycle lanes | Enlarge network of bicycle lanes by constructing or marking new bicycle lanes | Transport | Infrastructural |
| 5 | Bike-sharing/use | Increase number of bicycle hire stations and promote the use of bicycle | Transport | Infrastructural |
| 6 | Low emission vehicles | Increase the number of low emission vehicles operated by, or on behalf of, the municipality | Transport | Technology |
| 7 | Charging stations and free parking for EVs | Increase the number of charging stations for electric vehicles | Transport | Infrastructural |
| 8 | Compact urban planning | Increase the urban density of services | Transport | Infrastructural |
| 9 | Eco-districts | Establishing new eco-districts or convert existing districts to eco ones | Buildings | Infrastructural |
| 10 | Renovation of residential buildings | Improve the energy standards of residential buildings via renovation | Buildings | Infrastructural |
| 11 | Renovation of public buildings | Improve the energy standards of public buildings via renovation | Buildings | Infrastructural |
| 12 | Strengthening building codes | Strengthening of energy building codes for new constructions | Buildings | Regulatory |
| 13 | Supporting solar collectors in residential buildings | Introduction of heat pumps and solar collectors | Buildings | Infrastructural |
| 14 | Installing solar collectors in public buildings | Introduction of heat pumps and solar collectors | Buildings | Infrastructural |
| 15 | Heatpumps in residential buildings | Introduction of heatpumps | Buildings | Infrastructural |



23 measures have already been quantified (2/2)

| | Measure | Description | Sector | Type |
|----|---|--|-------------|-----------------|
| 15 | Heatpumps in public buildings | Introduction of heatpumps | Buildings | Infrastructural |
| 17 | Expand district heating | Increase the number of buildings connected to district heating network | Buildings | Infrastructural |
| 18 | Introduce smart meters | Introduce smart metres in residential and non-residential buildings | Buildings | Regulatory |
| 19 | Reduce natural gas use in centralized heat production | Reduce natural gas in centralized heat production | Energy | Infrastructural |
| 20 | Reduce coal use in centralized heat production | Reduce coal in centralized heat production | Energy | Infrastructural |
| 21 | Increase share of renewable energy | Increase share of renewable energy | Energy | Infrastructural |
| 22 | Waste prevention and separation | Encouraging waste prevention and separation | Consumption | Information |
| 23 | Urban farming/gartening | Establishing urban agriculture/gartening initiatives | Consumption | Infrastructural |

23 measures
3 options of implementation

For each measure the project specifies assumptions, model logic and (when available) the unit costs.

Measure: Bike sharing and use

Assumptions and sources

The effect of the introduction of different bike-sharing systems on modal shift was evaluated by **Ma et al, (2020)** for the Netherlands, a country where the adoption of such systems enjoys a long tradition and empirical data is available. For the Netherlands, it was noted that the introduction of bike-sharing schemes has led on average to a **replacement of bus/tram/train transport by bicycles in the order of 11.5%**. Other significant changes have been quantified for **the replacement of walking by bicycles in the order of 6.4%** **Ma et al, (2020)**. Similar shifts were also noted across different socio-economic and cultural contexts. **Fishman et al, (2014)** reports that **bike-sharing programs translated into mode substitution primarily via an average decrease of 40%** in the number of users of public transportation (...)

Modeling logic

Compiling the values of % car shift to bicycle for 10 cities reported in the literature (see section Assumptions and sources) and population density in hab/km², and empirical exponential function was constructed to estimate the potential car-to-bicycle shift for any city with population density between 100 and 6000 hab/km². We make use of such function to set a corresponding decrease of passenger transport via private car in the energy model due to the introduction of a bike sharing scheme. Reflecting the rationale in section Assumptions and sources, the introduction of bike-sharing systems leads to a penalty in the usage of public transportation (...)

Estimated costs

The real costs of implementing and operating the bicycles are taken from the case of Paris. Paris pays around **4000 euros a year for each bicycle** in its Vélib' service reported in **Héran (2015)**.

Different measure implementation options are provided

Free public transport

Implementation options

Choose between the available options below. By default the most ambitious one is selected.

