ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

espon.eu

EU2022.CZ

Czech Presidency of the Council of the European Union

The ESPON GGIA tool

Kimmo Lylykangas
Professor, head of Academy
Academy of Architecture and Urban Studies
Tallinn University of Technology

Contents

QGasSP project 2020–21

Quantitative Greenhouse Gas Impact Assessment Method for Spatial Planning Policy

Four stakeholders

- Eastern and Midlands Regional Authority (IE)
- Scottish Government – Planning & Architecture Division (UK)
- Department of Infrastructure, Northern Ireland (UK)
- Regional Council of Kymenlaakso (FI)

Service providers

- Tallinn University of Technology (EE)
- Stockholm Environment Institute, Tallinn Centre (EE)
- CODEMA (IE)

QGasSP project 2020–21

Quantitative Greenhouse Gas Impact Assessment Method for Spatial Planning Policy

Objective: to develop a methodology and a tool for

- **quantification of GHG emissions in spatial planning across Europe**
- **collection of comparable GHG baseline emissions data at national, regional and local levels**
- **cross-country, inter-regional and inter-municipality comparisons**
- **enhancing GHG quantification in SEA process (Strategic Environmental Assessment)**

Challenges

- **The methods for quantifying the GHG emissions of territories, regions, cities, municipalities are not harmonized.**
- **The most common approach in quantification (territorial approach) does not provide comparable results**
- **Viable quantification should enable the use of local data sources, which are diverse and dispersed**

ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

espon.eu

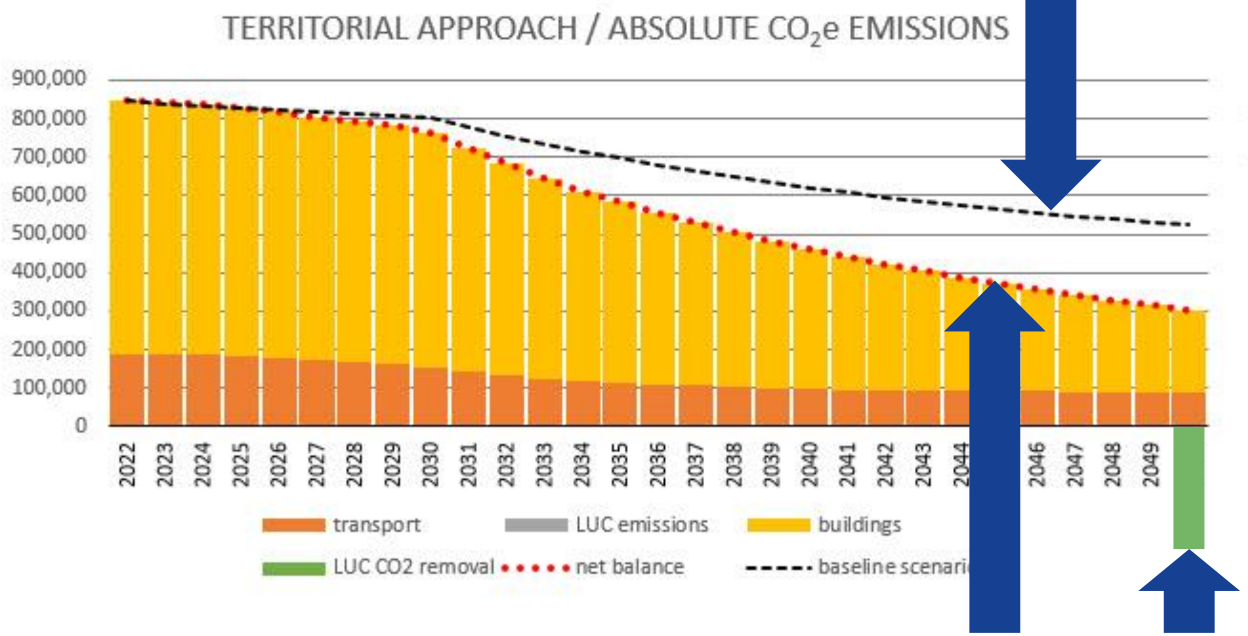
EU2022.CZ

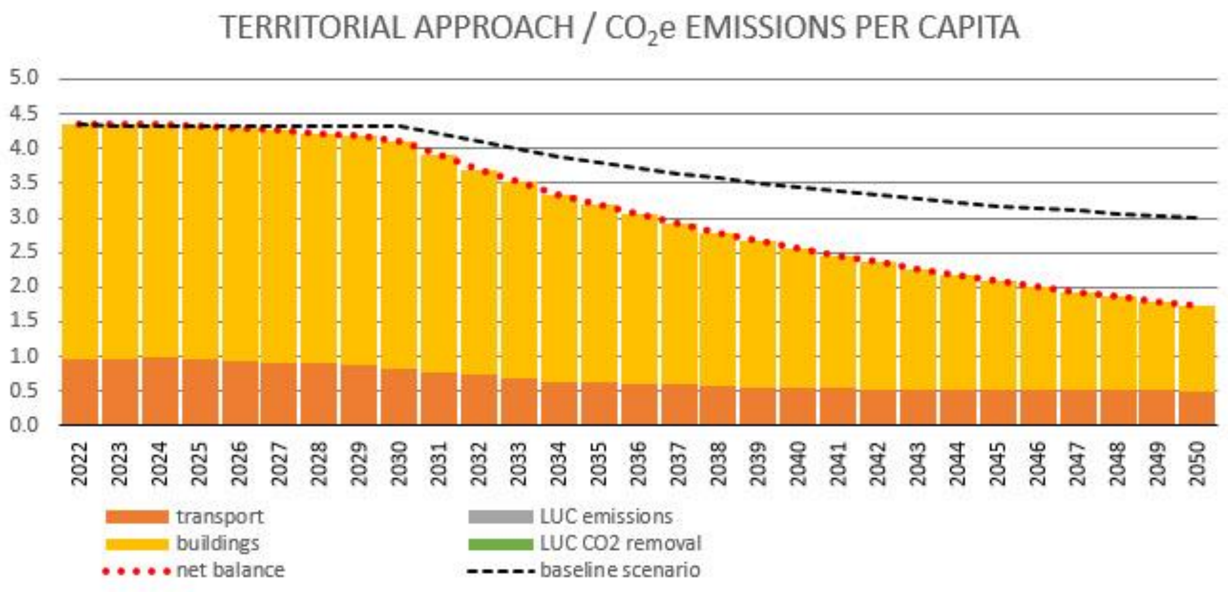
Czech Presidency of the Council of the European Union

1 The ESPON GGIA tool

GGIA tool – What is it for?

