Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

The ESPON QGasSP project

Contents

1 The QGasSP project 2020–21

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)**

QGasSP project 2020–21

Quantitative Greenhouse Gas Impact Assessment Method for Spatial Planning Policy

STAKEHOLDER

- **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)**

2 Methodological background

GHG ACCOUNTING FOR CITIES AND REGIONS

ALTERNATIVE EMISSIONS ALLOCATION PRINCIPLES:

extraction-based

income-based

production-based

consumption-based

- **None of these approaches can be prioritized over the others as a measure for just and effective climate policy, and it would be beneficial to apply multiple accounting systems** (Steininger, Lininger, Munoz, & Schinko, 2015)
- ***"As hard as scientists and technocrats try to provide objective definitions and tools, measuring something as complex as a country or city requires opinions, assumption, and limits. Metrics are political."*** (GHG EMISSIONS INVENTORIES: AN URBAN PERSPECTIVE. The City Climate Finance Gap Fund – Technical Note #1. The World bank, 2021)

GHG ACCOUNTING FOR CITIES AND REGIONS

„The Dual GHG accounting approach“

Community-wide infrastructure-supply chain GHG emission footprint (CIF) (Scope 1+2+3)

Consumption-based footprint (CBF)

- ***“There is increasing recognition that CIF and CBF inform GHG accounting for cities in complementary ways, focusing on infrastructure/production in the former, and consumption in the latter.“***

(Ramaswami & Chavez, 2013)

THE DUAL ACCOUNTING APPROACH

Two complementary perspectives to local GHG emissions

TERRITORIAL APPROACH

- **Today, most regions and cities apply territorial approach that assesses the direct greenhouse gas emissions within the geographic boundaries of the area of assessment, for example the city boundary.**
- **GHG emissions within the geographic boundaries of an assessment area sectoral calculation by Scope 1 + Scope 2 (+ Scope 3)**
- **Limitations of territorial approach are widely recognized, yet consumption-based GHG accounting is not expected to replace territorial GHG accounting**

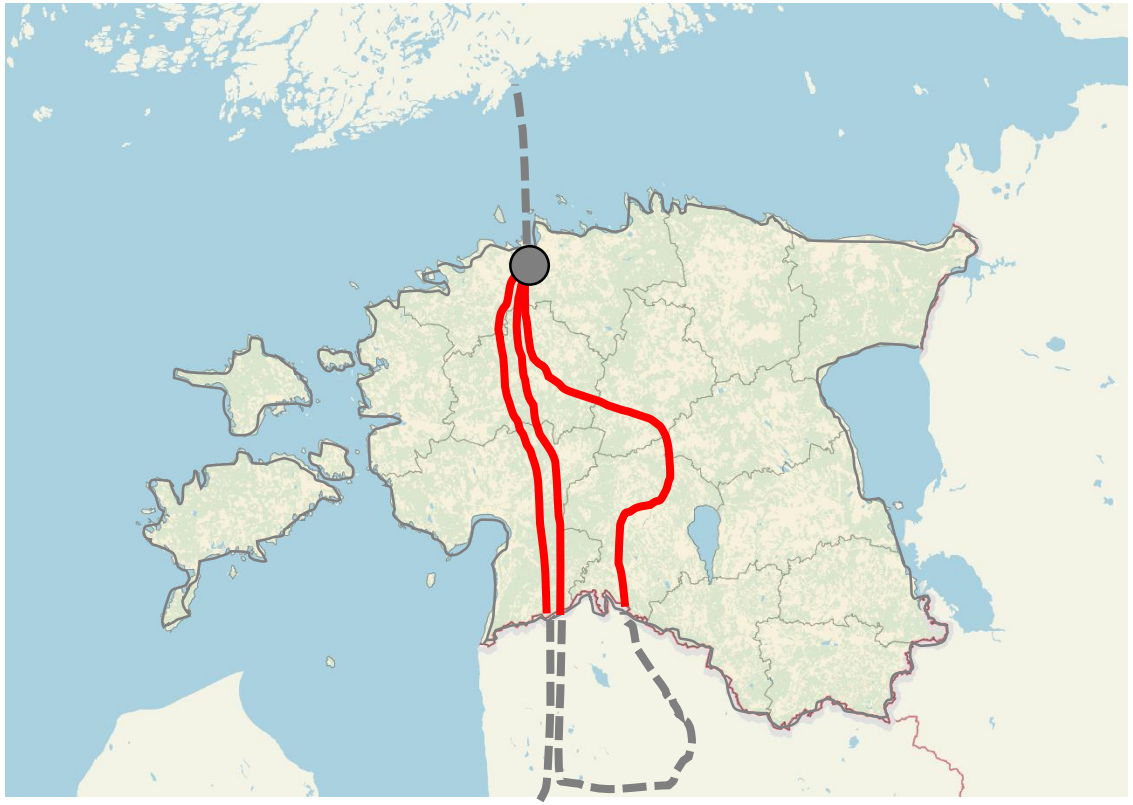
(Afionis, Sakai, Scott, Barrett, Gouldson. 2017)

CONSUMPTION-BASED APPROACH

A consumption-based approach aims to assess the global greenhouse gas emissions of the local residents.