Everyone

Senior and young

Senior

Renovation of public buildings

Implementation options

Choose between the available options below. By default the most ambitious one is selected.

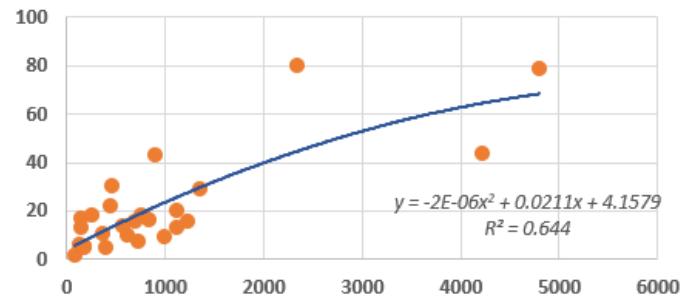
25% of public building stock

50% of public building stock

80% of public building stock

Charging stations for EVs

Public chargers per million hab vs % of EV in new car sales for EU cities (for the year 2021)



Implementation options

Choose between the available options below. By default the most ambitious one is selected.

100 chargers/100000 habitants

250 chargers/100000 habitants

500 chargers/100000 habitants

- Cities were interested in having more choice on how measures are implemented.
- For each measure three options of implementation are (usually) available.
 - Quantitative
 - *Population affected by the measure*
 - *Building stock affected by the measure*
 - *Based on empirical relations*
 - Qualitative
 - *Selecting particular technologies*

Different measure implementation options are provided

Low/zero emissions zones

Implementation options

Choose between the available options below. By default the most ambitious one is selected.

EURO4

Electric

- Cities were interested in having more choice on how measures are implemented.
- For each measure three options of implementation are (usually) available.
 - Quantitative
 - *Population affected by the measure*
 - *Building stock affected by the measure*
 - *Based on empirical relations*
 - Qualitative
 - *Selecting particular technologies*



Different measure implementation options are provided

Implementation options

Choose between the available options below. By default the most ambitious one is selected.

EURO4

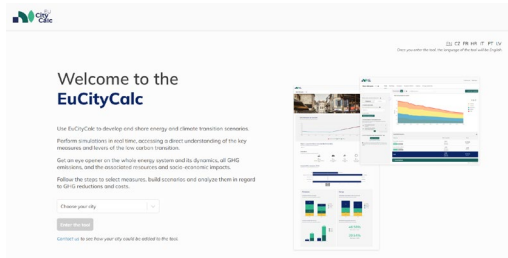
Electric

- Cities were interested in having more choice on how measures are implemented.
- For each measure three options of implementation are (usually) available.
 - Quantitative
 - *Population affected by the measure*
 - *Building stock affected by the measure*
 - *Based on empirical relations*
 - Qualitative
 - *Selecting particular technologies*



4. Webtool

WEBTOOL: structure



Welcome page

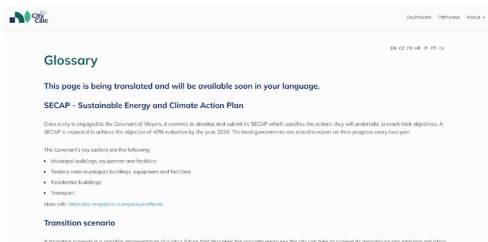
Introduction and basics about the webtool and project



Content of webtool

- Dashboard page
- Pathways page

Build, compare and visualize impacts of scenarios



About

- User guide
- Glossary
- References

How to use the webtool and methodology details



WEBTOOL: Main functionalities



[EN](#) [CZ](#) [FR](#) [HR](#) [IT](#) [LV](#) [PT](#)

Once you enter the tool, the language of the tool will be English.

Welcome to the EuCityCalc

Use EuCityCalc to develop and share energy and climate transition scenarios.

