ICOS Cities
Pilot Applications in Urban Landscapes

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MAPPING OF FUTURE EMISSIONS BASED ON CITY CLIMATE PLANS

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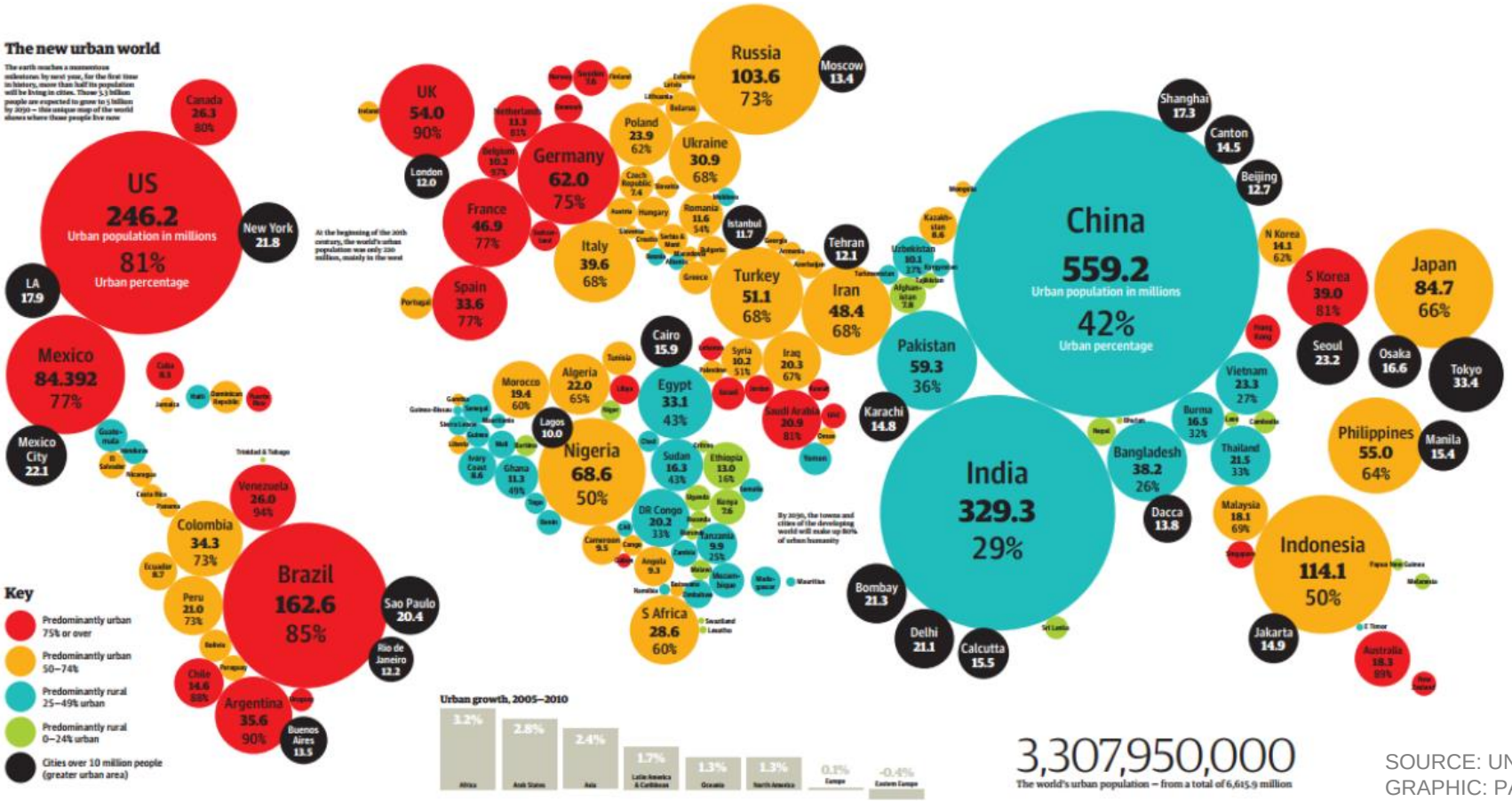
ICOS Cities, aka Pilot Applications in Urban Landscapes - Towards integrated city observatories for greenhouse gases (PAUL), has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037319

By 2030 more than 70% of the world's population will be living in cities



SOURCE: UNFPA
GRAPHIC: PAUL SCRUT

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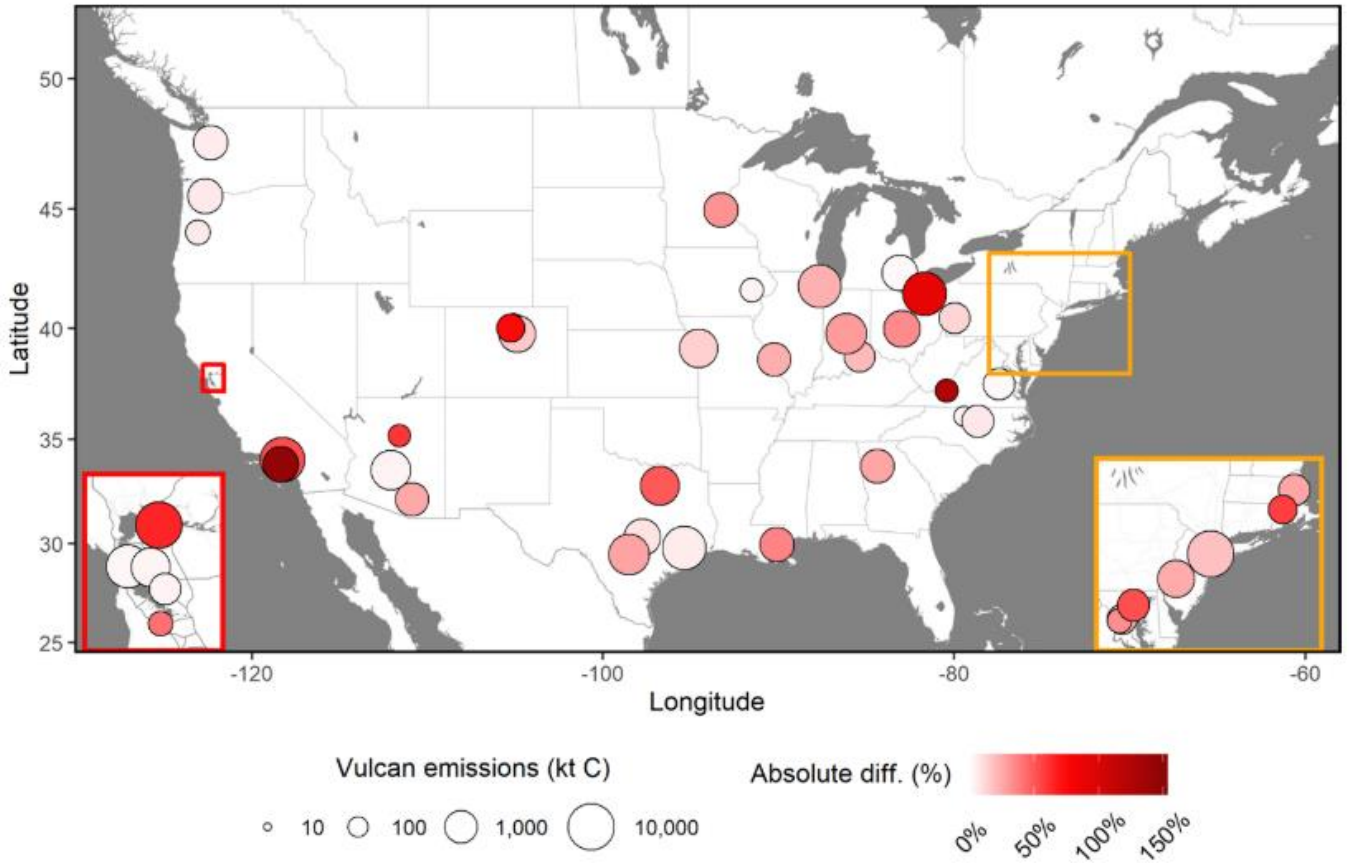
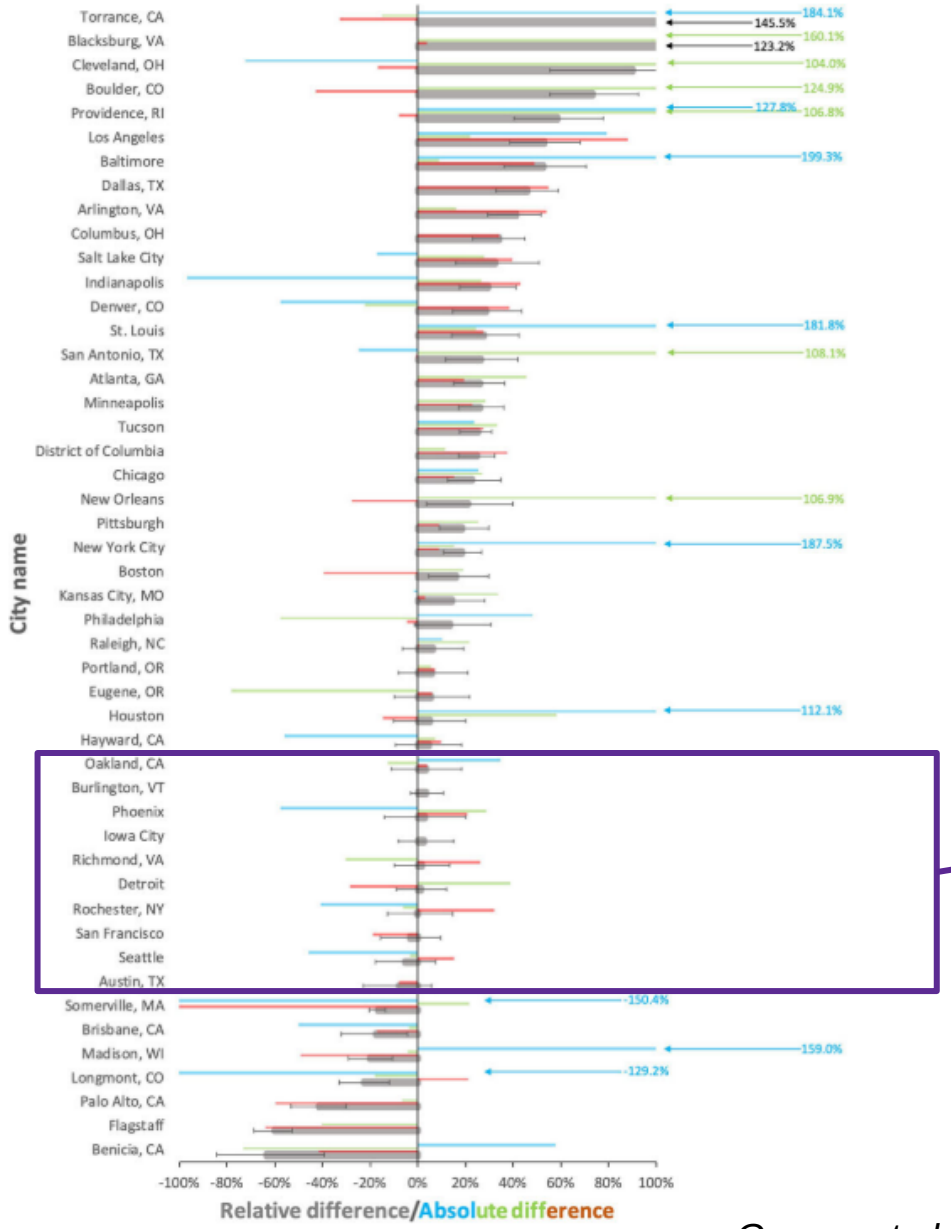
Underreporting of City Inventories