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

TERRITORIAL GHG ACCOUNTING APPROACH - CHALLENGES



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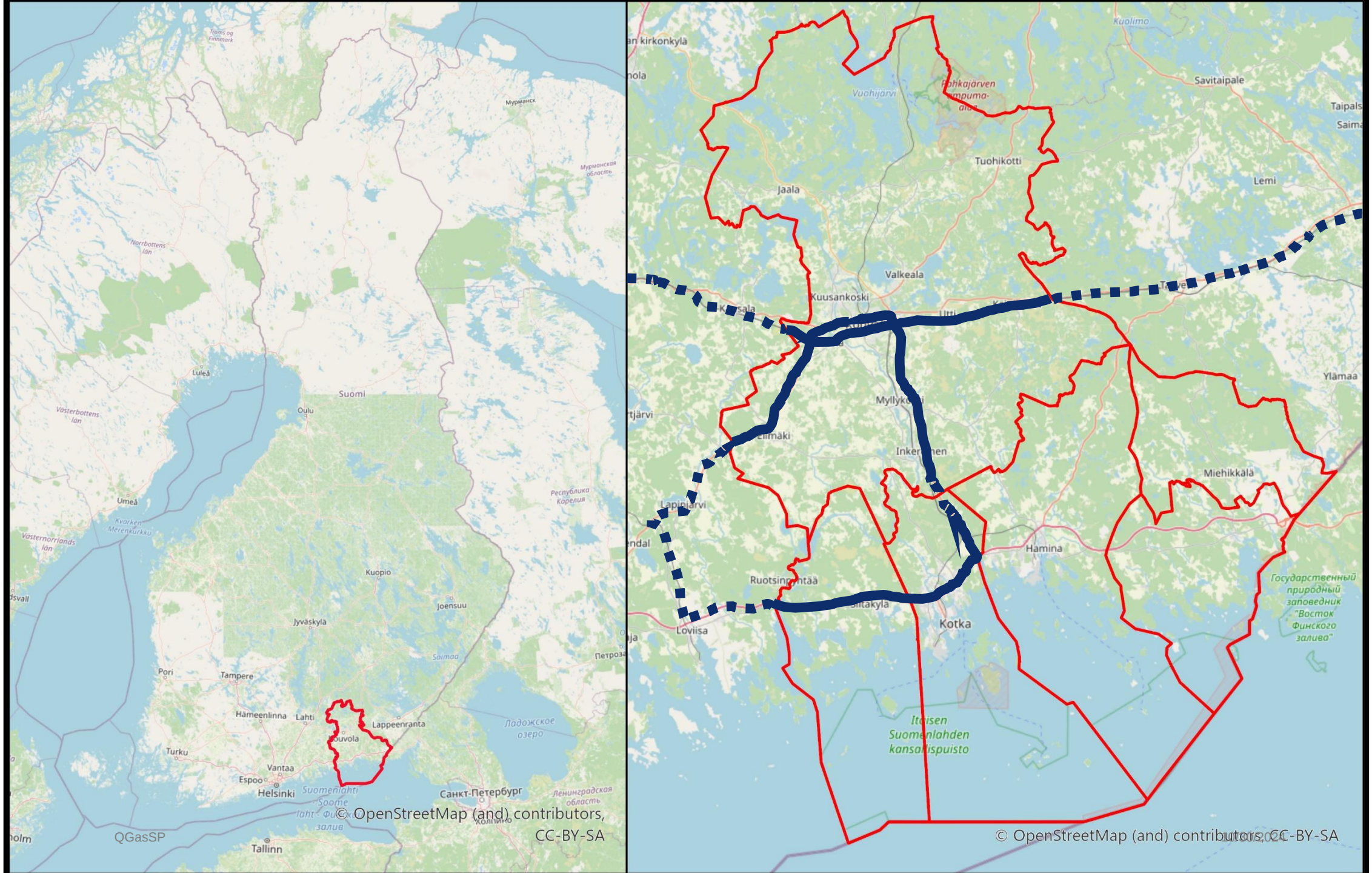
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Lahti
Hämeenlinna
Espoo
Vantaa