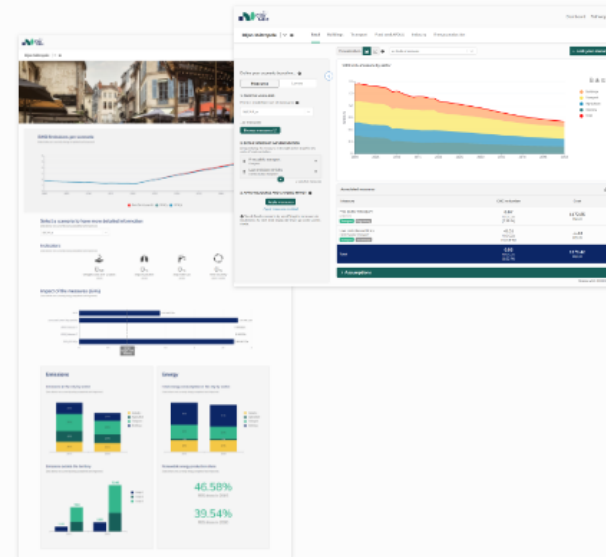
Perform simulations in real time, accessing a direct understanding of the key measures and levers of the low carbon transition.

Get an eye opener on the whole energy system and its dynamics, all GHG emissions, and the associated resources and socio-economic impacts.

Follow the steps to select measures, build scenarios and analyze them in regard to GHG reductions and costs.

Choose your city

- Choose your city
- Dijon Métropole
- Riga
- Mantova
- Žďár nad Sázavou
- Palmela
- Sesimbra
- Setúbal
- Konjuniča




to the tool.



EuCityCalc?



WEBTOOL: Main functionalities

Dashboard Pathways About

Setúbal | Total Buildings Transport Food and AFOLU Industry Energy production

Visualisation   a. GHG emissions Lock your scenario +

Define your scenario based on...

1. CHOOSE MEASURES

From a predefined set of measures

...or manually

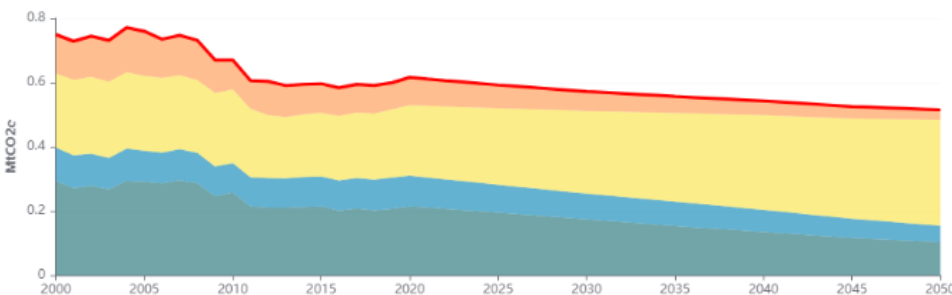
2. DEFINE ORDER OF IMPLEMENTATION

Drag and drop the measures in the table below to define the order of implementation.

| | |
|--|---|
| Free public transport Everyone | x |
| Low emission zones Electric | x |
| City-center fee All | x |
| Eco-districts 10% of building stock | x |
| Renovation of residential buildings 25% of residential building stock | x |
| Renovation of public buildings 80% of public building stock | x |
| Strengthening building codes Very high efficiency standards | x |
| Expand district heating Additional 15% of building stock | x |
| Introduce smart meters 30% of building stock | x |
| Urban farming/gartening Urban farming/gartening | x |

10 selected measures

Total GHG emissions by sector (incl. SCOPE 2)



Legend: Buildings (orange), Transport (yellow), Agriculture (blue), Industry (teal), Total (red)

| Year | Industry | Agriculture | Transport | Buildings | Total |
|------|----------|-------------|-----------|-----------|-------|
| 2000 | 0.25 | 0.10 | 0.15 | 0.10 | 0.60 |
| 2005 | 0.28 | 0.10 | 0.15 | 0.10 | 0.63 |
| 2010 | 0.25 | 0.10 | 0.15 | 0.10 | 0.60 |
| 2015 | 0.20 | 0.10 | 0.20 | 0.10 | 0.60 |
| 2020 | 0.20 | 0.10 | 0.25 | 0.10 | 0.65 |
| 2025 | 0.18 | 0.10 | 0.25 | 0.10 | 0.63 |
| 2030 | 0.15 | 0.10 | 0.25 | 0.10 | 0.60 |
| 2035 | 0.12 | 0.10 | 0.25 | 0.10 | 0.57 |
| 2040 | 0.10 | 0.10 | 0.25 | 0.10 | 0.55 |
| 2045 | 0.08 | 0.10 | 0.25 | 0.10 | 0.53 |
| 2050 | 0.05 | 0.10 | 0.25 | 0.10 | 0.50 |

Associated measures

No measure associated with this scenario.