BASELINE





GHG EMISSIONS
WITH POLICY IMPACT

CO2 SEQUESTRATION
(LUC)

Features of the new tool

- Browser-based, modular, open source
- Baseline (absolute emissions) + future projection
- Quantification of the impact of spatial planning
- applicable for a region of any scale in 32 European countries
- comparable results enhancing the exchange of best practises
- Developed for ESPON EGTC in the QGasSP project in 2021–22 by

  Tallinn University of Technology

  Stockholm Environment Institute

  CODEMA

Two approaches in GHG quantification

TERRITORIAL APPROACH

GHG emissions within the geographic boundaries of an area of assessment (Scope 1) + extensions (Scope 2, Scope 3)

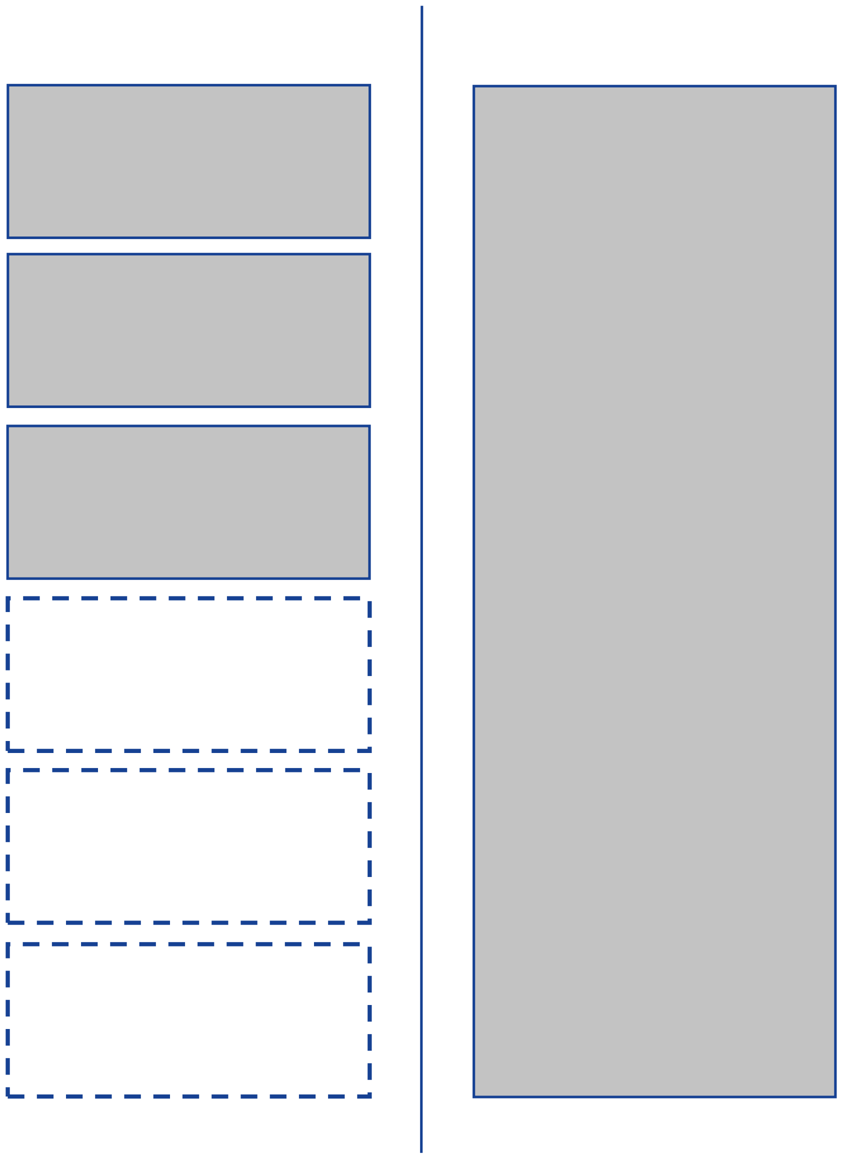
CONSUMPTION-BASED APPROACH

the global greenhouse gas emissions of the local residents

The guidelines of C40 cities network for climate action recommends applying both of these approaches.

Two quantification modes

- **Territorial mode**
  - **modules:**
    - **land-use change**
    - **energy use in buildings**
    - **transport**
    - **placeholders for new modules**
- **Consumption-based mode**
  - **sectors: all-inclusive**
  - **Extended Environmental Input-Output (EEIO) method**



ESPON GGIA TOOL

Territorial quantification

START | TRANSPORT | LAND-USE CHANGE | BUILDINGS | CONSUMPTION-BASED QUANTIFICATION | USER-GUIDE | GENERATE REPORT

Welcome to the GGIA tool

The ESPON GGIA tool is designed to quantify the greenhouse gas emissions in spatial planning. It has two quantification modes: territorial mode and consumption-based mode.

The first step is to estimate the baseline CO2 emissions. After that the CO2 emissions of new settlements and/or various planning policies can be quantified.

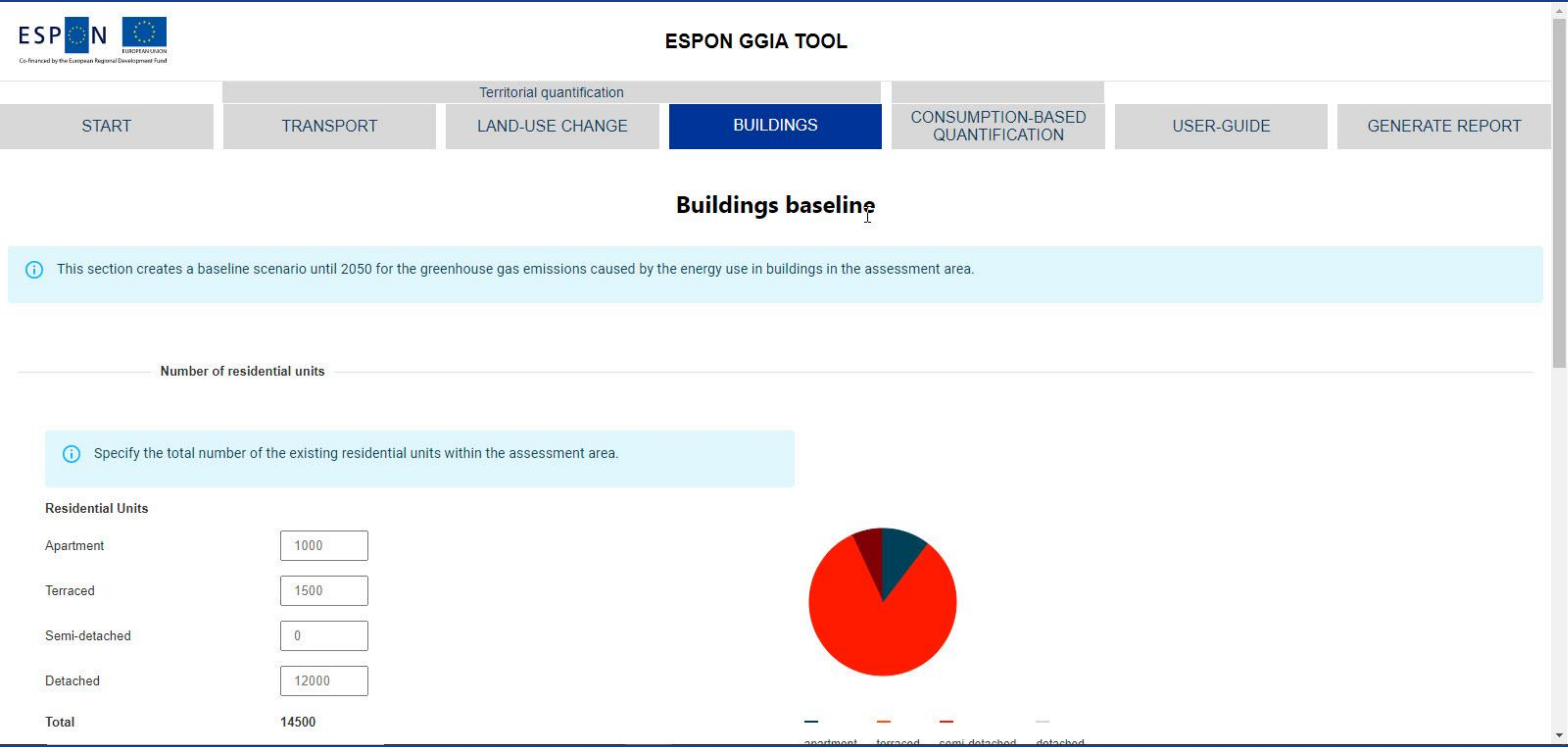
When using the default values, GGIA down-scales country-level European data and creates future projections based on the EU Reference Scenario 2016. Consumption-based quantification applies the Exiobase matrix and the data from Household Budget Surveys (HBS).