Санкт-Петербург
Мурманск
Jaala
Tuohikotti
Valkeala
Kuusankoski
Savitaipale
Lemi
Ylämaa
Miehikkälä
Hamina
Kotka
Loviisa
Ruotsinpyhtää
Lapinjärvi
Elimäki
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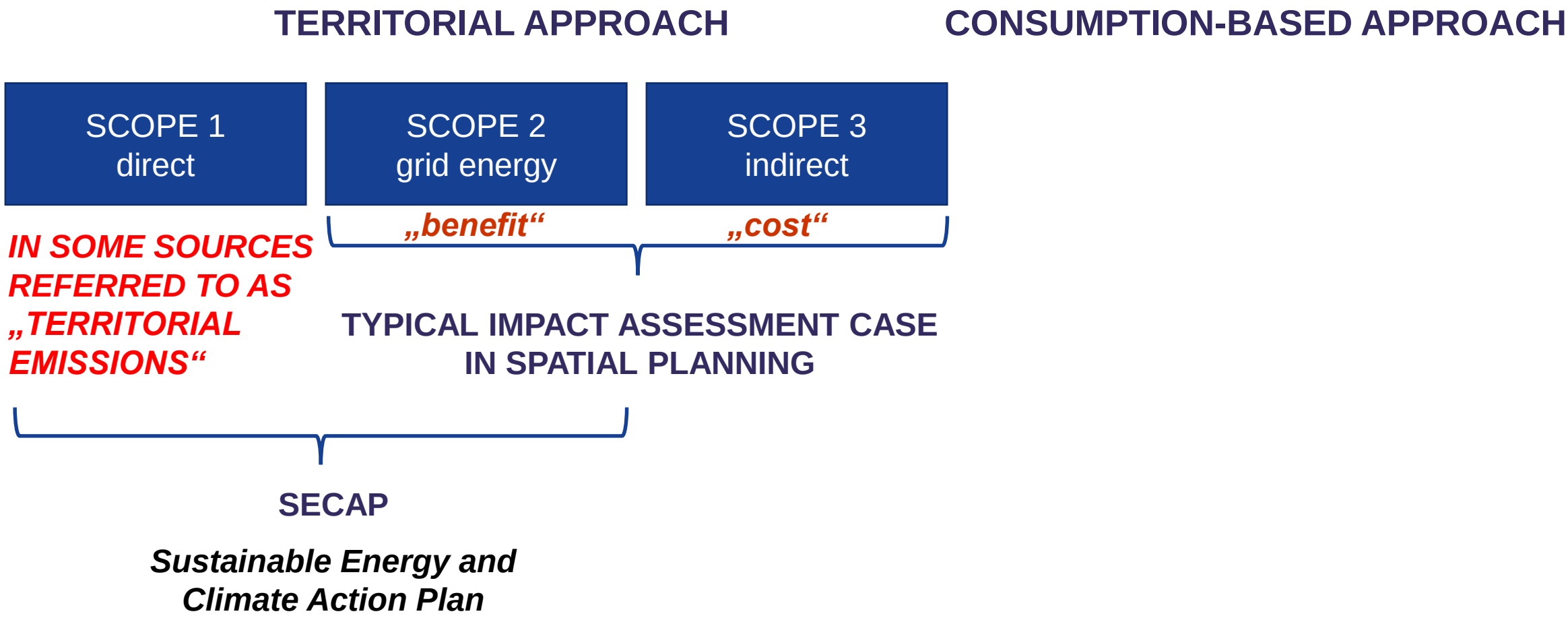
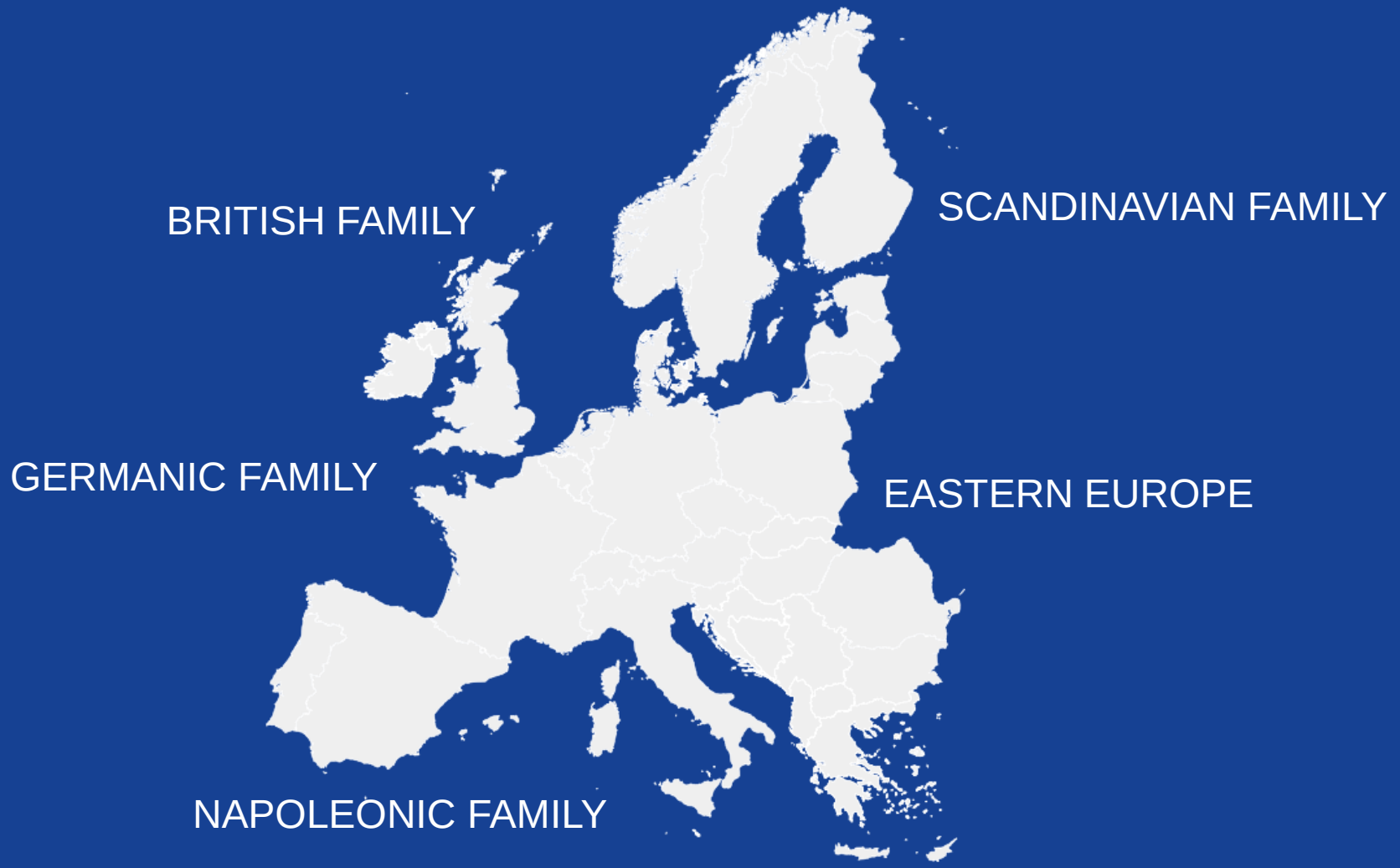
QGasSP