> Assumptions

Release v31.1.1, 26/04/2023. [Explore the data inputs.](#)



WEBTOOL: Main functionalities

Measures Validate selection

Select the measures to integrate in your pathway. Then validate your selection. [More details](#)

Search by sector: Buildings | Search by type of measure: All types of measure Show only selected measures

10 measures corresponding to your search. Reset Select all Select all Buildings

- > Eco-districts Buildings Infrastructural
- > Expand district heating Buildings Infrastructural
- > Heatpumps in public buildings Buildings Infrastructural
- > Heatpumps in residential buildings Buildings Infrastructural
- > Installing solar collectors in public buildings Buildings Infrastructural
- ▼ Introduce smart meters Buildings Regulatory
 - This measure refers to the introduction of smart meters in households. Smart meters are devices that records information such as consumption of electric energy and communicate the information to the consumer for greater clarity of consumption behaviour, and electricity suppliers for system monitoring and customer billing. The roll-out of smart meters requires upfront investment by energy suppliers in supporting IT systems as well as their installation and ongoing operation.
 - Implementation options**
Choose between the available options below. By default the most ambitious one is selected.
 10% of building stock 20% of building stock 30% of building stock
 - Estimated costs**
304.3 €/household
 - Duration**
2 years
 - Assumptions and sources**
Research has shown that providing feedback information about a household's energy consumption - such as the case of smart meters - can lead to energy savings (Ehrhardt-Martinez et al 2010). Smart meters put consumers in control of their energy use, allowing them to adopt energy efficiency measures that can help save on energy costs. Several studies have evaluated the effect of smart-meters and other individual metering approaches on energy consumption of household. In the city of Exter (UK) homes that received tailored textual messages with action prompts following the installation of smart-meters lowered their internal temperature which resulted in mean household gas consumption by 14–29% with a mean of 22.0% (Mogles et al, 2017). In Italy, the installation of smart-meters in 31 family dwellings was associated with a 18% electricity savings (D'Oca et al, 2014), a similar value found for Shanghai - 11% - in Zhang et al (2019). In the city of Bilbao (Spain), the effect of smart-metering approaches in hot and heating energy came associated with a 15% average reductions measured across 142 dwellings (Teres-Zuhiana et al, 2018).



WEBTOOL: Main functionalities

Define your scenario based on...

Measures

Levers

1. CHOOSE MEASURES

From a predefined set of measures

Ambitious ▾

...or manually

Browse measures

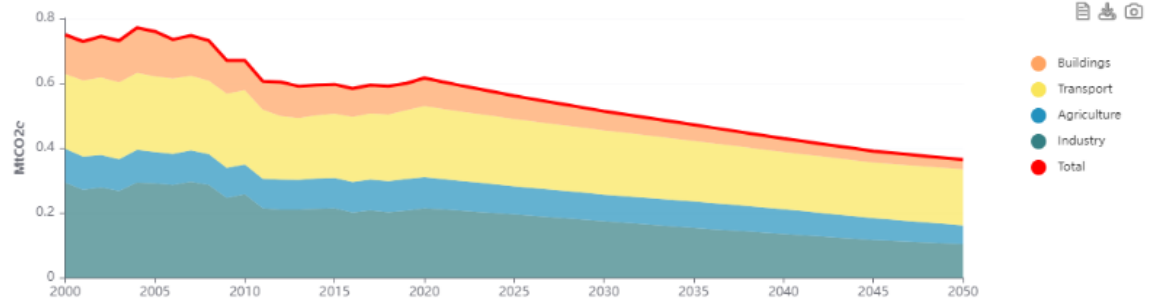
2. DEFINE ORDER OF IMPLEMENTATION

Drag and drop the measures in the table below to define the order of implementation.