For more accurate results, local experts can create a local dataset and upload it into the GGIA tool in csv format. This way the most accurate data available can be applied in the quantification.

As the quantification results depend on the input values, ESPON EGTC cannot guarantee the authenticity of results and cannot be held responsible for any decisions taken based on the results or indications from the GGIA tool.

GGIA is an open-source application. The source code in Python is available in GitHub . ESPON EGTC welcomes all new hard-coded proposals on additional quantification modules or module versions that improve the current calculation methodology.

Start


ESPON GGIA TOOL
Territorial quantification
START
TRANSPORT
LAND-USE CHANGE
BUILDINGS
CONSUMPTION-BASED QUANTIFICATION
USER-GUIDE
GENERATE REPORT
Buildings baseline
This section creates a baseline scenario until 2050 for the greenhouse gas emissions caused by the energy use in buildings in the assessment area.
Number of residential units
Specify the total number of the existing residential units within the assessment area.
Residential Units
Apartment 1000
Terraced 1500
Semi-detached 0
Detached 12000
Total 14500

START | TRANSPORT | LAND-USE CHANGE | BUILDINGS | CONSUMPTION-BASED QUANTIFICATION | USER-GUIDE | GENERATE REPORT

Land-use change

This section estimates the greenhouse gas emissions from the land-use changes of a plan or a planning policy. The quantification is based on the six IPCC land use categories.

First You need to specify the land use types of the areas that will change when the plan or the policy in concern is implemented. GIS tools and databases such as Corine Land Cover and European soil database can be applied to define the land use categories and their surface areas.

Find the relevant land-use changes in the tables below. Then insert three values per each change to calculate the impact: total land area converted from one category to another in hectares, and the shares of mineral and organic soils within this land area. Other rows and tables can be left empty.

All built environment belongs to the category settlement.

- ☐ Land-Use Change to Forest Land
- ☐ Land-Use Change to Crop Land
- ☐ Land-Use Change to Grassland
- ☐ Land-Use Change to Wetland
- ☐ Land-Use Change to Settlements
- ☐ Land-Use Change to Other Land

Land-Use Change	Total area, ha	Soil area (mineral), ha	Soil area (organic), ha
Total area (ha)	0	0	0

Calculate and save emissions | Reset

ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

espon.eu

EU2022.CZ

Czech Presidency of the Council of the European Union

2 Baseline emissions and open data

Territorial approach - TRANSPORT

- **Passenger transport: car, bus, tram, metro, train**
- **Freight transport: road, rail, inland waterways**
- **Tank-to-wheel emissions (combustion) + grid electricity emissions**

  electric vehicles according to the national grid electricity
- **Car fleet (fuel types) as in the national car fleet according to Eurostat statistics**
- **Future projections as in EU Reference Scenario 2016 (PRIMES model)**
- **Default activity data is down-scaled from national statistics by population and settlement type.**

Territorial approach - LAND USE CHANGE

IPCC methodology

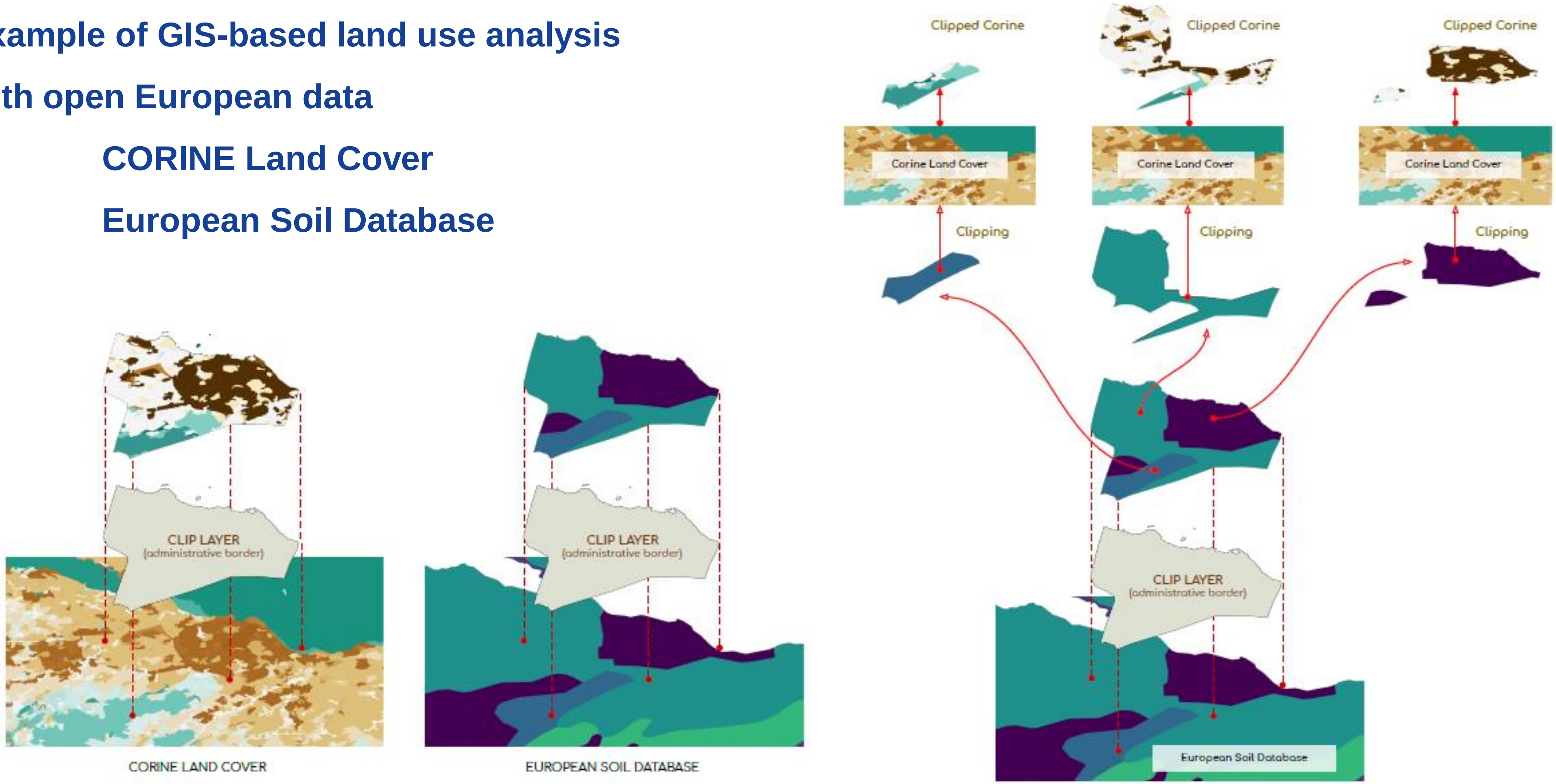
Land use categories	Carbon pools	
forest land	living biomass	aboveground
cropland		belowground
grassland	dead organic matter	dead wood
wetlands		litter
settlements (urban areas)	soil	mineral
other land		organic