PROBLEMS REGARDING THE TERMINOLOGY AND SCOPE



VARIATION IN SPATIAL PLANNING SYSTEMS

as in Newman, P & Thornley A (1996), Urban Planning in Europe. International competition, national systems and planning projects, Routledge, London/New York.



SEA

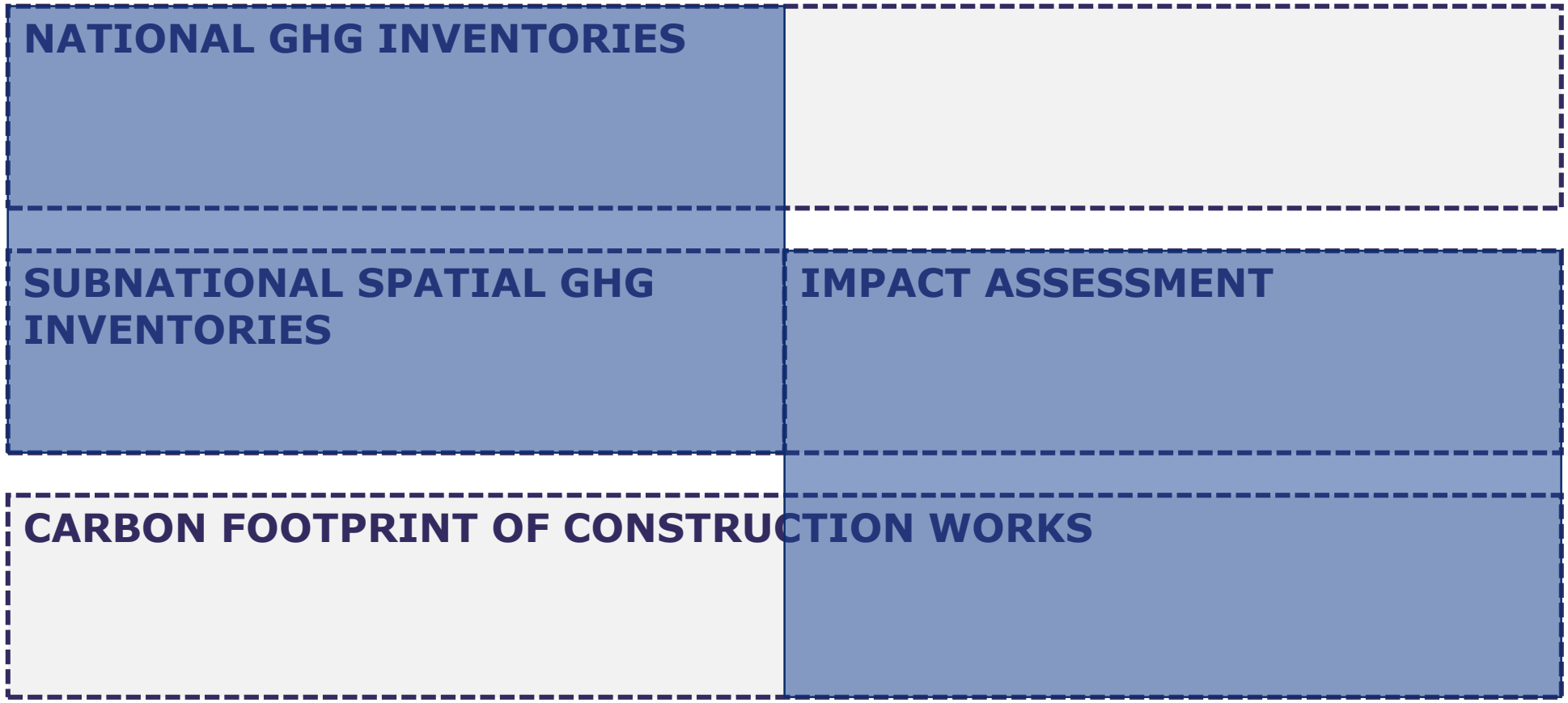
Strategic Environmental Assessment

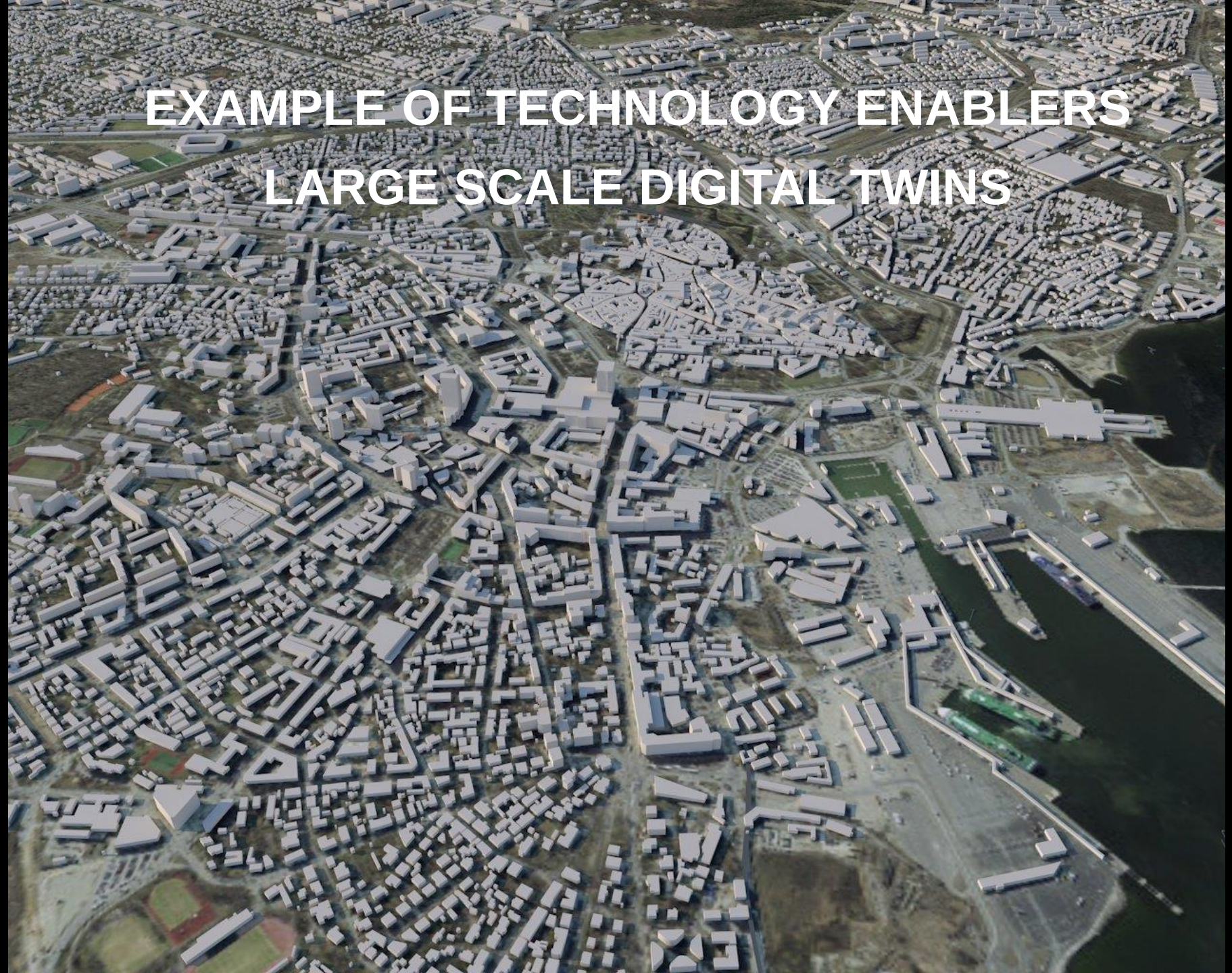
“In Europe, land use, residential and commercial development and the development of the transportation infrastructure are as a rule controlled by means of spatial planning instruments, for which Strategic Environmental Assessments (SEA) must generally be carried out under the terms of a European Union Directive European Parliament and Council of the European Union, 2001” (Wende et al. 2012).