- Free public transport ×
Everyone
- Low emission zones ×
Electric
- City-center fee ×
All
- Eco-districts ×
10% of building stock
- Renovation of residential buildings ×
25% of residential building stock
- Renovation of public buildings ×
80% of public building stock
- Strengthening building codes ×
Very high efficiency standards
- Expand district heating ×
Additional 15% of building stock
- Introduce smart meters ×
30% of building stock
- Urban farming/gartening ×
Urban farming/gartening

10 selected measures

Total GHG emissions by sector (incl. SCOPE 2)



Associated measures

| Measure | GHG reduction | Cost |
|--|---|------|
| Free public transport <small>Everyone</small> Transport Regulatory | - | - |
| Low emission zones <small>Electric</small> Transport Regulatory | - | - |
| City-center fee | - | - |
| Total | 58.3 ktCO₂e (10.32 %) | |

> Assumptions

WEBTOOL: Main functionalities

Define your scenario based on... ?

Measures Levers

Refine your pathway

Influenced by national policies 1 1.7 3 4

Socio-demography of the city 1 2 3 4

Influenced by city measures 1 2 2.5 4

Buildings 1 2 3 4

Key behaviours - Buildings 1 2 2.4 4

Residential 1 2 3 4

Services 1 1.9 3 4

Transport 1 1.3 3 4

Food, Agriculture, forestry and land use 1 1.7 3 4

Industry 1 2 3 4

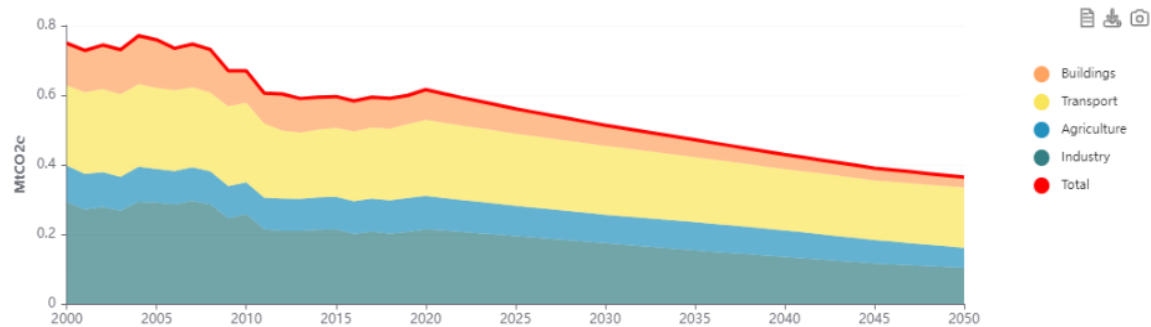
Energy production 1 2 3 4

Imports/exports 1 2 3 4

The levers ambitions position above correspond to the scenario you defined by specifying the measures to implement. If you want to modify the levers ambitions, click on the unlock button.

Unlock

Total GHG emissions by sector (incl. SCOPE 2)



Associated measures

| Measure | GHG reduction | Cost |
|---|--------------------------------------|------|
| Free public transport Everyone Transport Regulatory | - | - |
| Low emission zones Electric Transport Regulatory | - | - |
| City-center fee | | |
| Total | 58.3 ktCO2e (10.32 %) | |