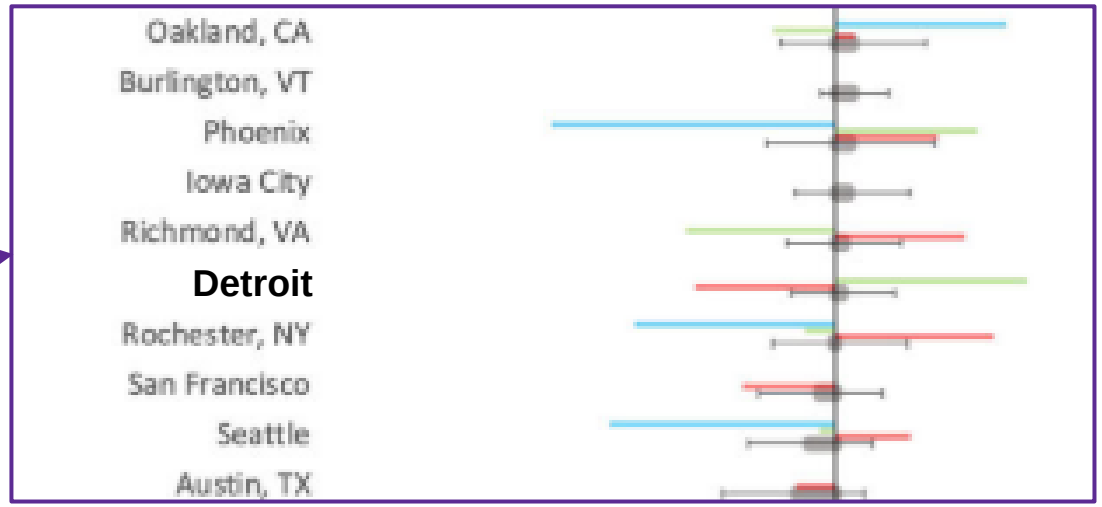


Gurney et al. 2021

The absolute difference between the Vulcan version 3.0 data product and the city self-reported inventories.

Large sectoral differences





Gurney et al. 2021

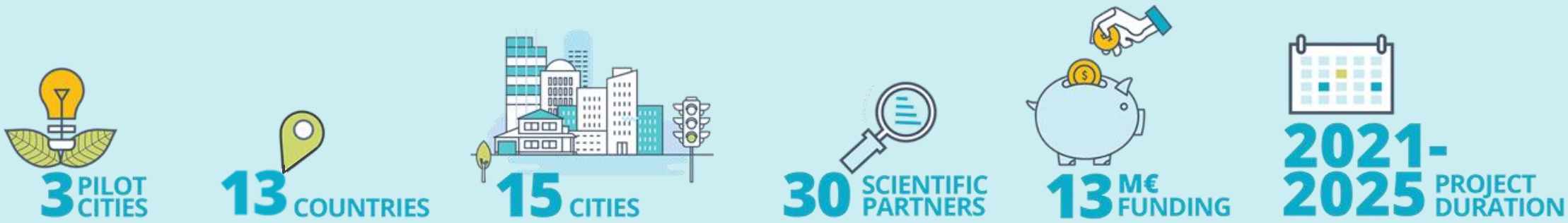
Black: total emissions RD
Red: Onroad emissions RD
Green: Stationary RD (residential+commercial+industrial)
Blue: other transporation RD

What is the ICOS Cities project about?

A European Green Deal project with **3** PILOT CITIES:

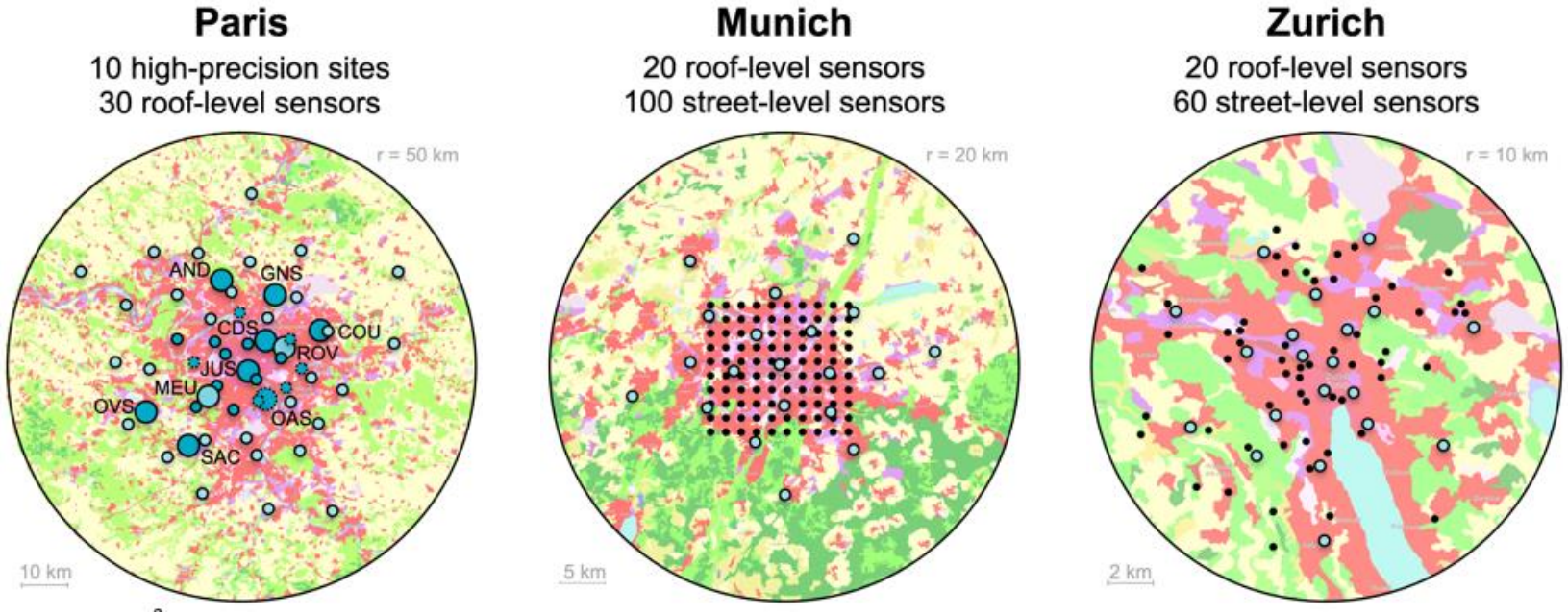
Paris, Munich and Zurich

- **develops systematic observations to monitor the level of greenhouse gas emissions in urban areas**
- **creates useful tools and services for cities in support of their local climate action plans**
- **provides data services that have societal impact**



Atmospheric network design

High-precision **atmospheric concentration networks** on **tall towers**, **roof-level** and street-**level** measurement networks will allow exploring options for urban- and local-scale inverse modelling.



Research Questions

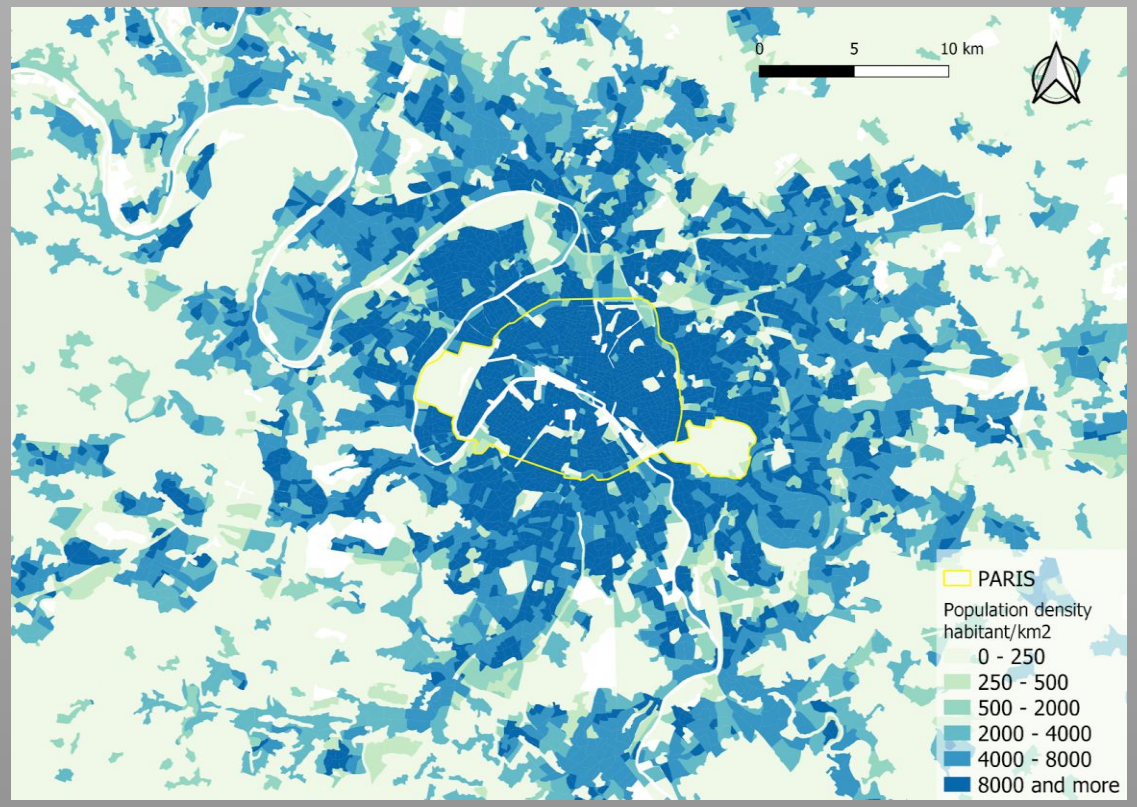
Are cities on track to reach their climate targets?

What influence Climate Action Plans have on the spatial distribution of future GHG emissions?

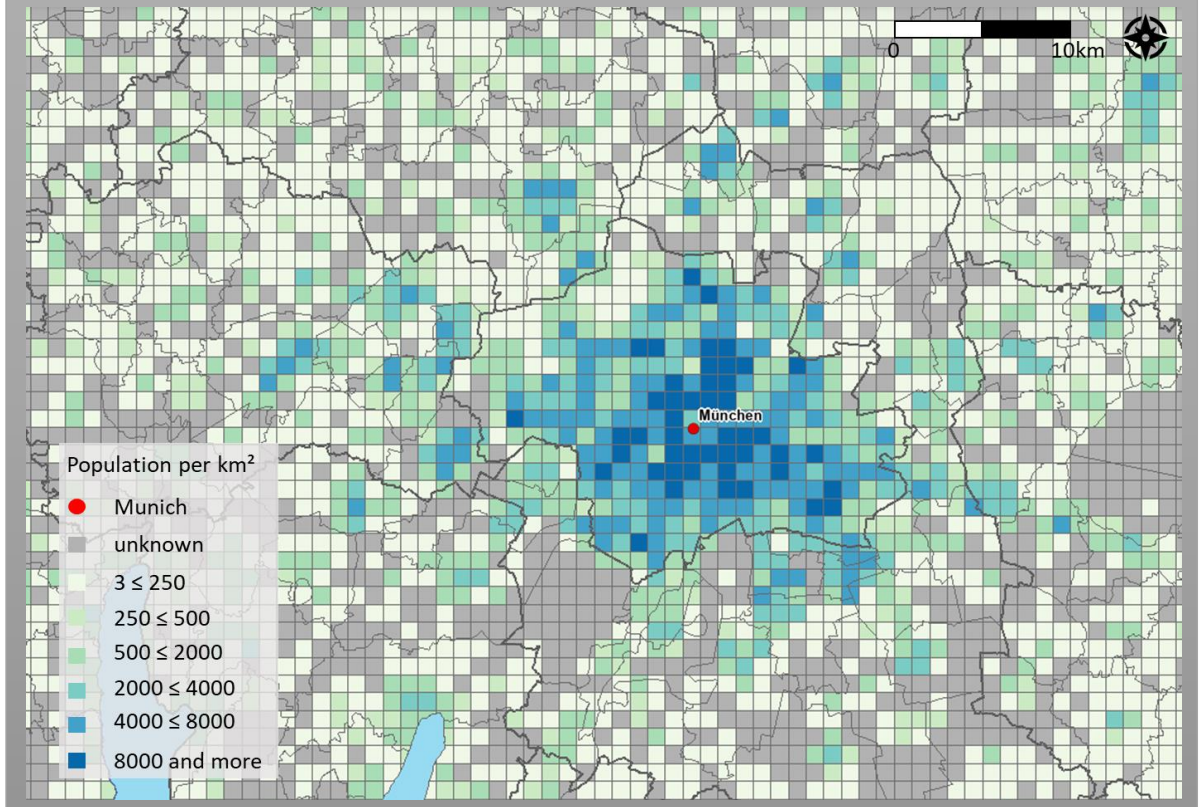
How to link atmospheric monitoring networks with future emission changes, based on Climate Action Plans?