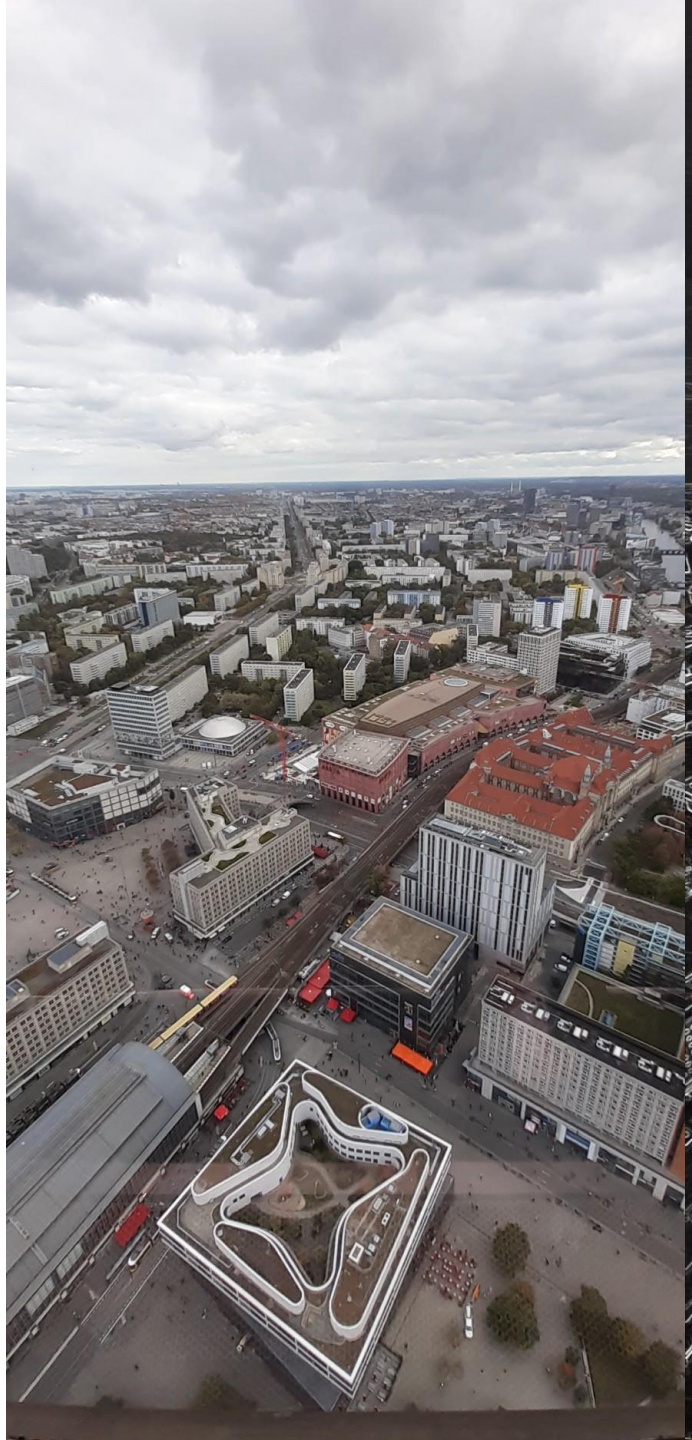
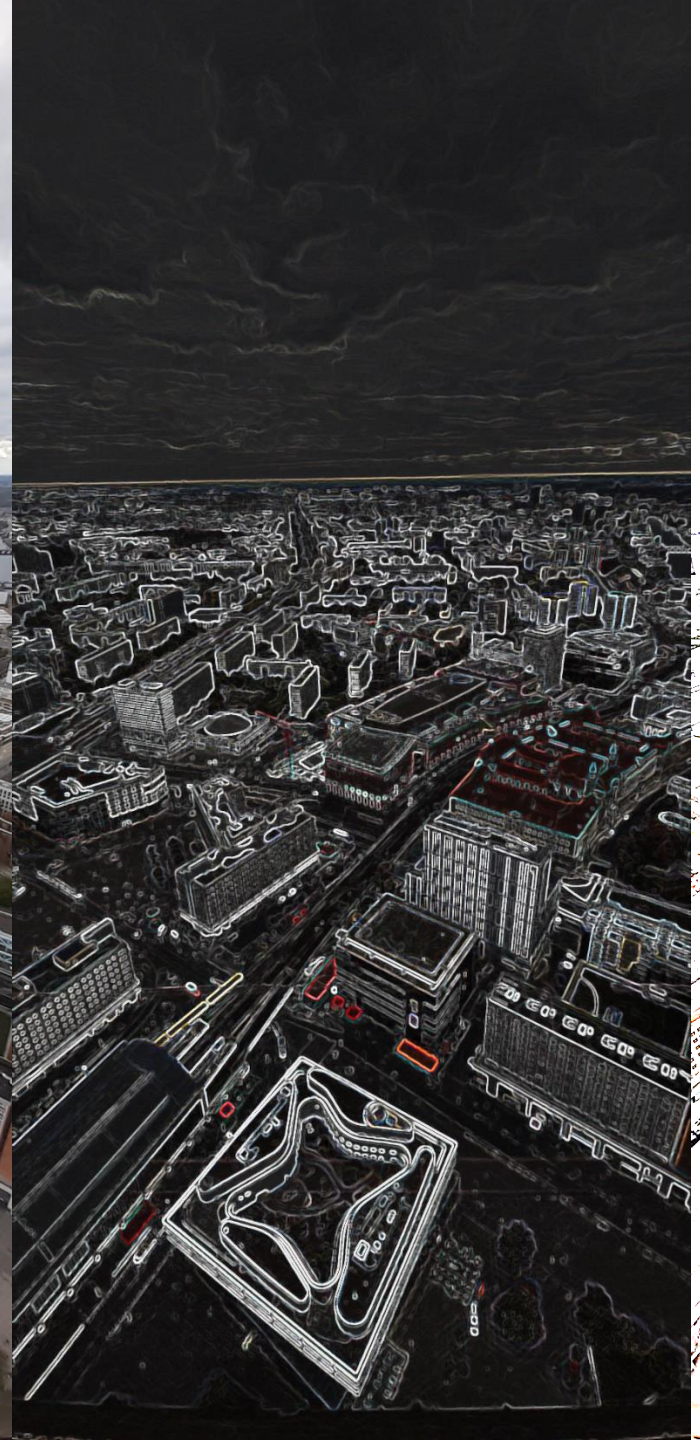
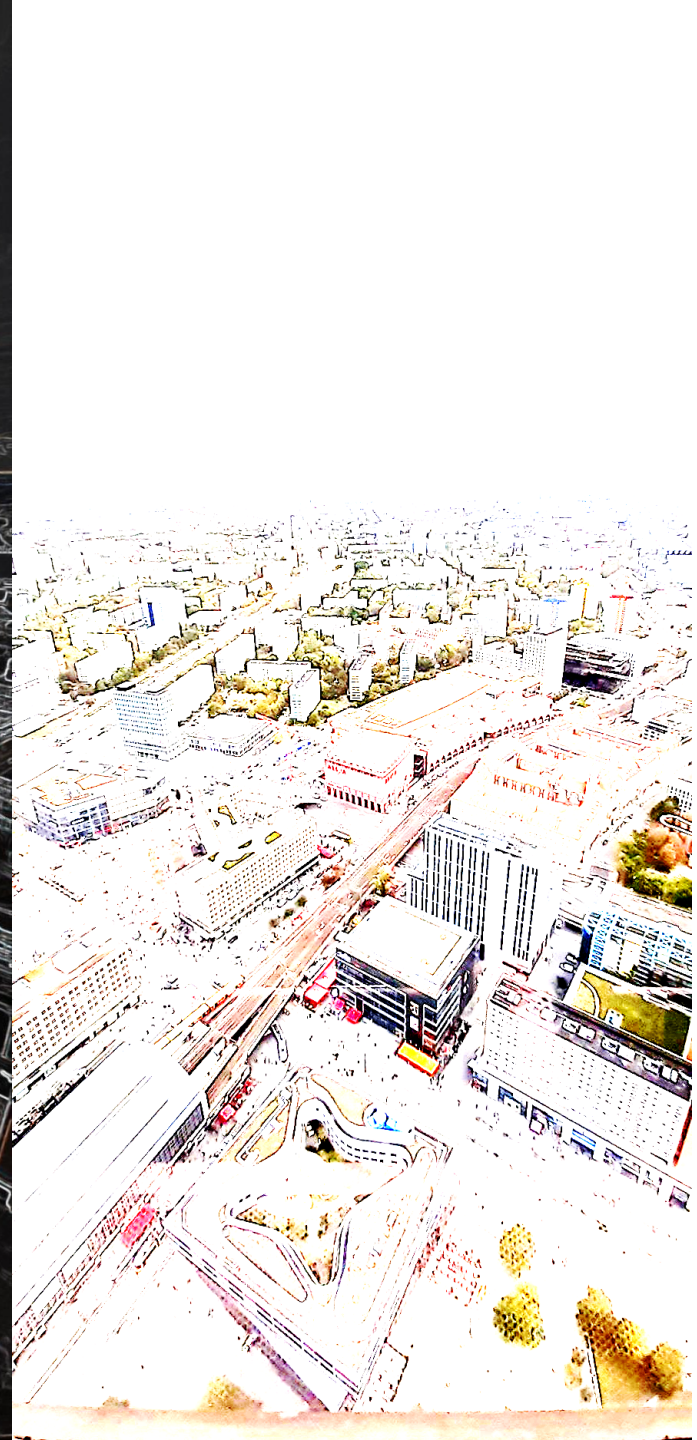
- **SEA is a systematic process for evaluating the likely environmental implications of a proposed policy, plan or programme.**
- **SEA provides means for looking at cumulative effects and appropriately addressing them, at the earliest stage of decision making, along with economic and social considerations.**
- **SEA is recognised as the vehicle for the implementation of climate protection within spatial planning.**