- **Carbon-Stock-Change (CSC) factors from the CRF tables of national inventory reports (NIR) for 32 European countries + FAO FRA data for deforestation.**
- **Requires an analysis of land use types within the area of assessment, for example with CORINE CLC and European Soil Database (applicable across Europe).**

Example of GIS-based land use analysis with open European data

CORINE Land Cover

European Soil Database



Territorial approach - BUILDINGS

- **Residential units: apartments, terraced, semi-detached, detached**
- **Commercial buildings: retail, health, hospitality, office, industrial, warehouses**
- **Energy consumption for eight energy carriers by building type**

  Default values according to the EU Buildings Database
- **Simplified modelling of buildings stock (annual demolition rate, annual rate of new construction)**
- **Expected decarbonisation of national grid electricity: the EU Reference Scenario 2016**

Consumption-based approach

- **EEIO (Extended Environmental Input-Output) method:**

  from expenditure to CO_2 emissions
- **Two main datasets**

  Exiobase

  Household Budget Survey (HBS)
- **Future projections are based on the EU Reference Scenario 2016**
- **Provides a holistic estimate on the global GHG emissions for the consumption of the residents in the assessment area**

Examples of data gaps

TERRITORIAL QUANTIFICATION

Transport

- **Vehicle occupancy rates**

Land Use

- **Carbon Stock Change factors**

Buildings

- **Future prognoses for demolition and construction rates (scenario)**
- **Emission factors for district heating systems**

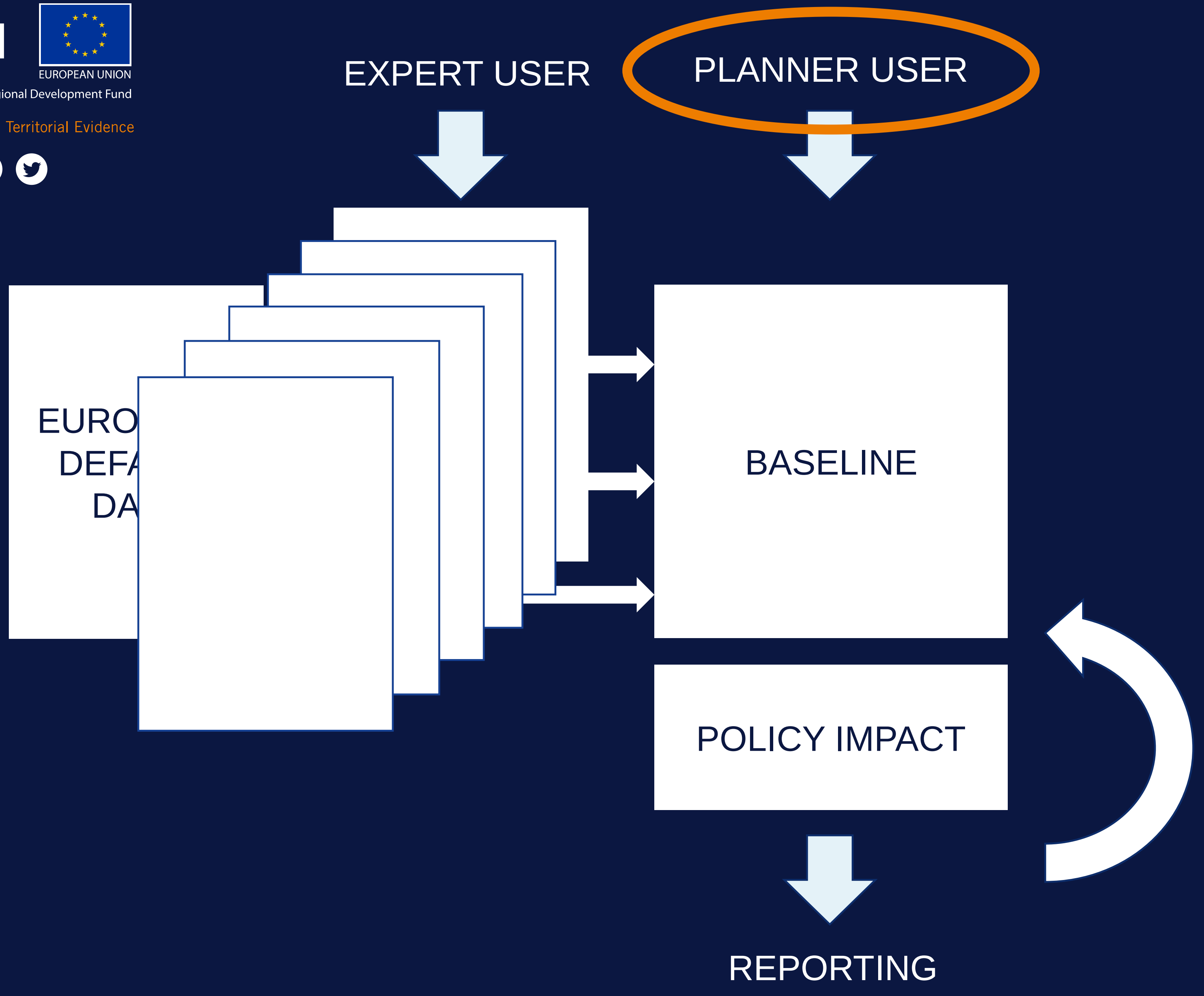
CONSUMPTION-BASED QUANTIFICATION

- **Household Budget Surveys**

ESPON
EUROPEAN UNION
Co-financed by the European Regional Development Fund
Inspire Policy Making with Territorial Evidence
espon.eu

EU2022.CZ
Czech Presidency of the Council
of the European Union

3 Existing baseline inventories


EXPERT USER
PLANNER USER
BASELINE
POLICY IMPACT
REPORTING

Three types of users

Planner User	no specific knowledge on GHG quantification required
Expert User	expertise on GHG quantification required
	can create a <u>local dataset</u> to apply the most relevant datasets
	two local dataset writers available in Github
	GGIA_local_dataset_T.xls for territorial csv dataset
	GGIA_local_dataset_C.xls for consumption csv dataset
	submission of a new dataset to include it in the GGIA tool: https://github.com/QGasSP/ggia-backend/tree/main/CSVfiles
Developer User	developer of additional or improved calculation modules
	open source Python code available in GitHub