Free public transport

Everyone

Transport Regulatory

Low emission zones

Electric

Transport Regulatory

City-center fee

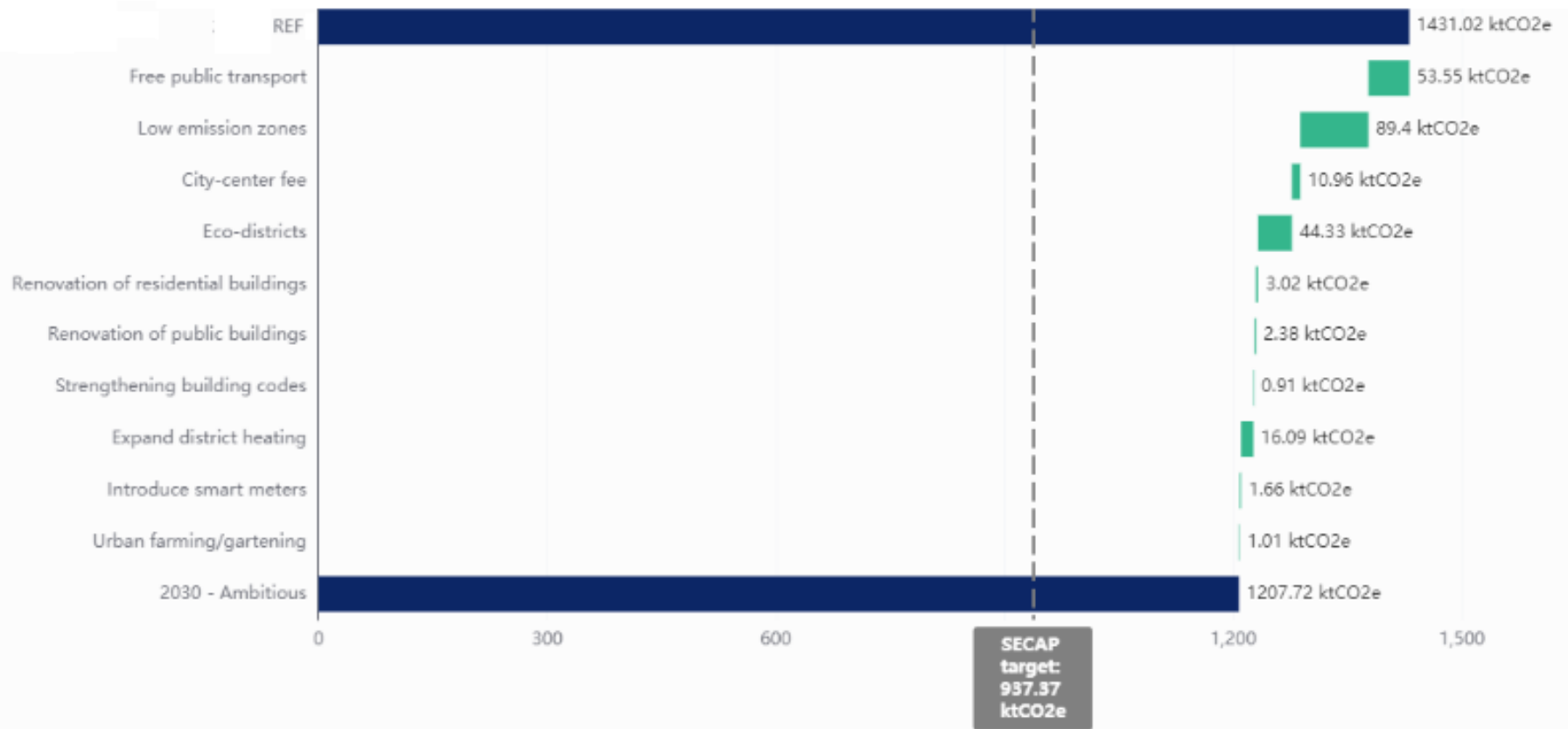
Total

**58.3
ktCO2e
(10.32 %)**

WEBTOOL: Summary visuals

Impact of the measures (GHG) by 2030

Data below are currently being completed and improved.

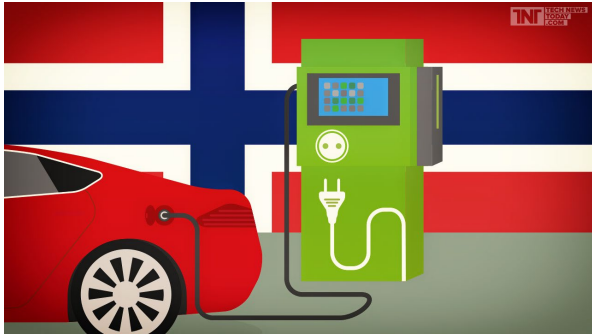


What I learned from today & some reflections...

- **Many technology & infrastructure based options, but paltry understanding how people respond to incentives to change travel patterns.**
 - *"we assume that info campaigns lead to attractiveness of shifting from car to other modes", "assume we migrate part of the population into the city core".*
 - Behavioral scientist should also participate in these projects to open perspectives.
 - "Citizen-informed" sensitivity rather than exploratory.