Application of GGIA in SEA

Screening	***Responsible authority assesses the likely environmental impacts of a plan*** **a decision not to conduct SEA could be briefly assessed by GGIA**
Scoping report	***The range of environmental issues to be covered by SEA is defined*** **assessing reasonable alternatives in GGIA**
Preparation of environmental report	***According to the scoping report, including the assessment alternatives and measures to mitigate drawbacks*** **assessing the relative GHG contributions of different reasonable alternative scenarios in GGIA**


NATIONAL GHG INVENTORIES
SUBNATIONAL SPATIAL GHG INVENTORIES
IMPACT ASSESSMENT
CARBON FOOTPRINT OF CONSTRUCTION WORKS


EXAMPLE OF TECHNOLOGY ENABLERS
LARGE SCALE DIGITAL TWINS

3 The ESPON GGIA tool

Challenges identified

- The methods for quantifying the GHG emissions of territories, regions, cities, municipalities are not harmonized and there is not shared approach behind the future scenarios.
- The comparisons are difficult because:

  There is variation in both calculation methods and datasets.

  The methods are typically based on the territorial approach.
- Most influential guidelines:

  Greenhouse Gas Protocol

  C40 guidelines

  IPCC guidelines for national GHG inventories
- The quantification should also enable the use of local data sources, which are not uniform, neither in structure nor in their content.