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

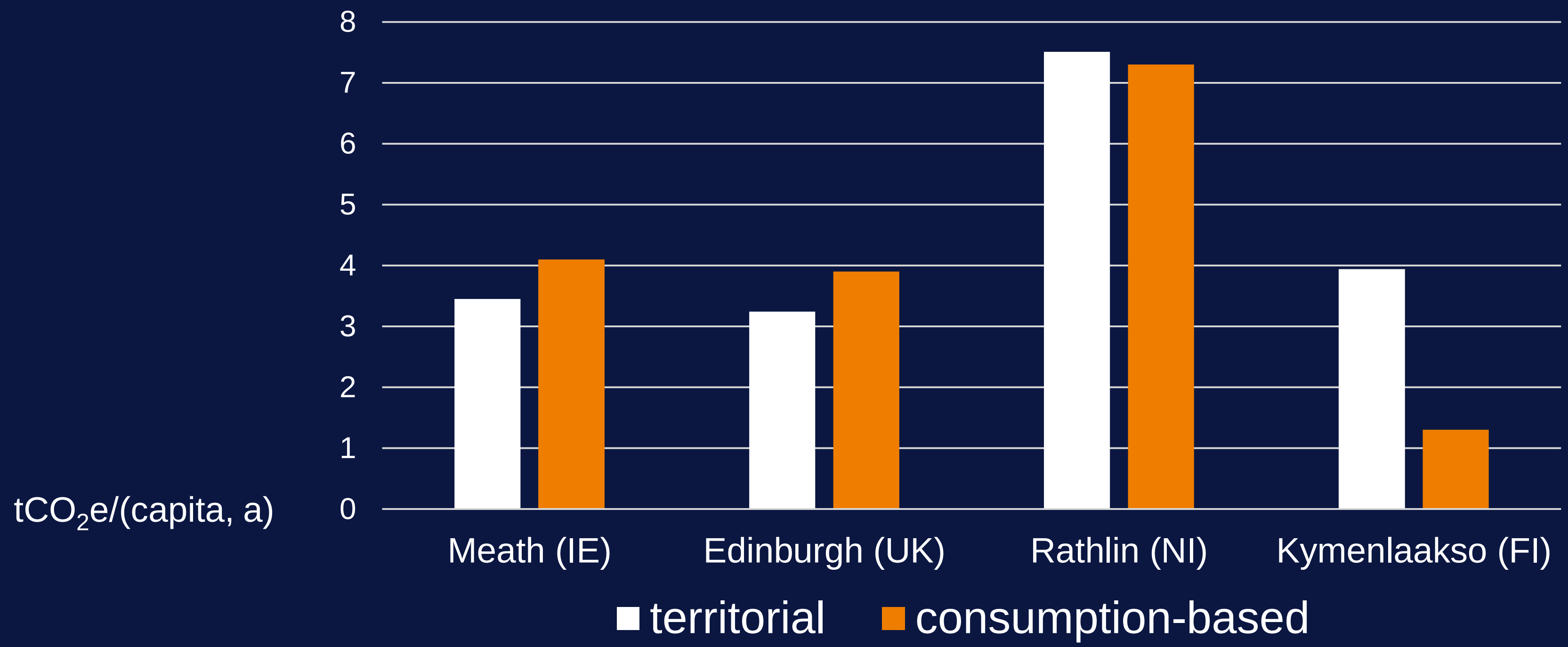
espon.eu

EU2022.CZ

Czech Presidency of the Council of the European Union

4 Observations from Case Studies

Territorial quantification - BUILDINGS



ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

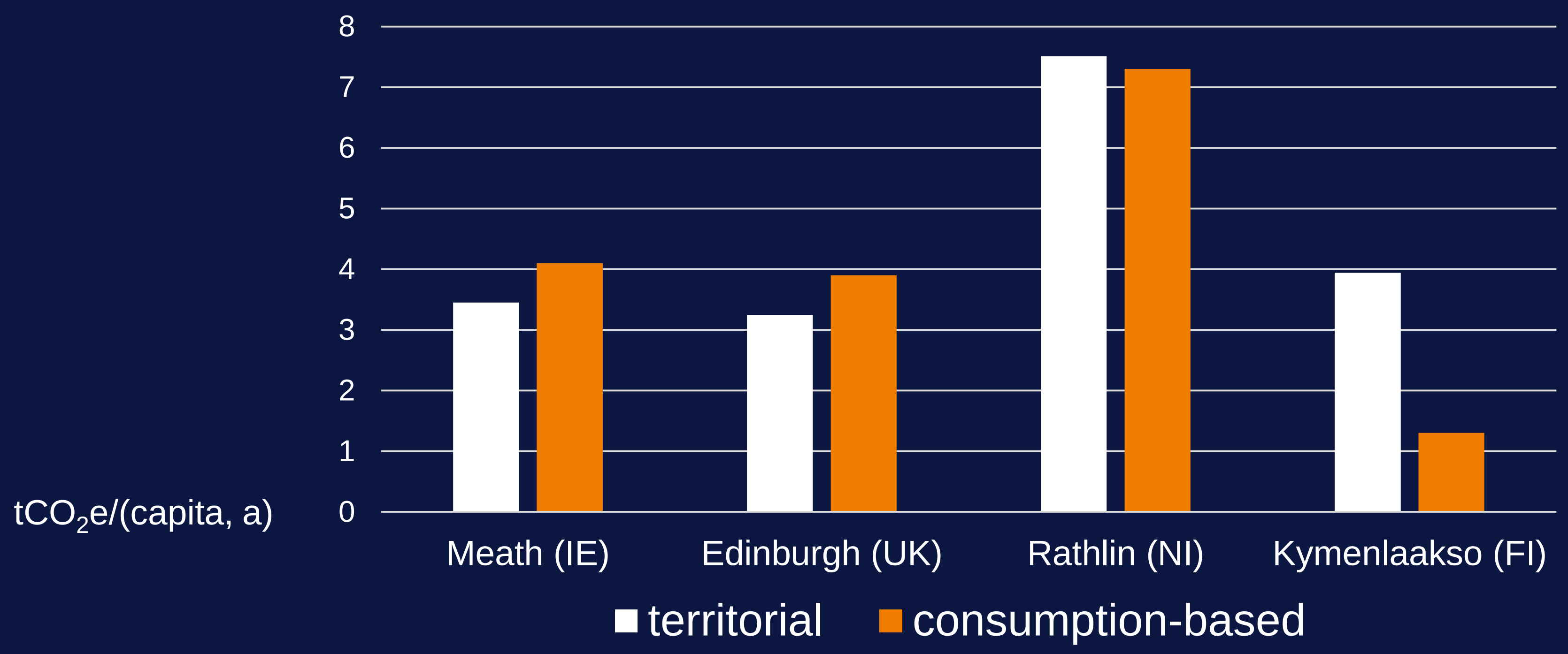
Inspire Policy Making with Territorial Evidence