Population Density

Paris

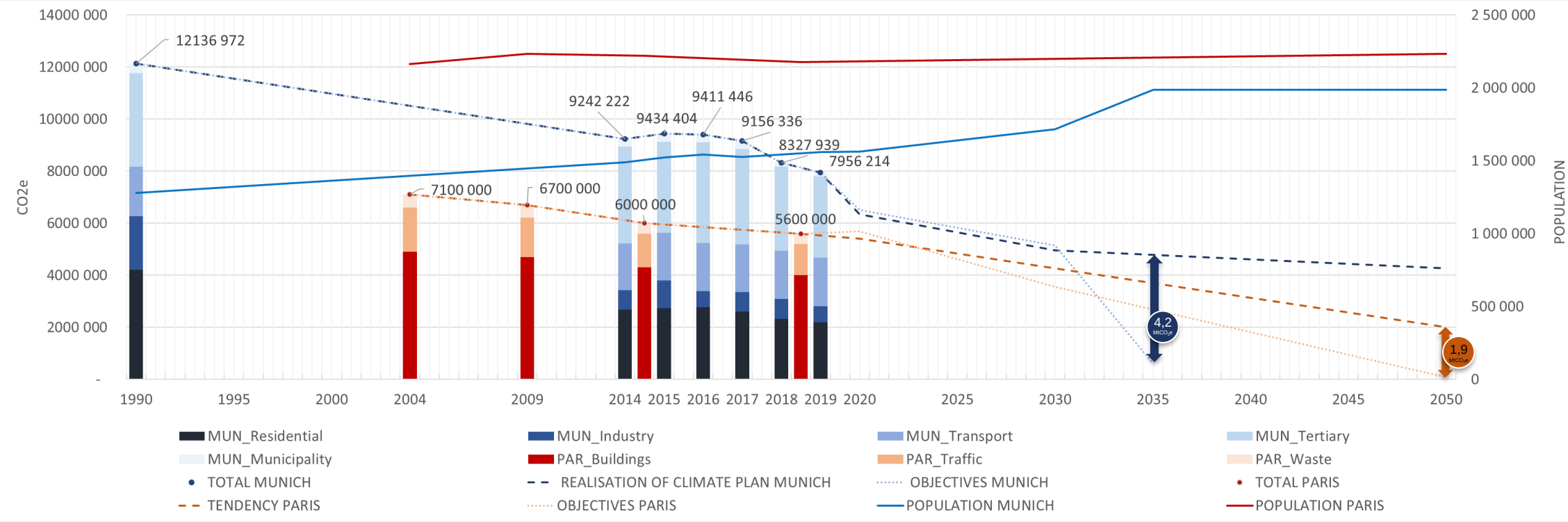


Munich



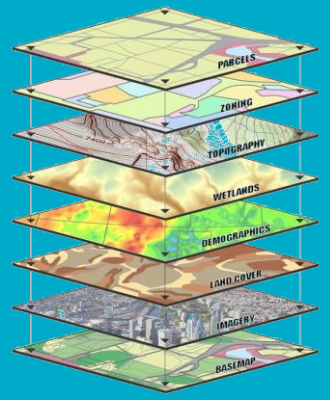
(https://atlas.zensus2011.de/#)

Are cities on track to climate neutrality?



Albarus, I. et al. (2023). Carbon Balance Management, under review

How to spatialize a Climate Plan?



Spatialized 1kmx1km 2019 CO_2 emissions inventory

Mitigation actions from the Climate Plan

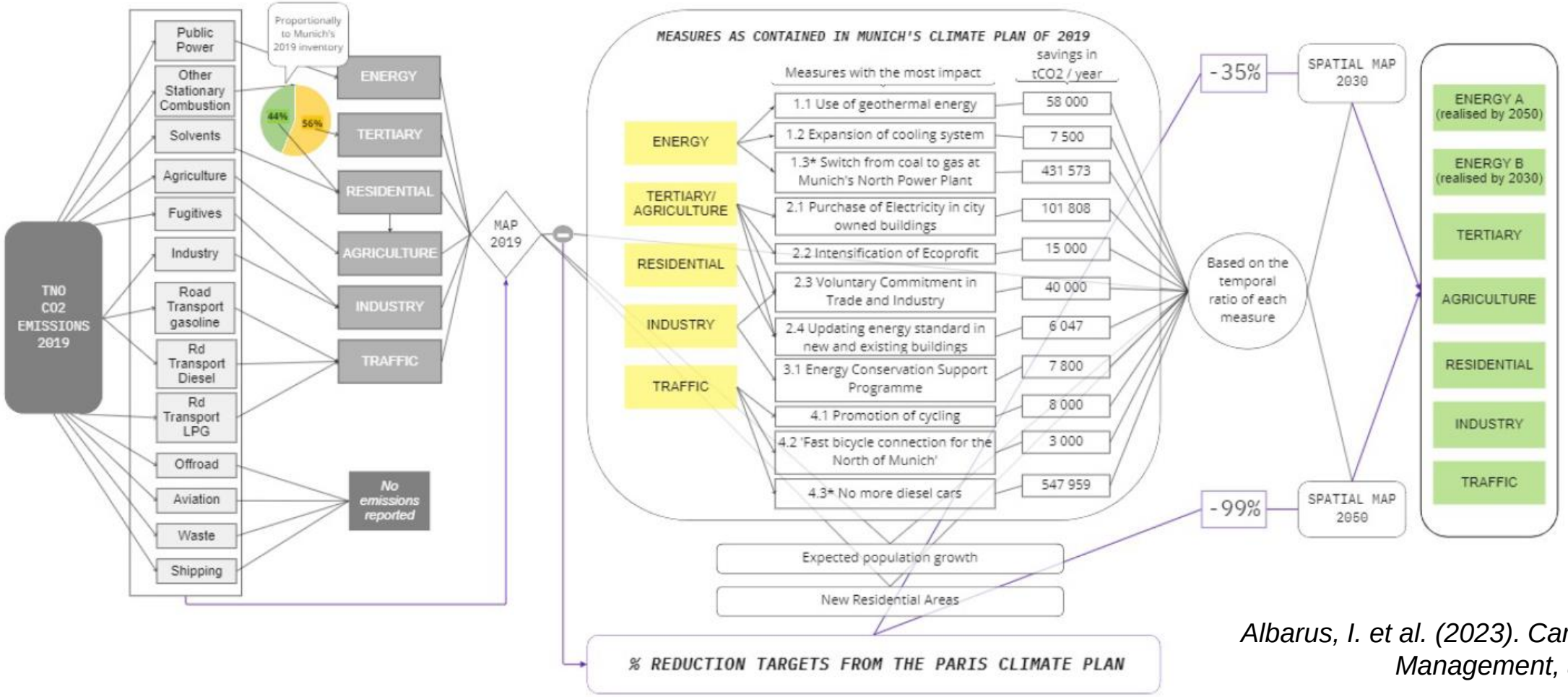
Projected emission maps

Harmonization

Quantification

Spatialization

How to spatialize a Climate Plan?

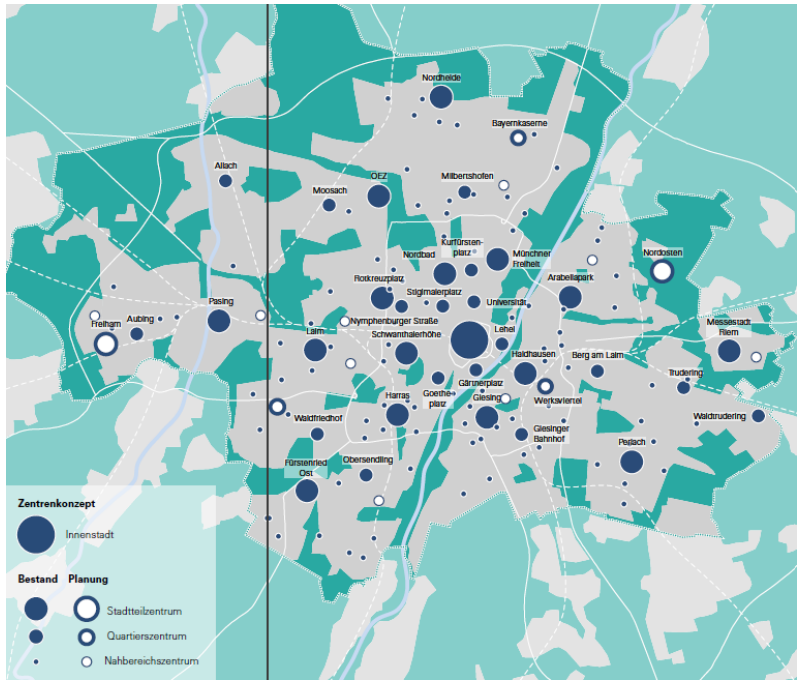


Albarus, I. et al. (2023). Carbon Balance Management, under review

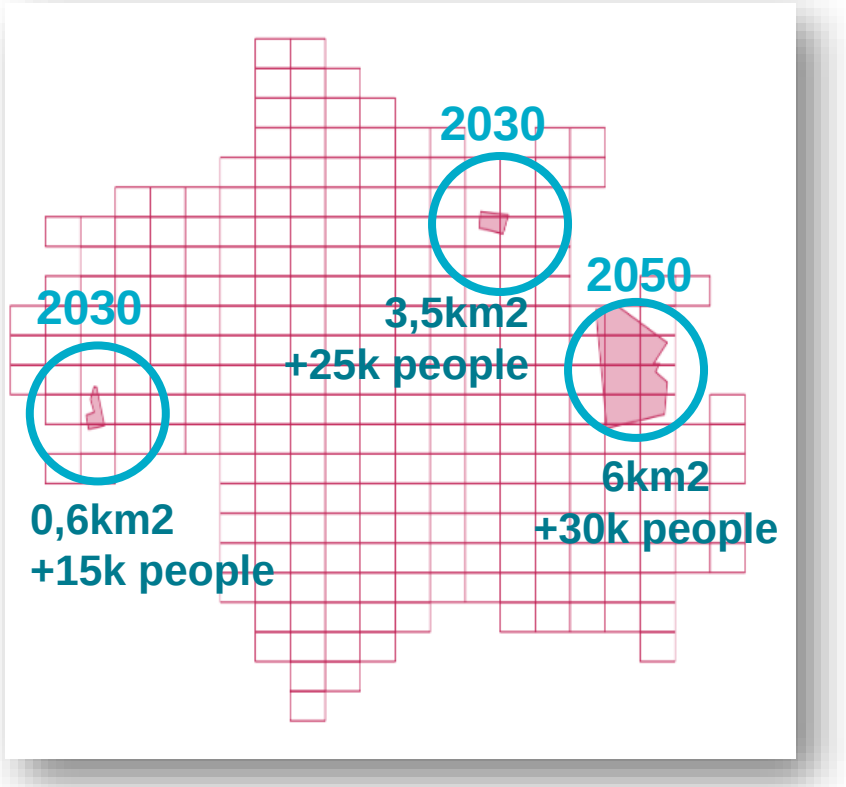
Harmonization | Quantification | Spatialization