In isolation, technology can only so as much...

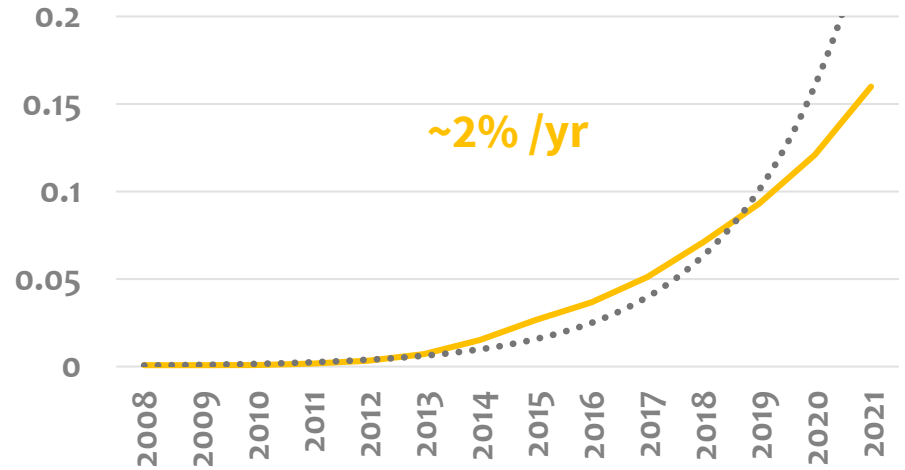


~0.8% /yr increase of distance travelled with private car...

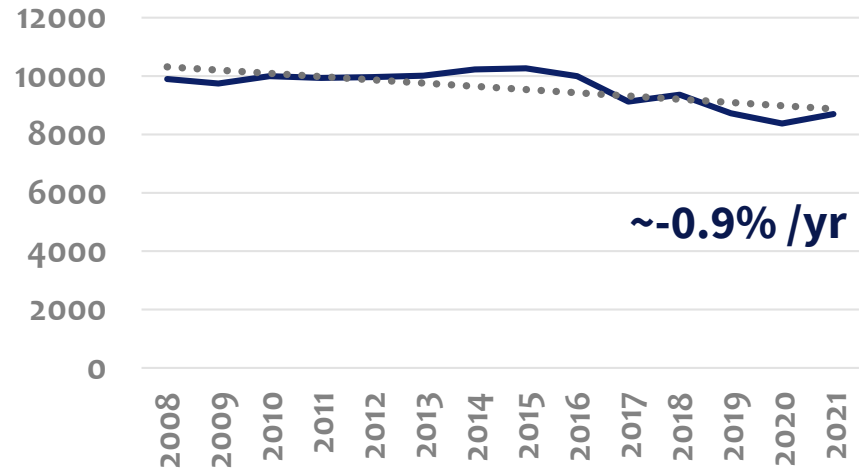


- behaviour*
- infrastructure*
- jobs*
- planning*
- public transport*
- ...

Fraction of EV's in national fleet



CO2 eq from road traffic (in 1000 tonnes)



What I learned from today & some reflections...