espon.eu

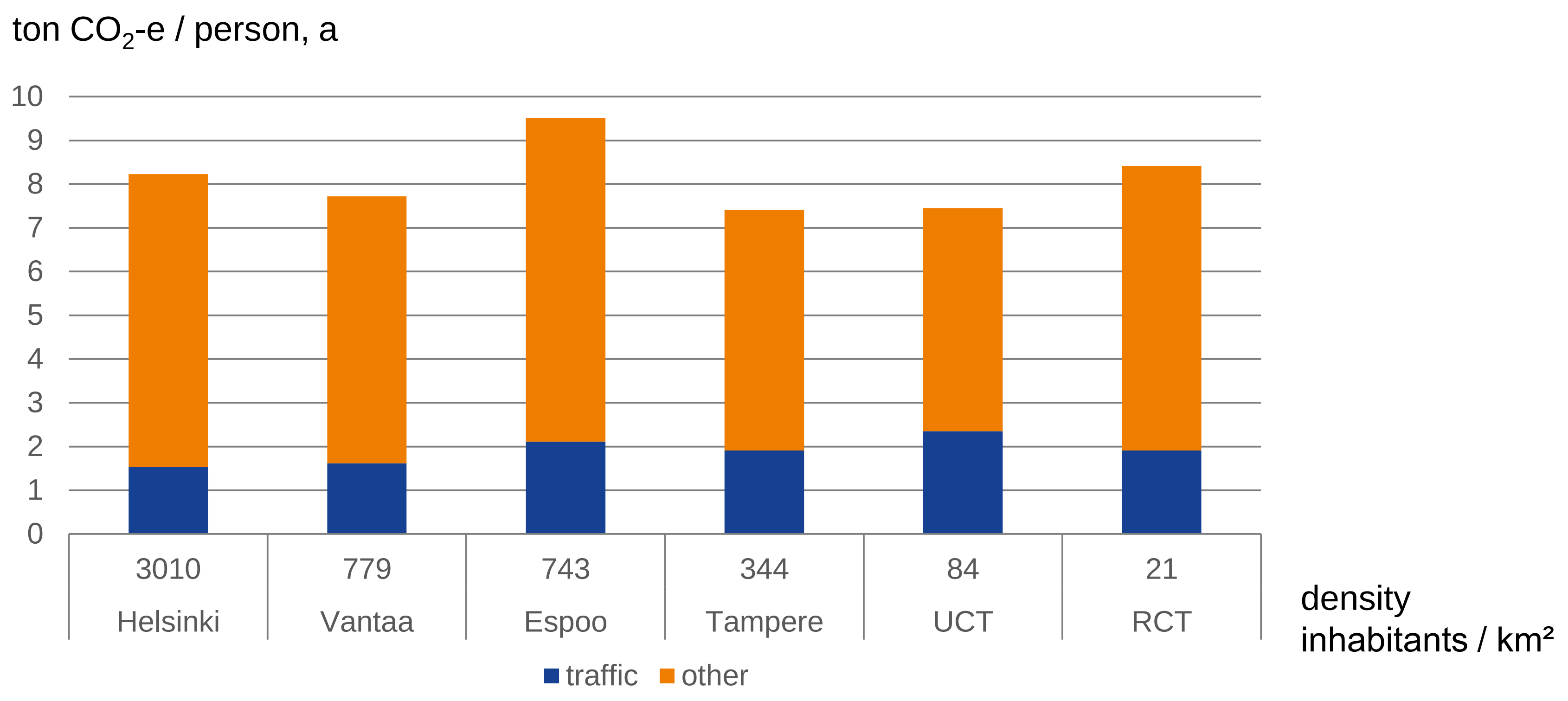
EU2022.CZ

Czech Presidency of the Council of the European Union

Territorial quantification - BUILDINGS



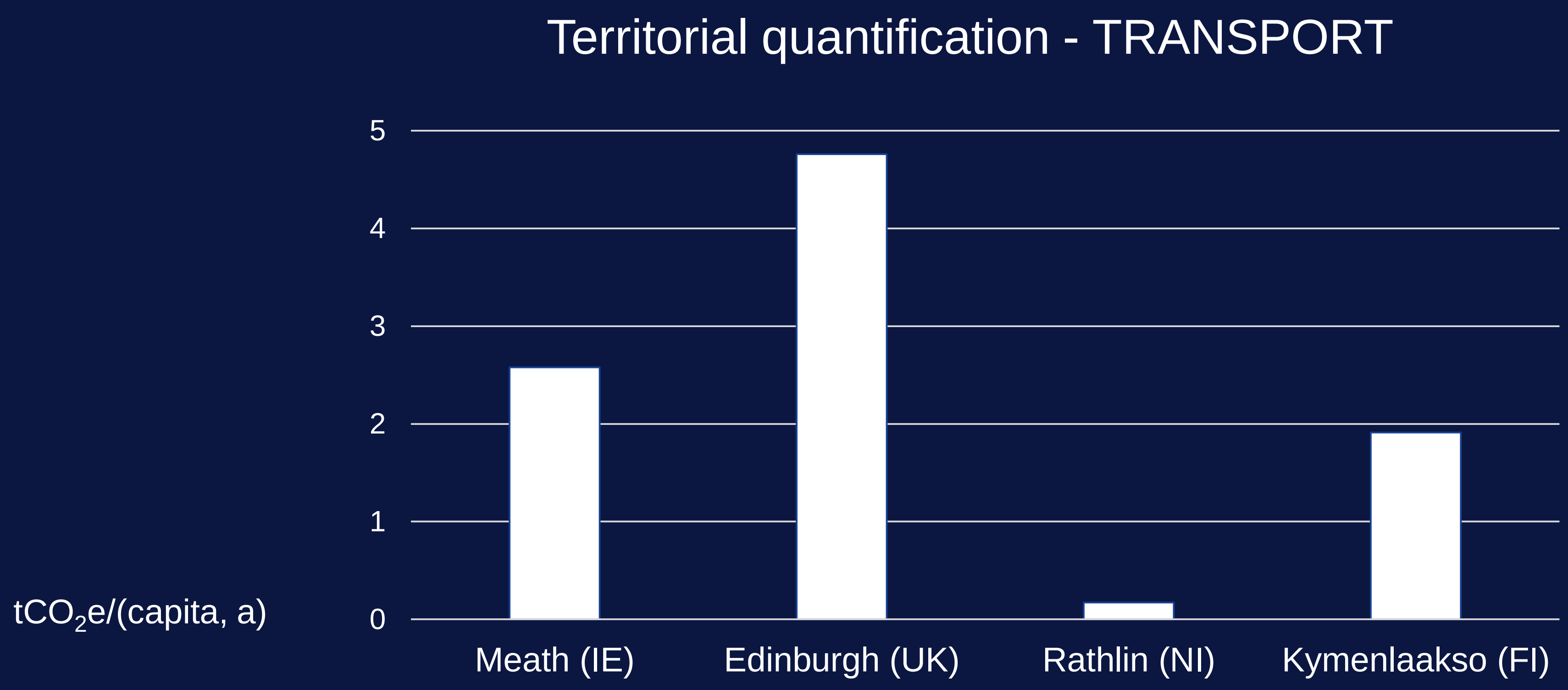
Density or lifestyle?



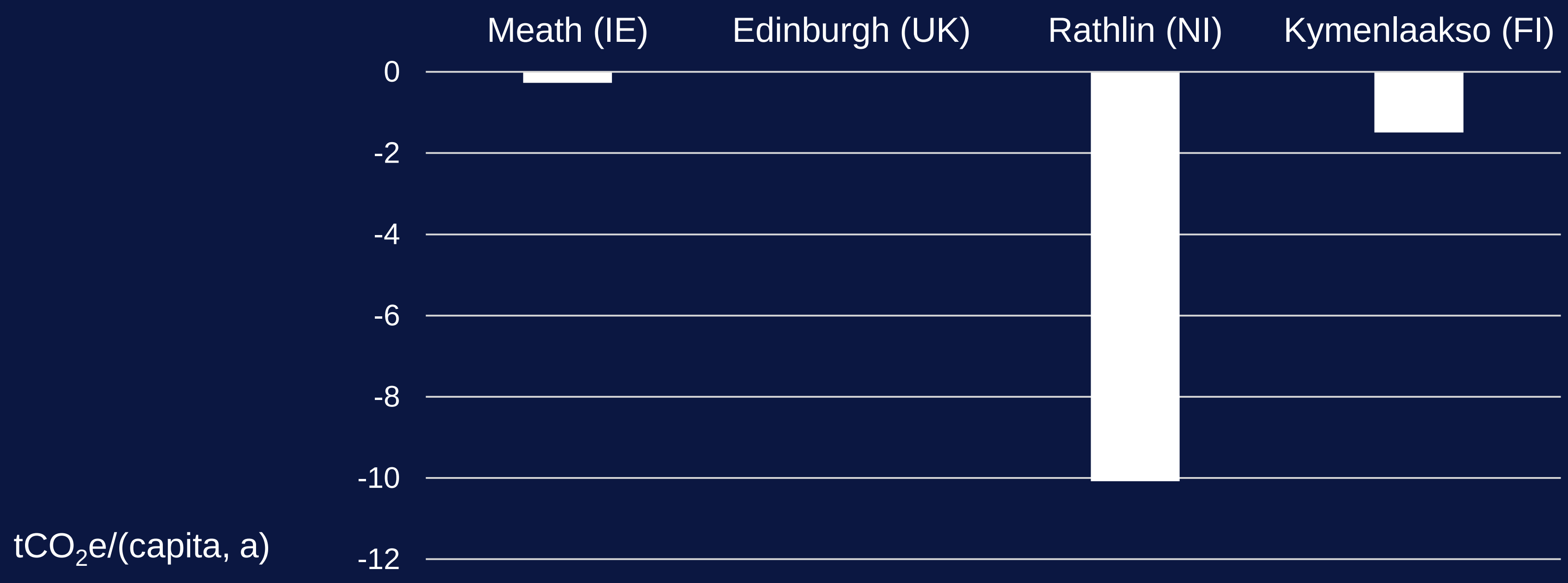
SOURCE: Heinonen, Jukka & Junnila, Seppo: Implications of urban structure on carbon consumption in metropolitan areas. Environmental Research Letters Volume 6 number 1 (2011).