Zoom residential sector in Munich

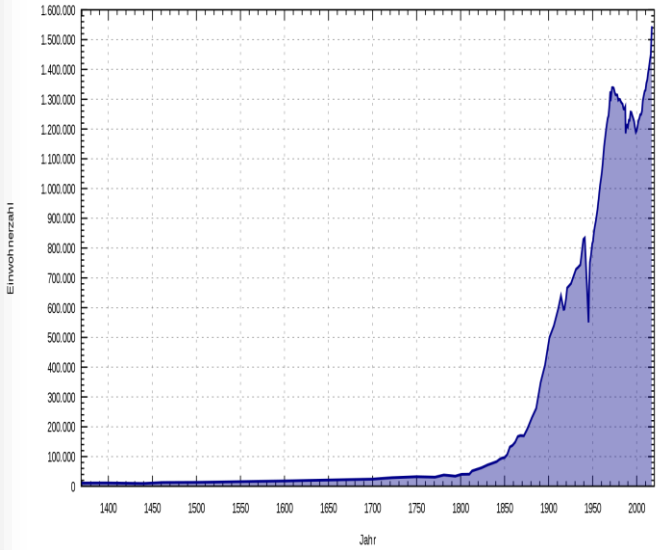
- 3 new residential areas



Munich's local urbanization plan



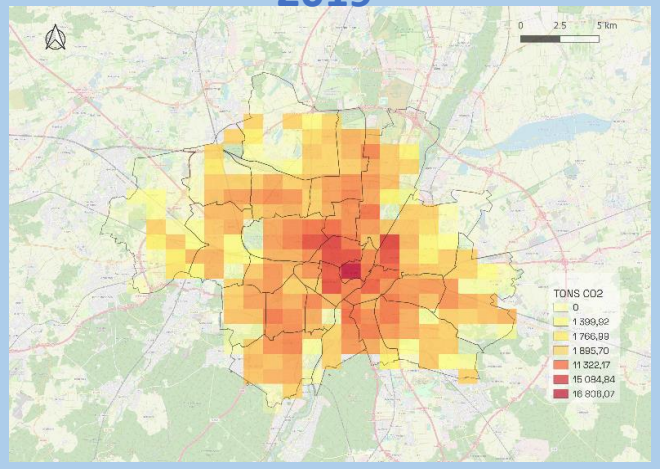
Population increase



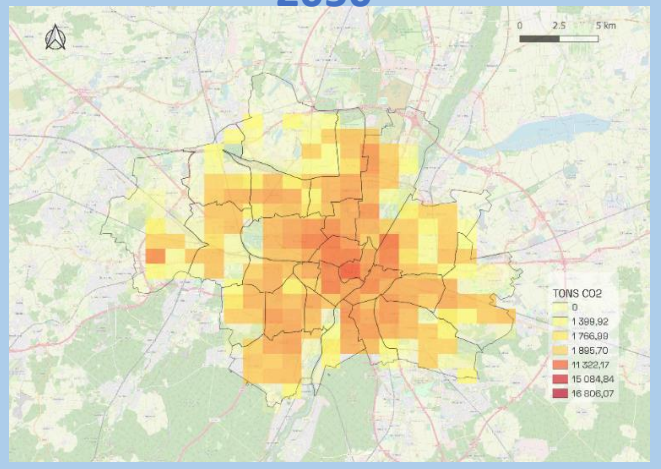
Spatialized Climate Plan of Munich

Residential CO_2 emissions

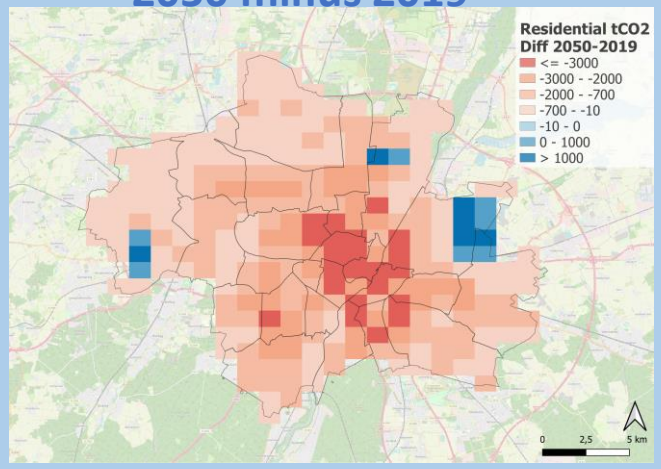
2019



2050

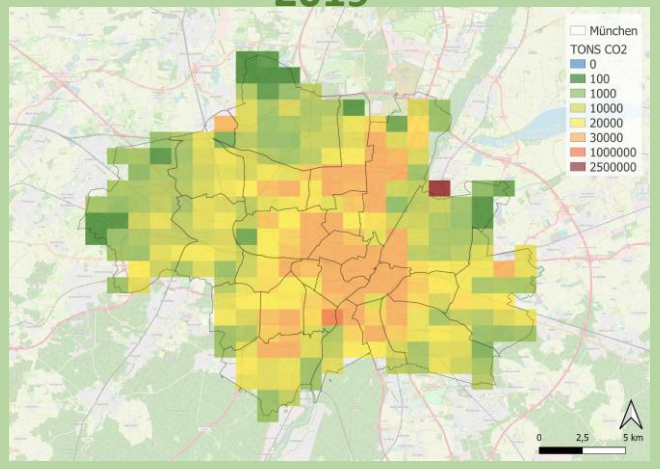


2050 minus 2019

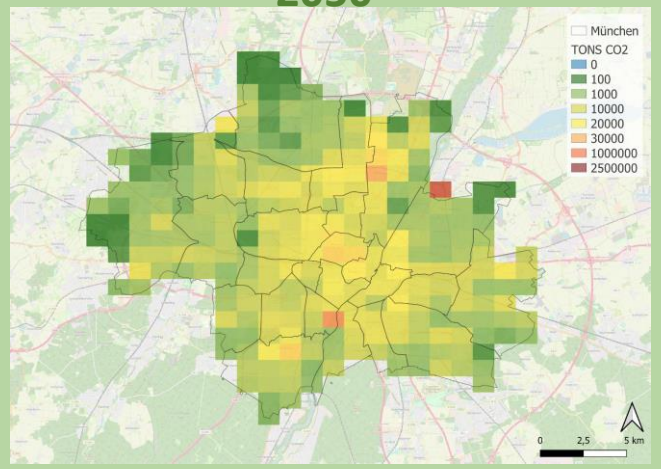


Total CO_2 emissions

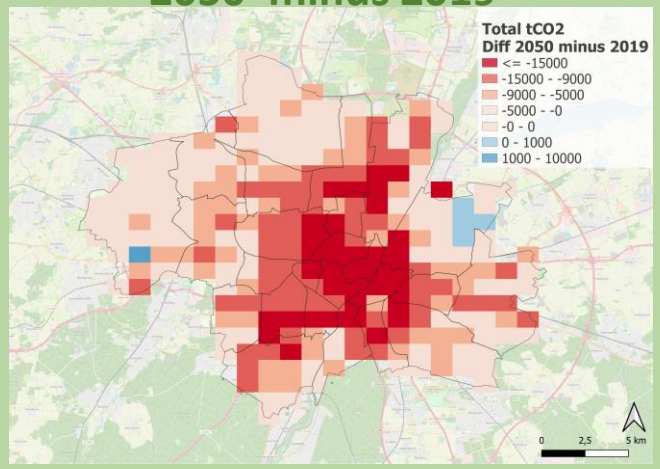
2019



2050

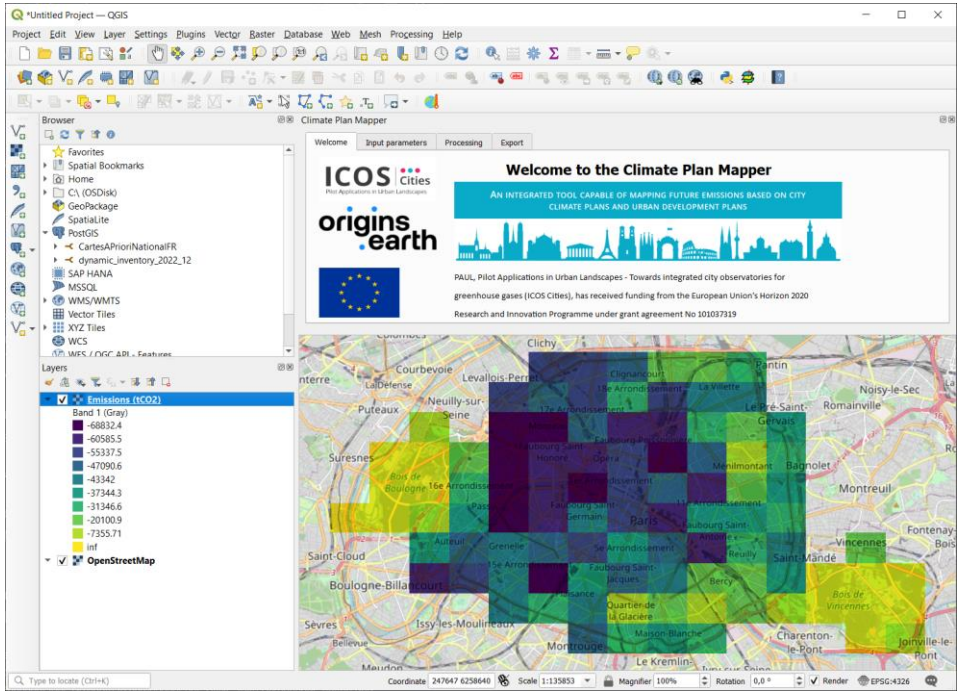


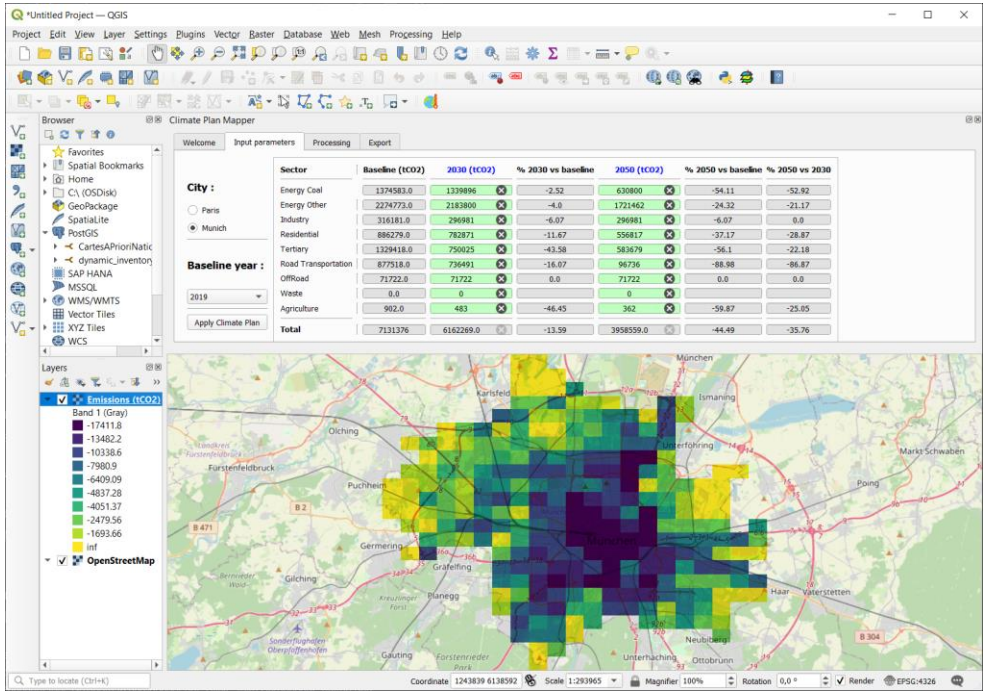