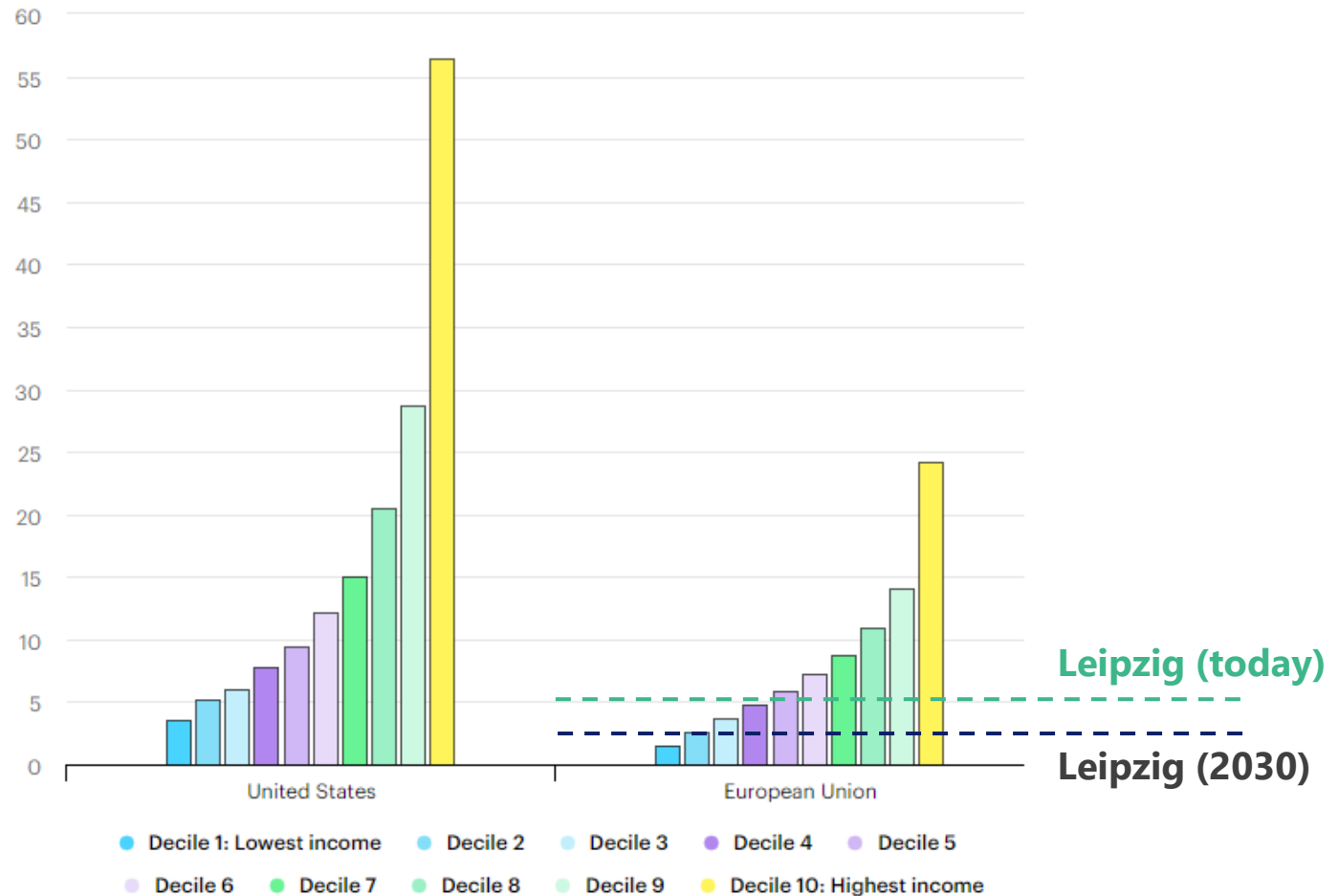
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- **How granular can the city/administration be in regards to sectioning measures by particular target groups? "Does one measure fit all"?**
 - No explicit differentiation of wealthy vs poor/vulnerable citizens in measures.
 - From social studies we know that much of the carbon footprint of citizens get "locked in" when a family is raised (where one lives, buying a house, etc...).
 - Restrictions or/vs incentives – both IF fair.



IEA report: The world's top 1% of emitters produce over 1000 times more CO2 than the bottom 1%.

Per/cap GHG emissions by income level (2021)

t CO2 per capita



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- **What reductions of emissions in the city are controlled by "external factors" at national level?**
 - Funding, fuel tax, electricity grid, building codes, etc...
- **Financing of projects on bringing different sectoral visions together, not in a technical way but as a concrete visions for the city.**
 - Go beyond the CO2-measure-improvements a "new better way of living".
 - You will live longer and save CO2.
- **Communication of results beyond the project/technical-minded persons seems challenging.**
 - Cross comparison of cities in a single figure, clear guide on what is and what is not in the scenarios.





THANK YOU

For more information contact:

Coordinator: Bénédicte Weber (Energy Cities)

Email: benedicte.weber@energy-cities.eu

WWW.EUCITYCALC.EU