ESPON
EUROPEAN UNION
Co-financed by the European Regional Development Fund
Inspire Policy Making with Territorial Evidence
espon.eu

EU2022.CZ
Czech Presidency of the Council of the European Union



Territorial quantification – LAND USE



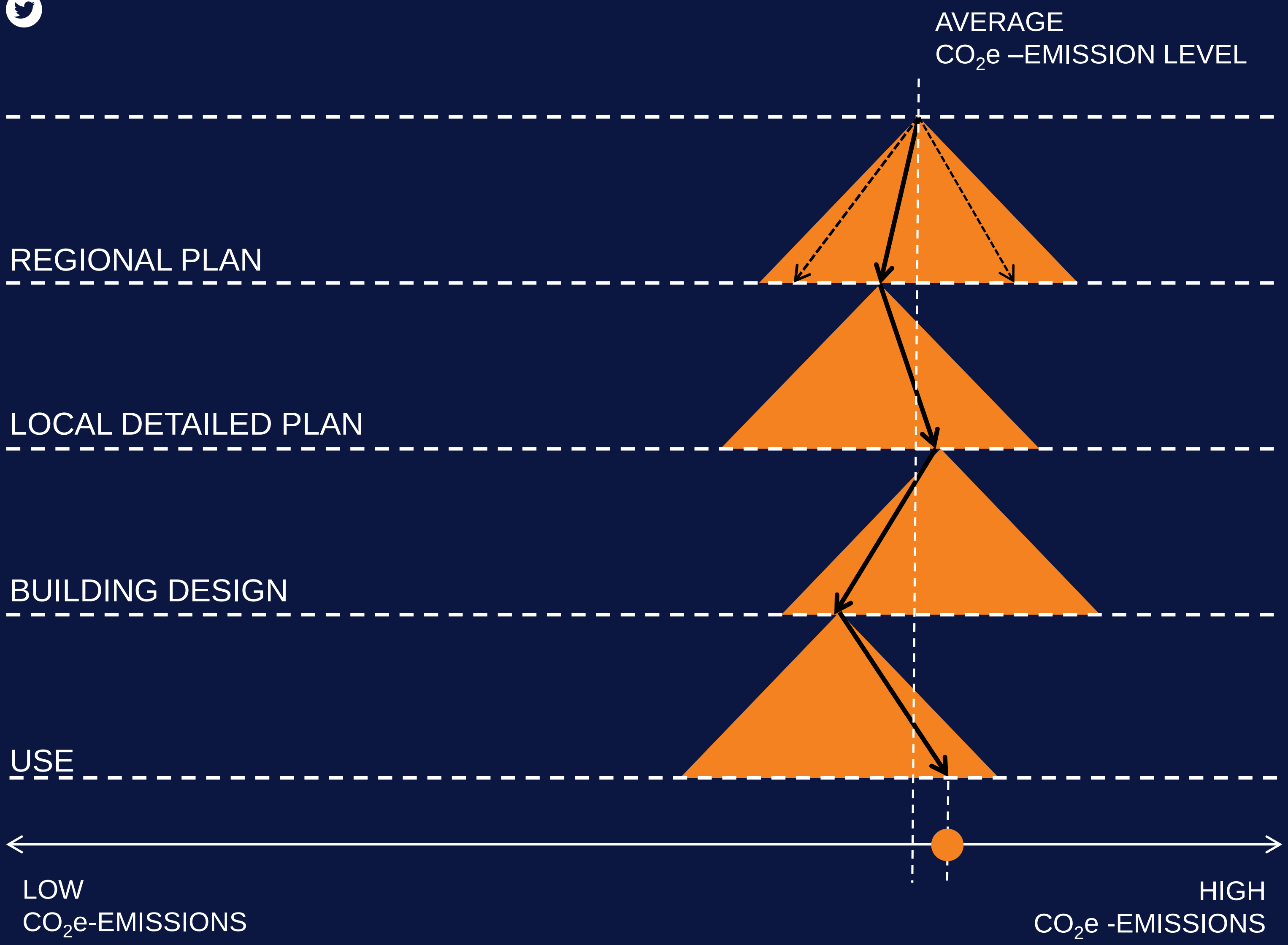
Co-financed by the European Regional Development Fund