2050 minus 2019



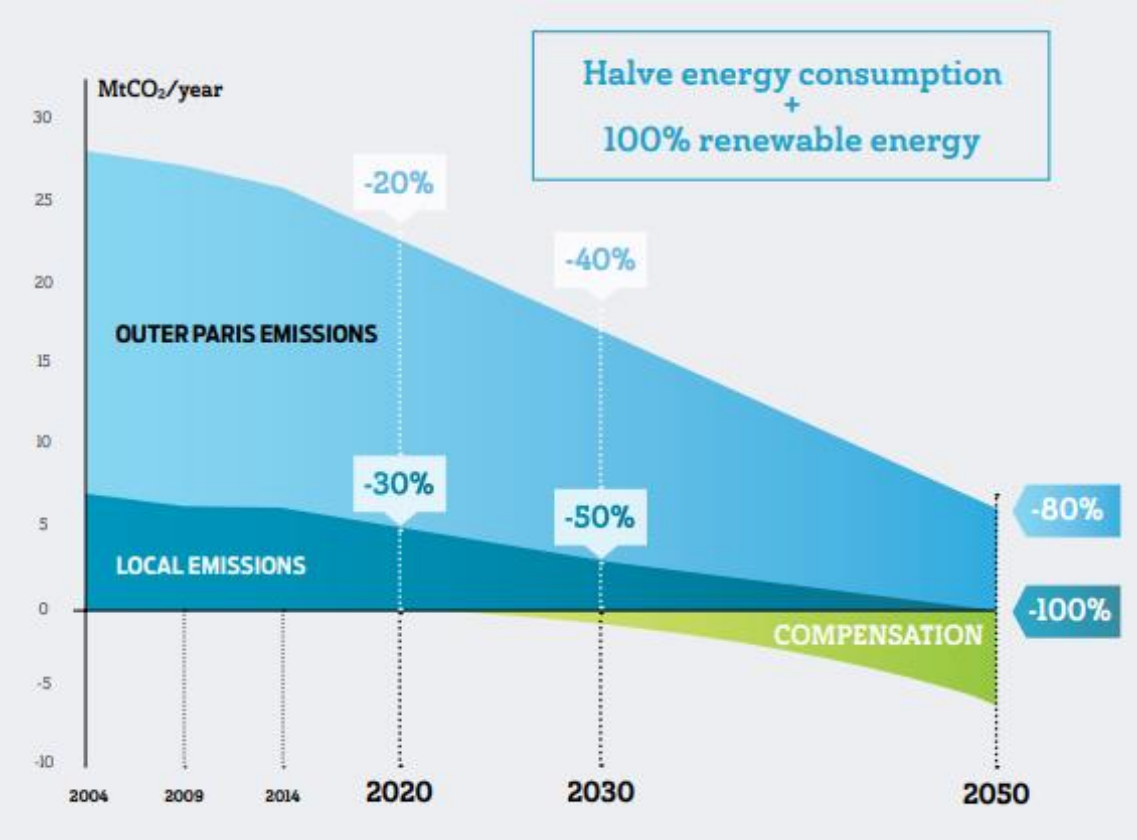
QGIS Plug-In: the Climate Plan Mapper

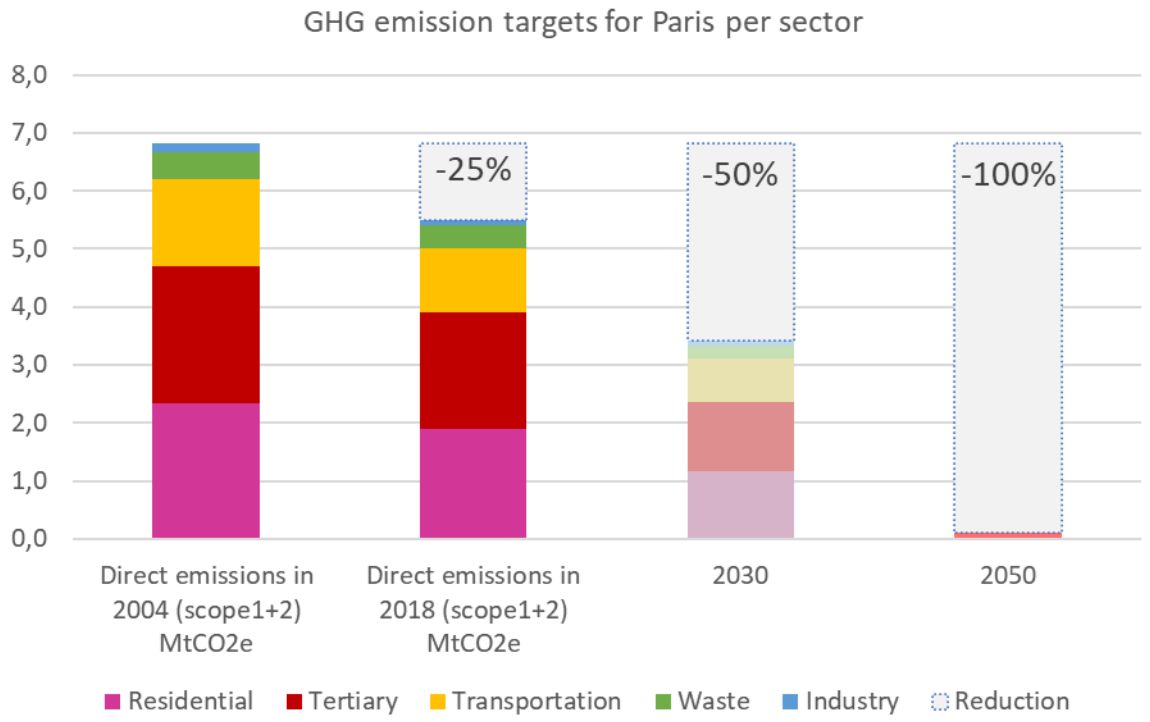
The Climate Plan Mapper is an integrated tool capable of mapping future emissions based on city climate plans and urban development plans for the cities of Paris and Munich.





PARIS – Inventory and Targets

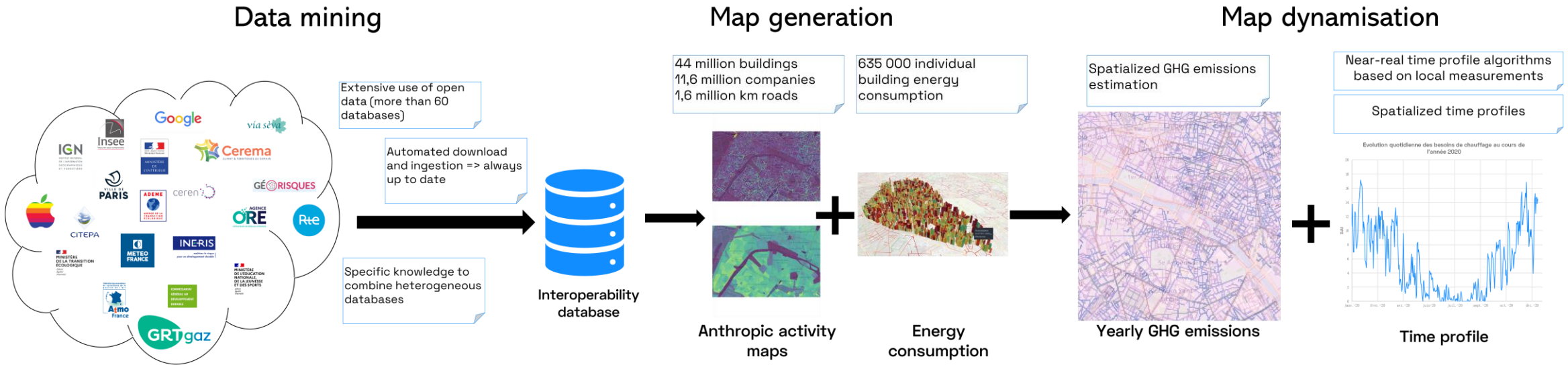




High resolution dynamic inventory

By integrating millions of data, CO_2 emissions from different anthropogenic sources (energy, residential, transport, waste, tertiary and industry) are compiled **every day** since 2018

Dynamic Inventory by origins.earth



Courtesy of Jinghui Lian, 2023

ZOOM: RESIDENTIAL SECTOR IN PARIS

Targets for the residential sector in Paris

2030

-33% energy consumption

2050

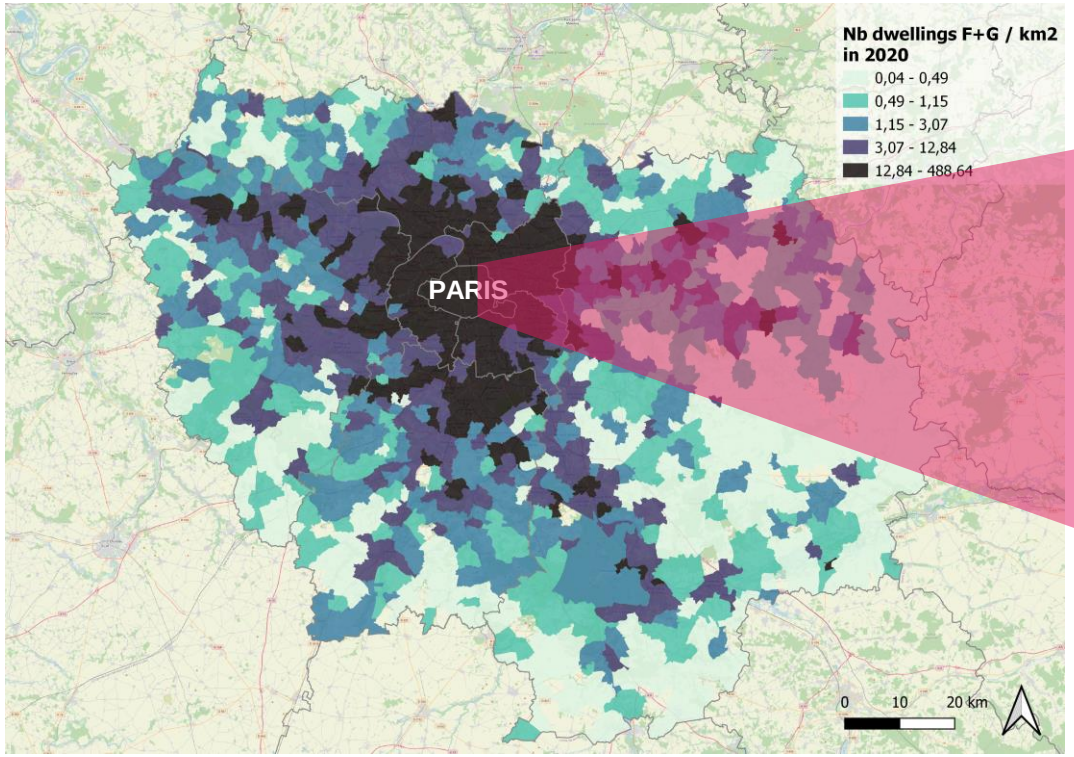
-50% energy consumption

Renovation of 1 million dwellings by 2050

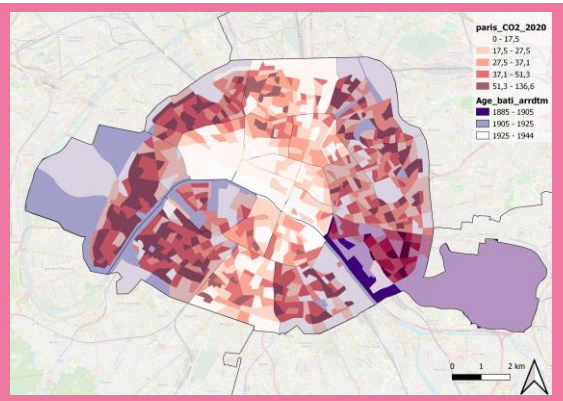
5 000 social dwellings/year

40 000 private dwellings/year

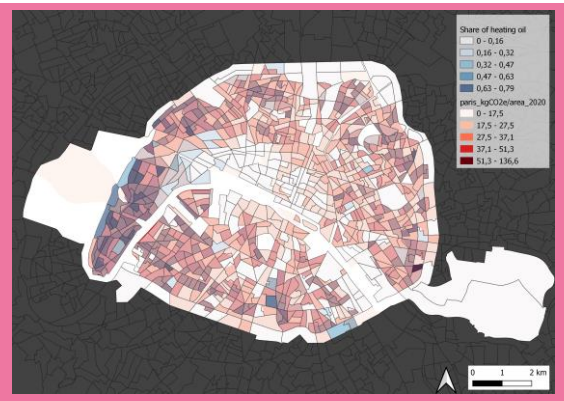
Renovation rate: from energy to GHG



Number of buildings per km^2 with an energy consumption of more than 330kWh/m^2/year



CO_2eq. emissions and building age



CO_2eq. emissions and share of oil heating

A **renovation rate of 3% year^{-1}** can result in a **50% decrease from 2019 till 2030 in energy consumption and GHG emissions**.

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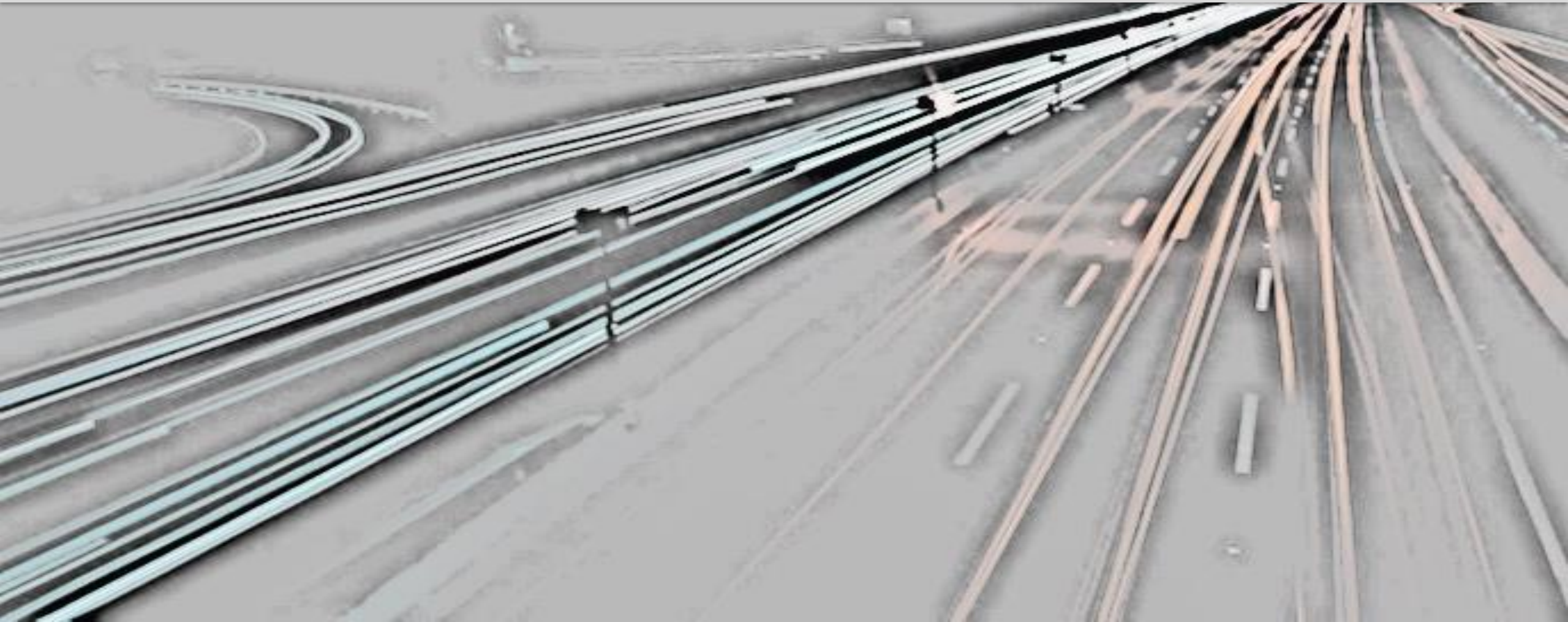
ZOOM:TRAFFIC SECTOR IN PARIS



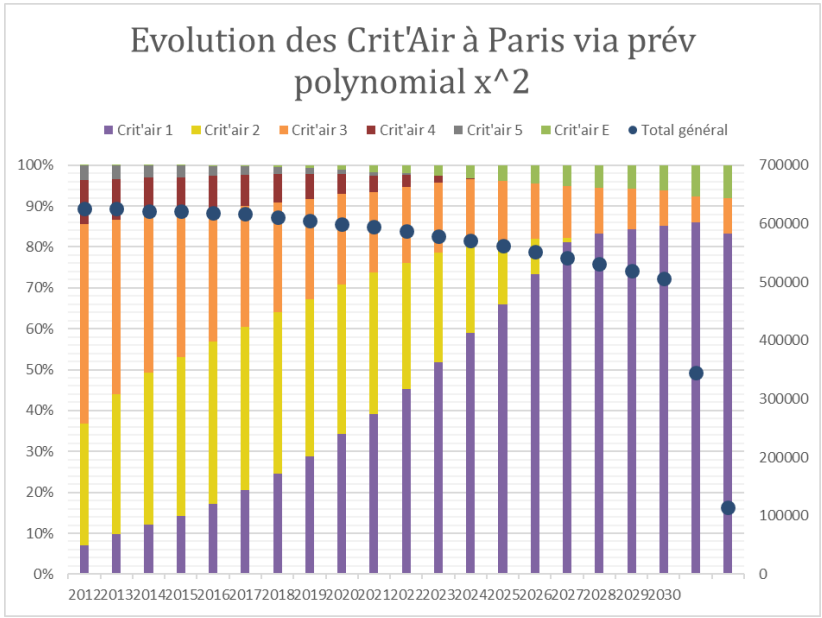
End of fuel powered vehicles

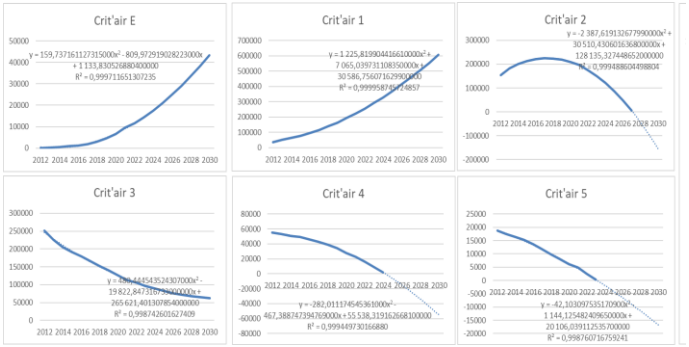
The Paris Climate Plan foresees two major agressive objectives :

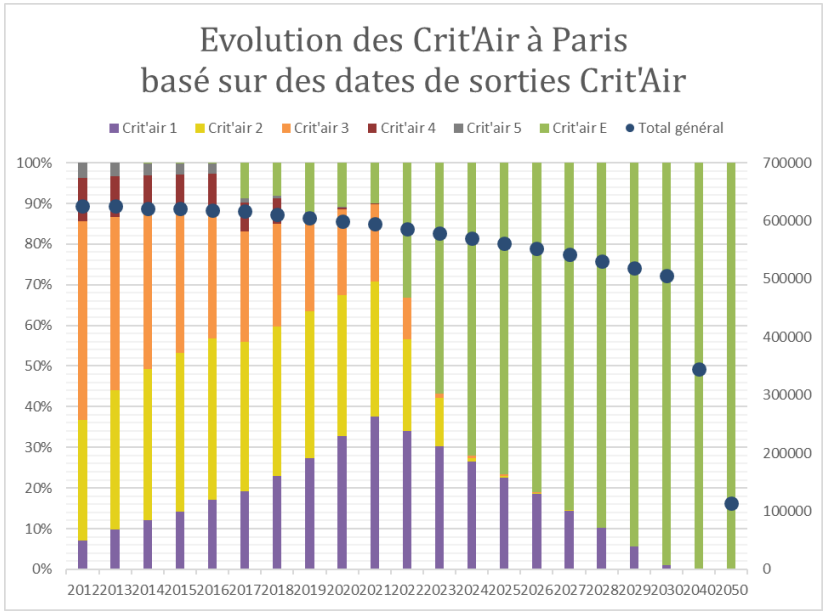
- Ban on diesel vehicles from 2024,
- Ban on gasoline vehicles from 2030

Paris Traffic Sector

Polynomial forecast versus Application of the Paris Climate Plan







Traffic: End of fuel powered vehicles by 2030

The Paris Climate Plan foresees two major objectives :