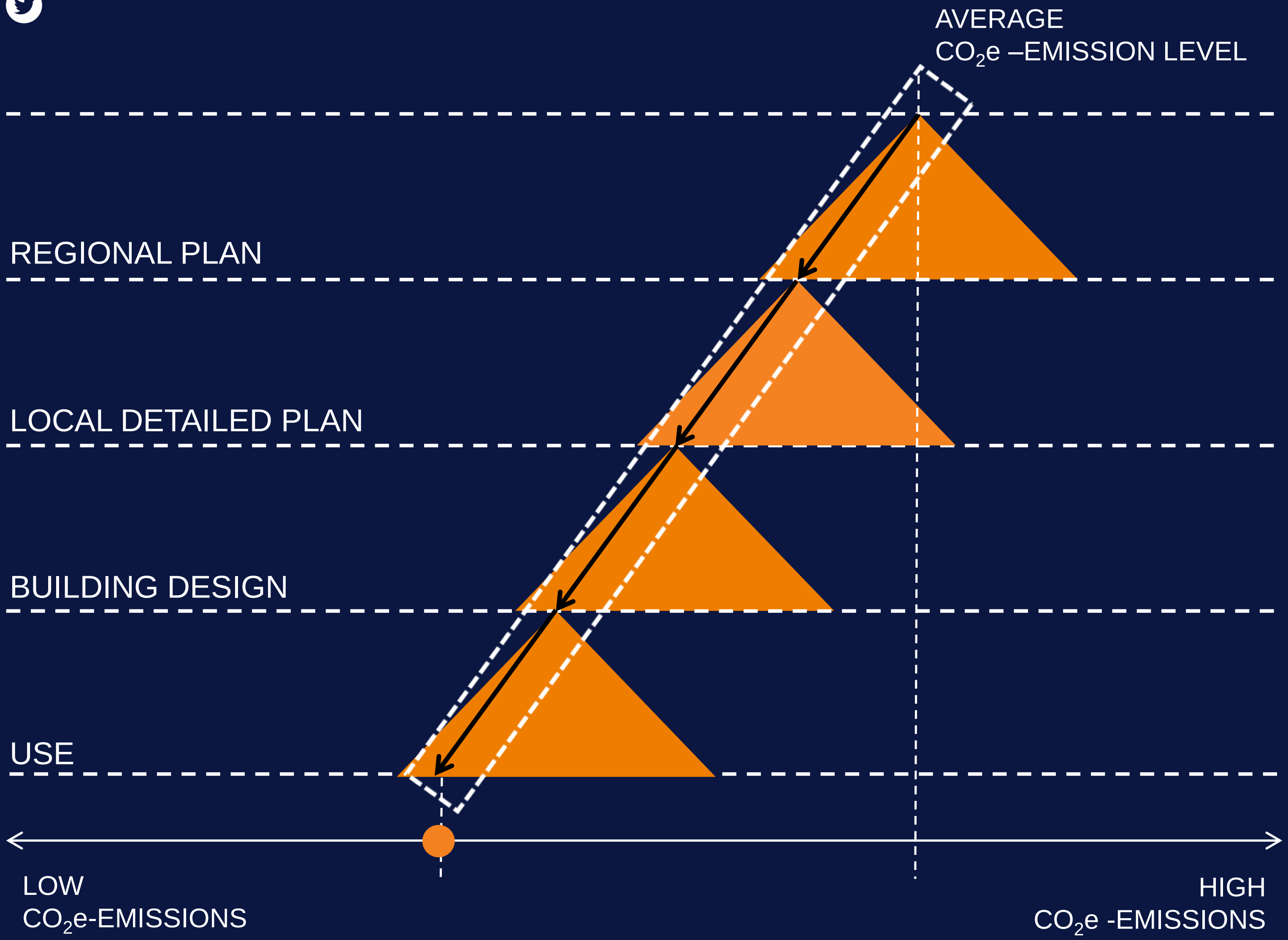
Inspire Policy Making with Territorial Evidence

espon.eu

EU2022.CZ

Czech Presidency of the Council of the European Union




AVERAGE
CO2e –EMISSION LEVEL
REGIONAL PLAN
LOCAL DETAILED PLAN
BUILDING DESIGN
USE
LOW
CO2e-EMISSIONS
HIGH
CO2e -EMISSIONS

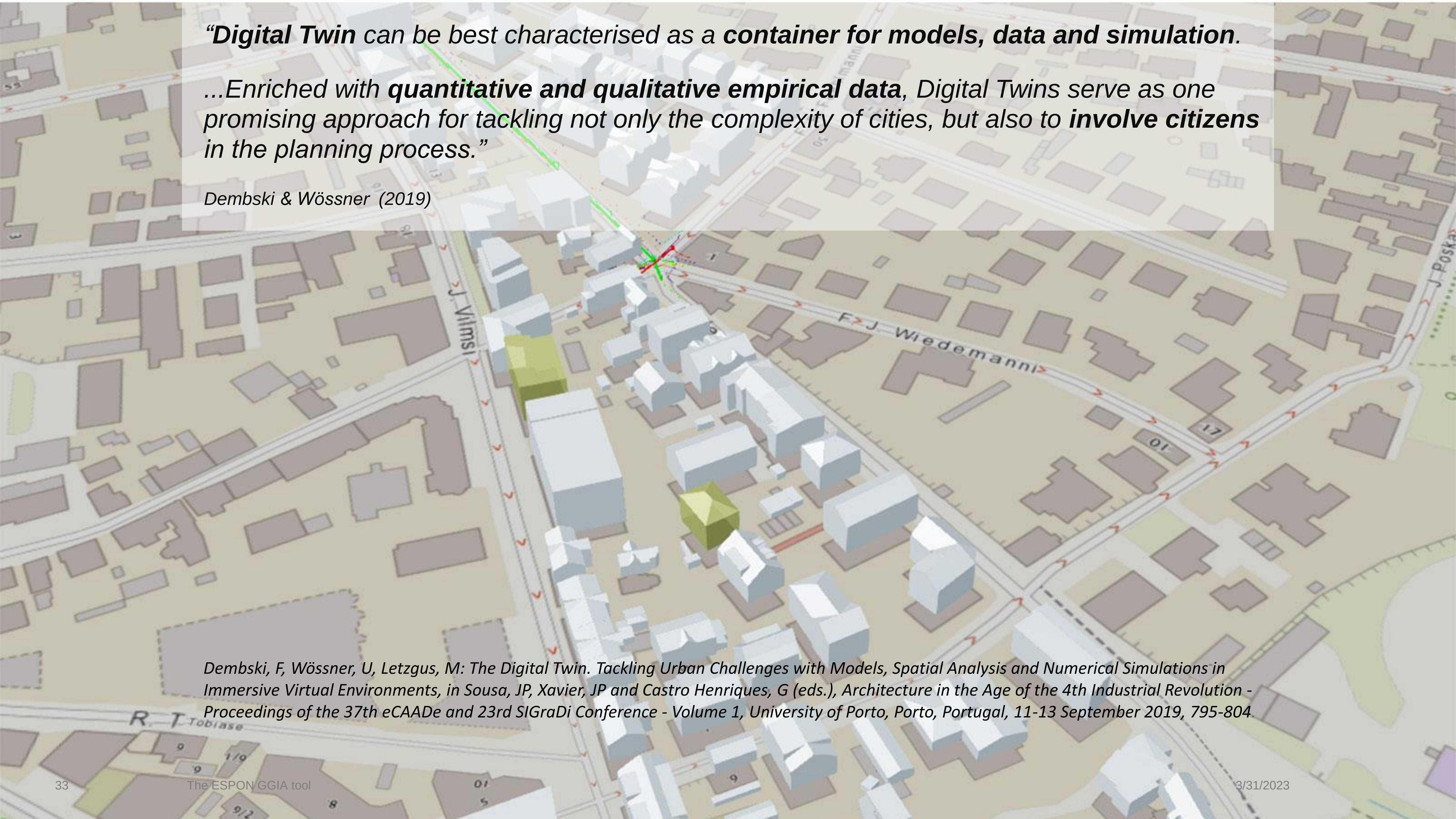
Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

espon.eu

Czech Presidency of the Council of the European Union

5 Future perspectives



*“**Digital Twin** can be best characterised as a **container for models, data and simulation**.*

*...Enriched with **quantitative and qualitative empirical data**, Digital Twins serve as one promising approach for tackling not only the complexity of cities, but also to **involve citizens** in the planning process.”*

Dembski & Wössner (2019)

Dembski, F, Wössner, U, Letzgus, M: The Digital Twin. Tackling Urban Challenges with Models, Spatial Analysis and Numerical Simulations in Immersive Virtual Environments, in Sousa, JP, Xavier, JP and Castro Henriques, G (eds.), Architecture in the Age of the 4th Industrial Revolution - Proceedings of the 37th eCAADe and 23rd SIGraDi Conference - Volume 1, University of Porto, Porto, Portugal, 11-13 September 2019, 795-804

Image: GreenTwins project, Tallinn University of Technology.

ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

EU2022.CZ

Thank you

Kimmo Lylykangas, Tallinn University of Technology