- Ban on diesel vehicles from 2024,
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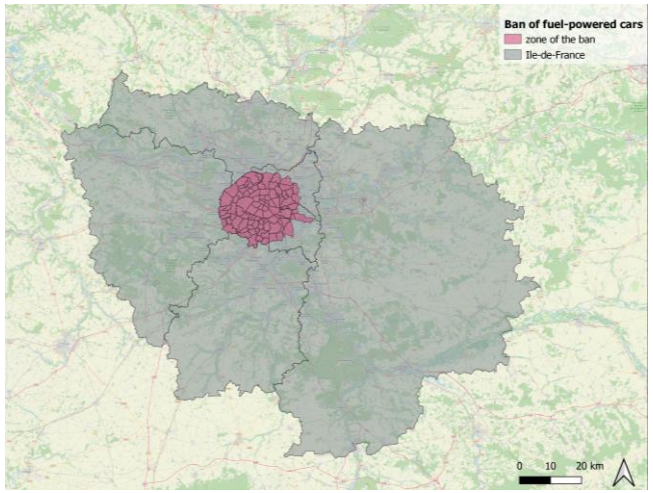
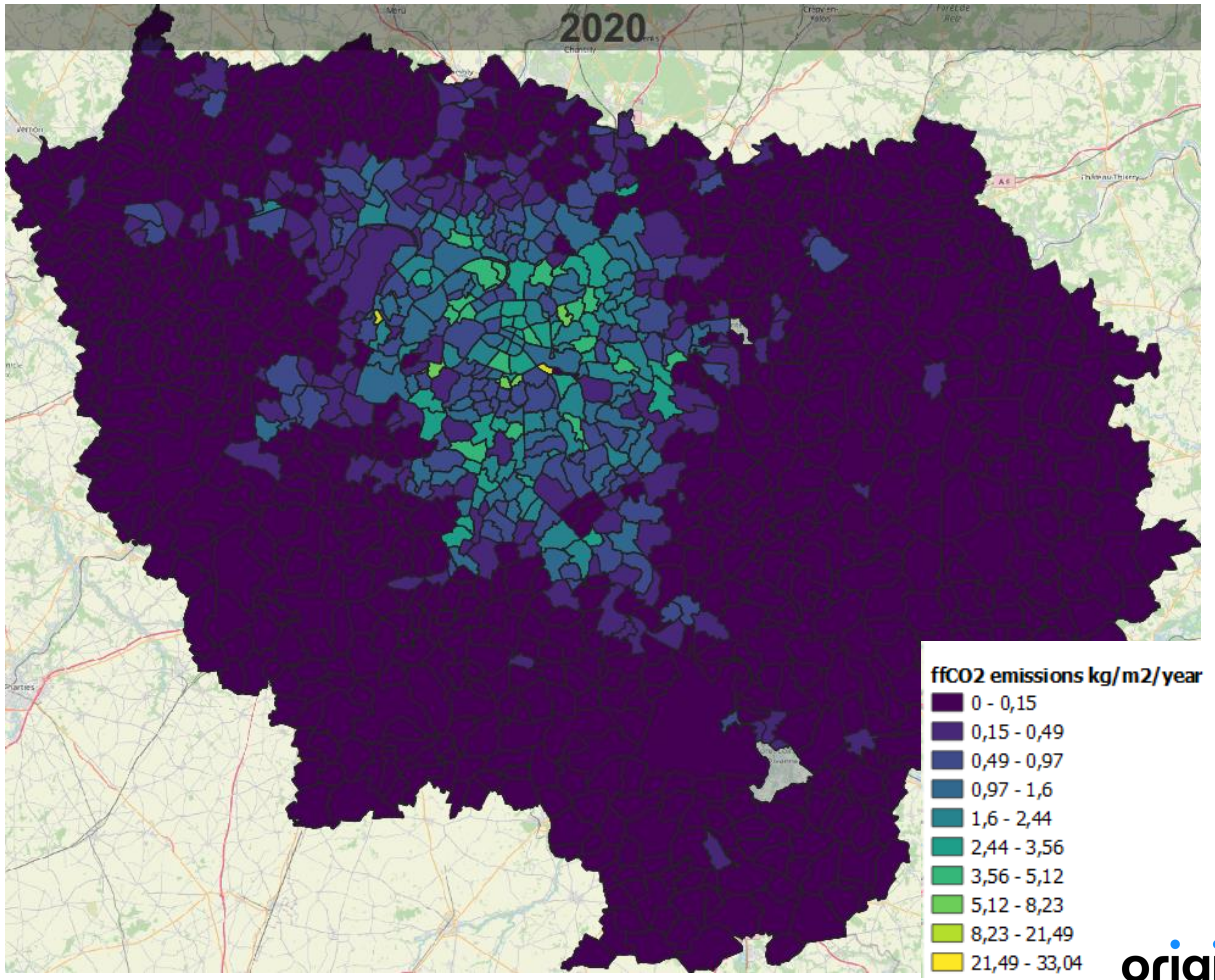


Zone of application



ZOOM: TERTIARY SECTOR IN PARIS

Targets in the tertiary sector in Paris

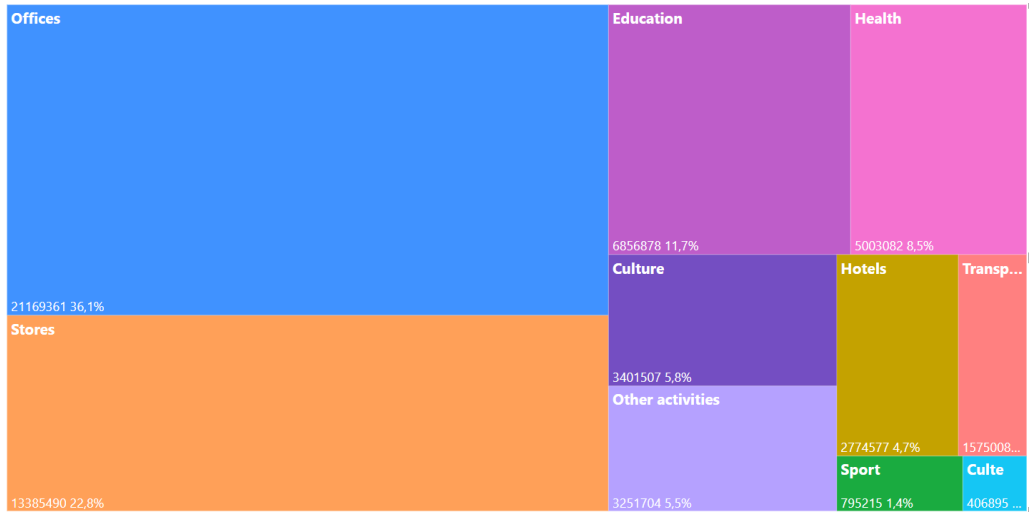
French National Law from Oct 2019 requires:

floor area greater than or equal to 1,000 m^2 => reduction of final energy consumption in existing tertiary buildings of at least:

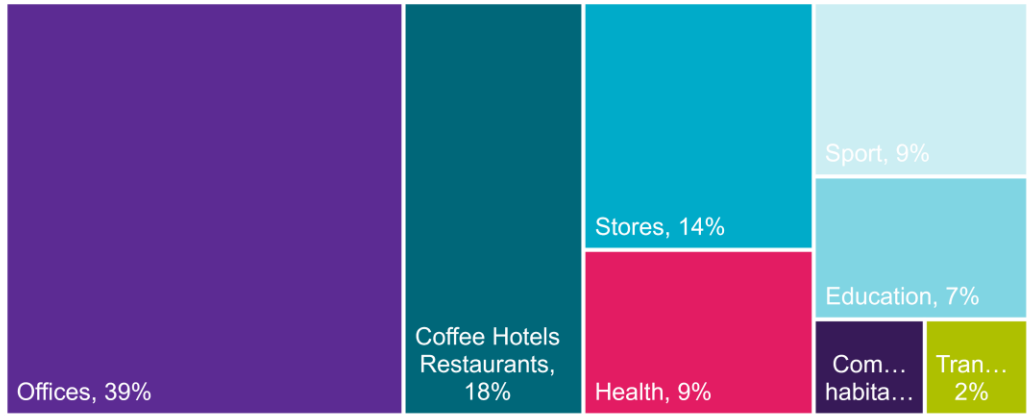
- **40 % by 2030,**
- **50% in 2040 and**
- **60% in 2050 compared to 2010.**

Offices have the biggest contribution

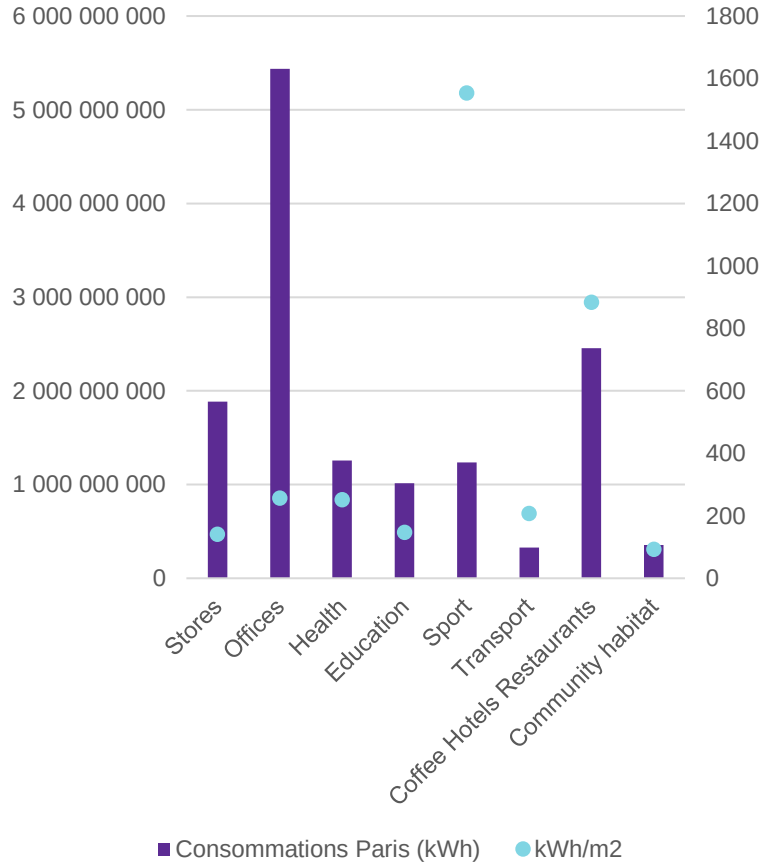
Tertiary space occupation in Paris (m^2)



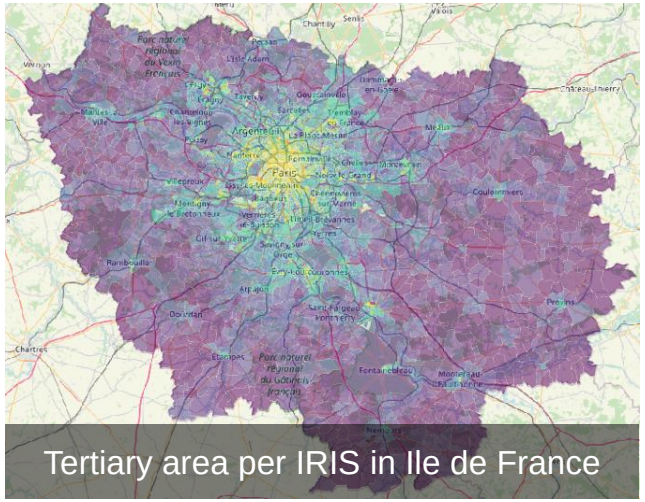
Tertiary energy consumption in Paris (kWh)



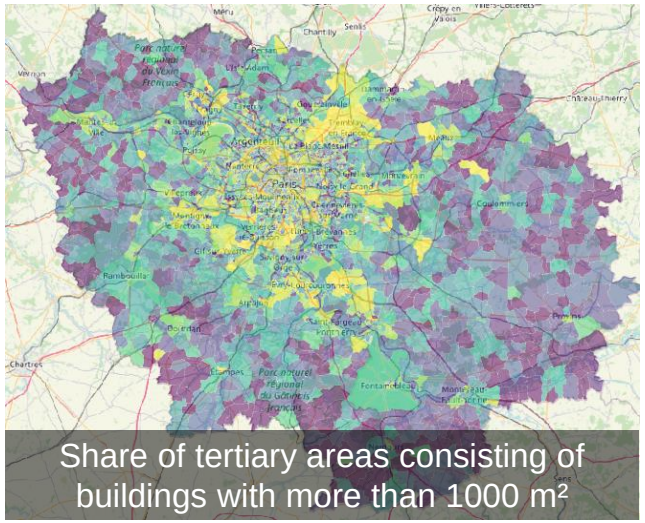
Tertiary energy consumption in Paris



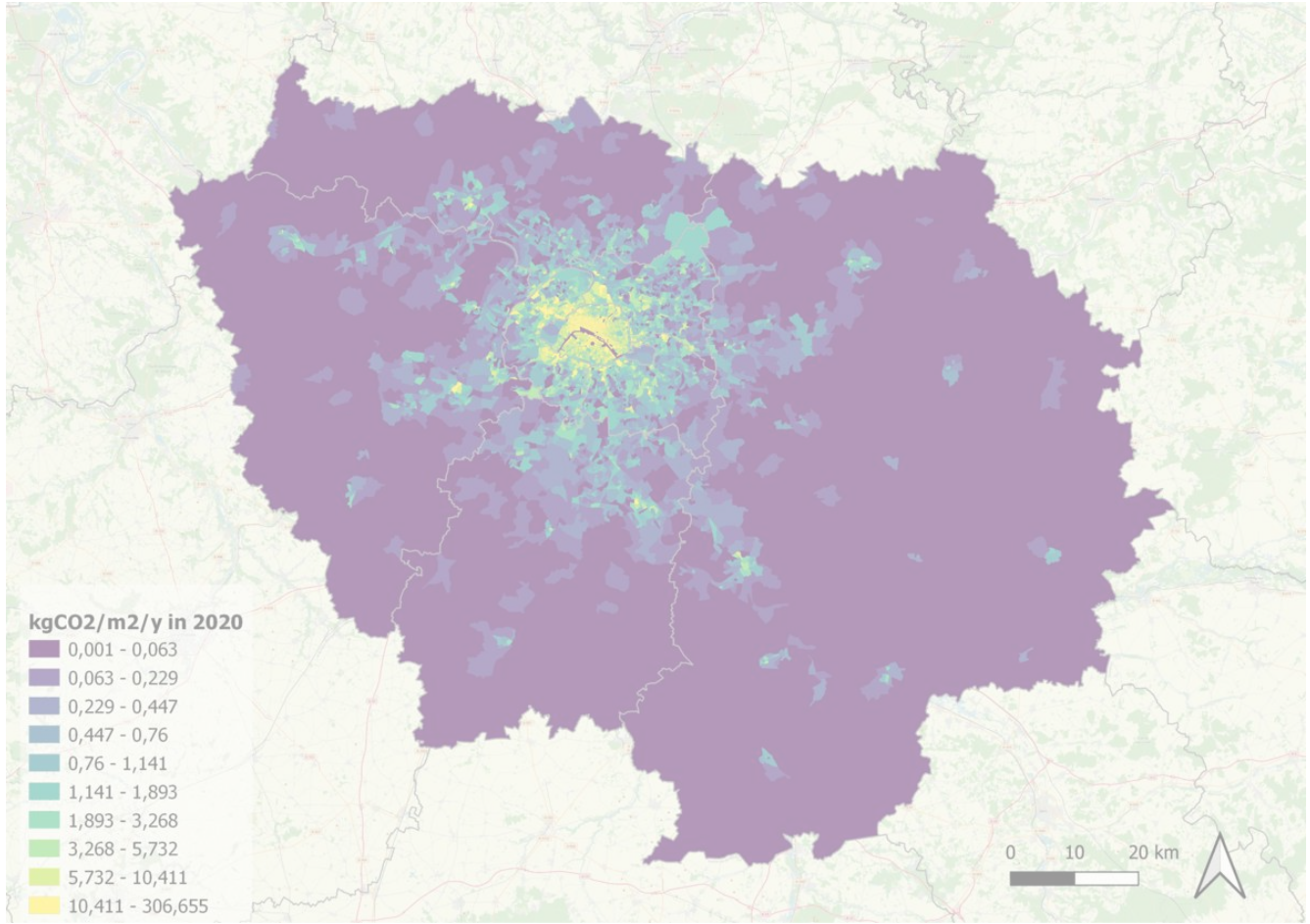
Tertiary buildings and CO_2 emissions



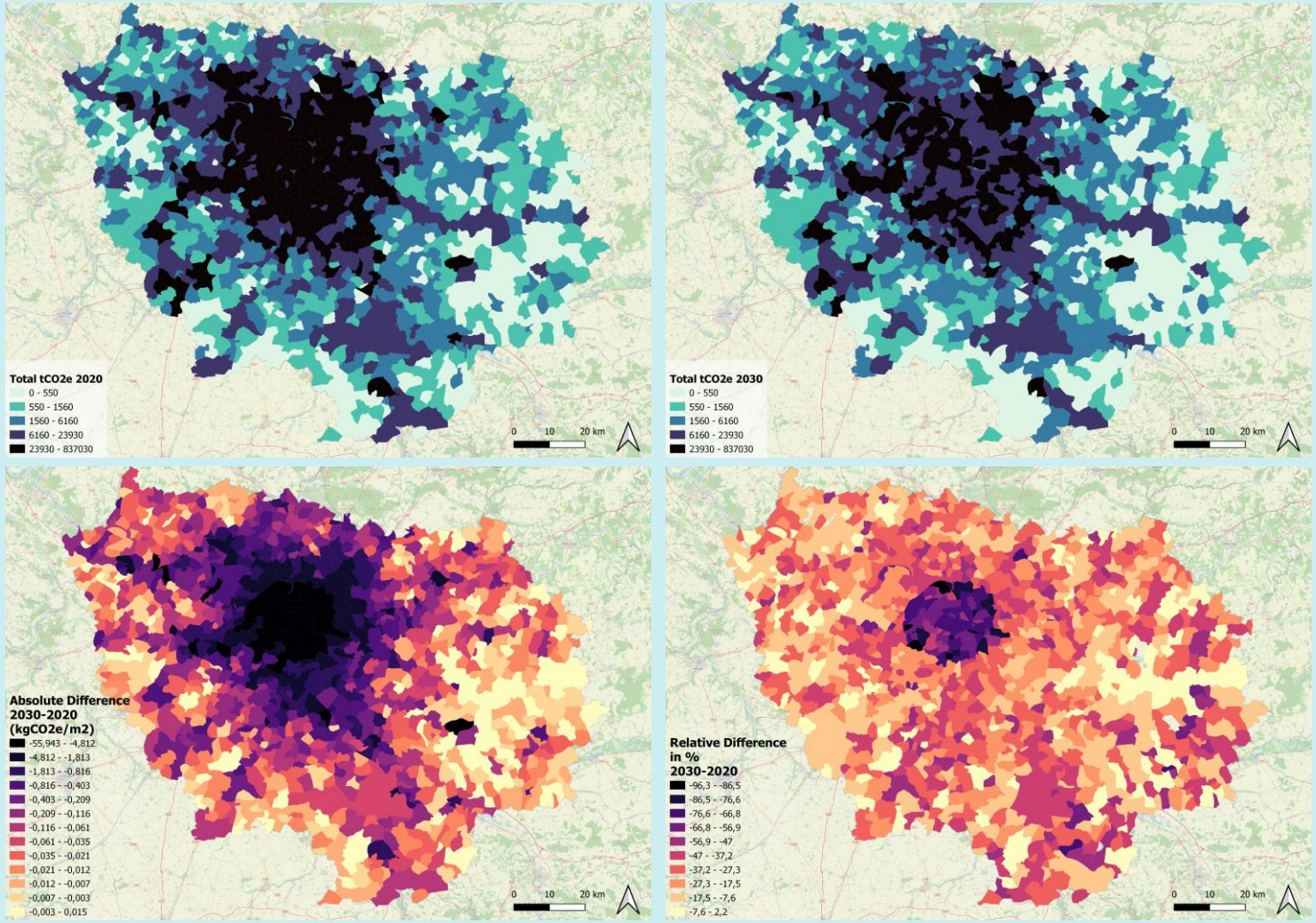
Tertiary area per IRIS in Ile de France



Share of tertiary areas consisting of buildings with more than 1000 m²



Spatial heterogeneity of total GHG emissions in the Paris metropolitan area



Take-Home

- Cities are heading the right direction but are too slow
- High spatial heterogeneity across the metropolitan area for each sector
- Atmospheric networks will need to consider future GHG emissions and not only urban spatial expansions

Outlook

- Definition of an optimal atmospheric monitoring network
- Scale to further cities

THANK YOU

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ICOS Cities

www.icos-ri.eu/icos-cities ICOS_RI #ICOSCities

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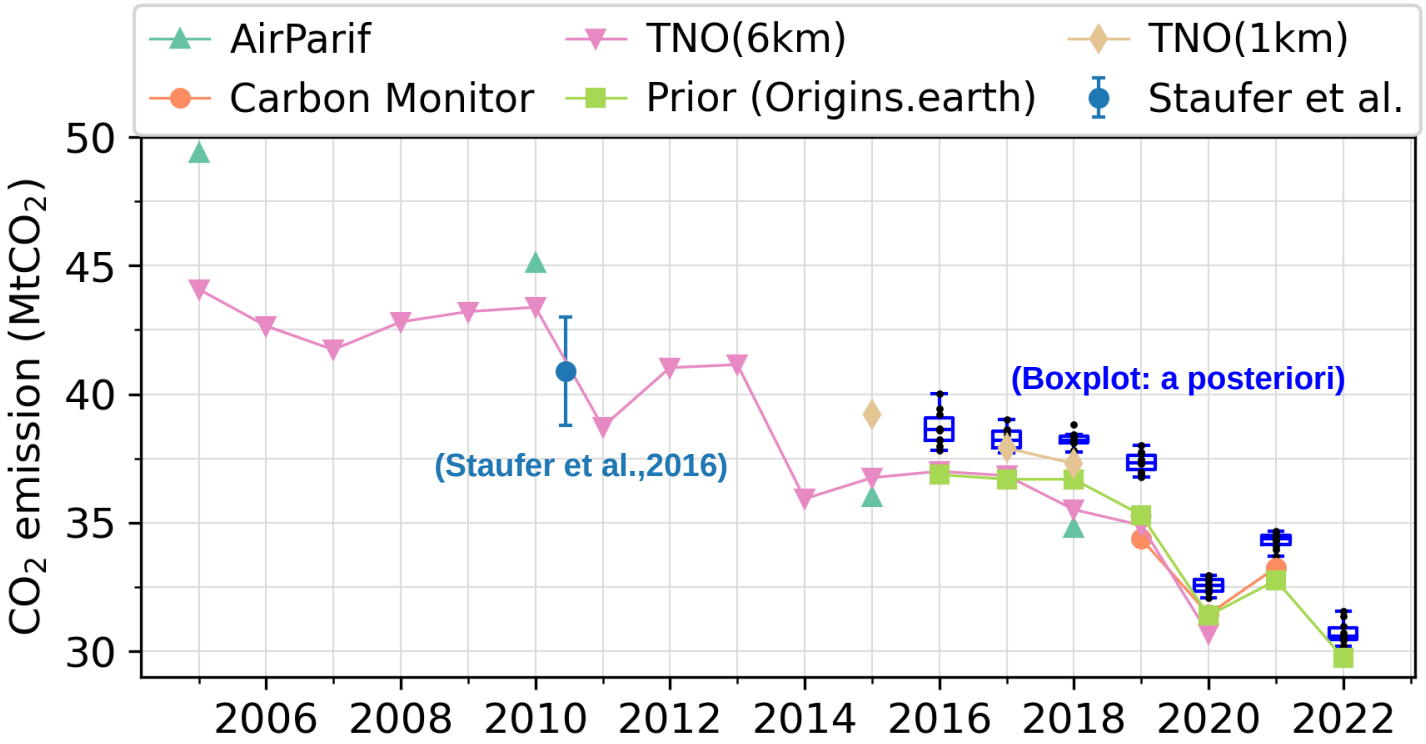
Back-up slides

ICOS Cities, aka Pilot Applications in Urban Landscapes - Towards integrated city observatories for greenhouse gases (PAUL), has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037319

Decreasing trend in urban CO_2 emissions



Jinghui Lian et al., ACPD, 2023
https://doi.org/10.5194/egusphere-2023-401

- The overall decreasing trend during 2005-2021 is mainly linked to reductions in the residential and industry emissions
- The annual CO_2 emissions declined at a rate of **~2% per year** from 2016 to 2019.
- The COVID-19 pandemic in 2020 led to a **12%** emission reduction with respect to 2019.
- The annual emission in 2021 rose by **5%** compared with 2020, but remains below the pre-COVID-19 level in 2019
- The emission decrease in 2022 is mainly linked to less heating because of warm temperature and energy crisis in winter
- The agreement among the various estimates of the annual fossil fuel CO_2 emission is within **~10%**