Solutions

IN ACCORDANCE WITH THE C40 CITIES' GUIDANCE - TWO CALCULATORS:

1) **TERRITORIAL APPROACH**
2) **CONSUMPTION-BASED APPROACH**

- **enables cross-country, inter-regional and inter-municipality comparisons**
- **enables collection of comparable GHG baseline emissions data at national, regional and local levels**

MODULAR & OPEN SOURCE TOOL

- **makes the tool future-proof**

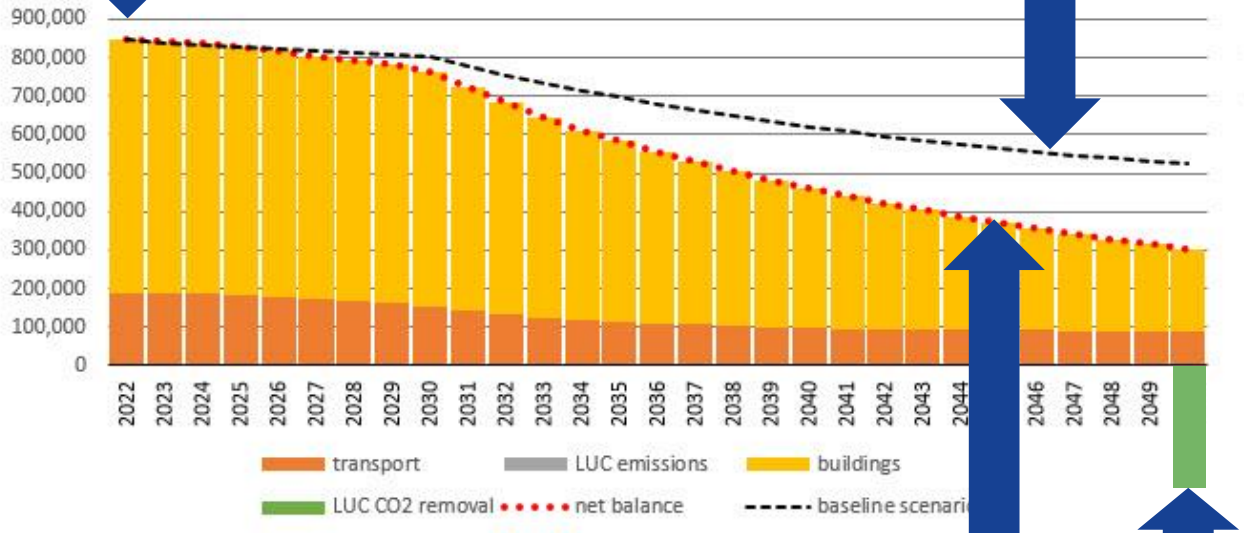
LOCAL DATASET FUNCTION

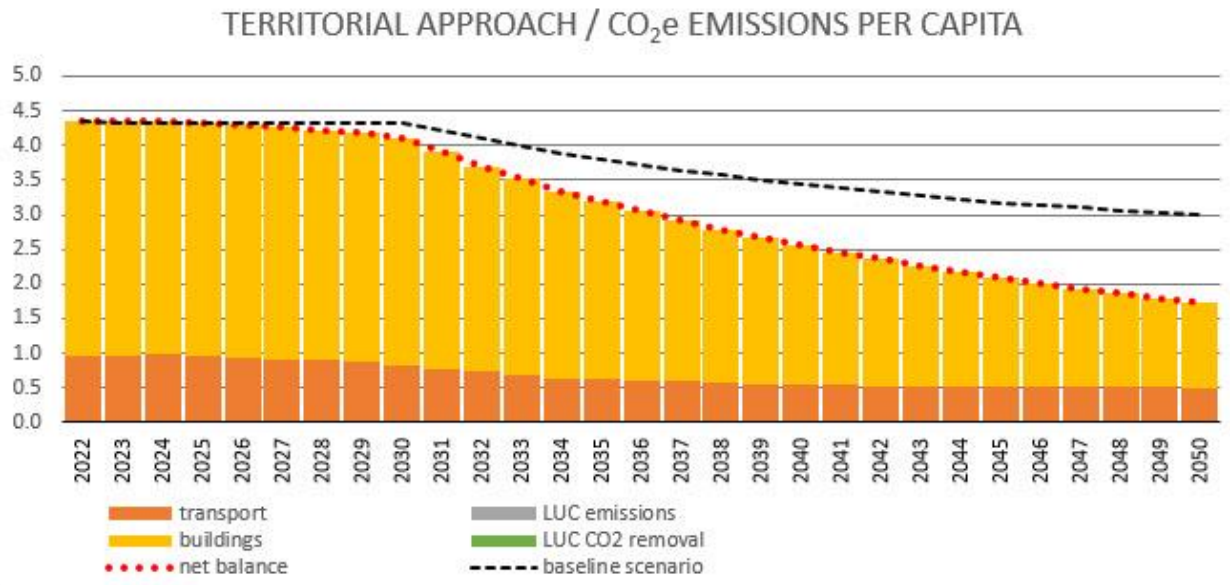
- **enables GHG quantification with the datasets that are considered most accurate**

EXPECTED RESULT OF A GHGINVENTORY (BASELINE) + FUTURE PROJECTIONS (SCENARIOS)

BASELINE

BASELINE SCENARIO





GHG EMISSIONS WITH POLICY IMPACT

CO_2 SEQUESTRATION (LULUCF)

Features of the new tool

- Browser-based, modular, open source
- Baseline (absolute emissions) + future projection
- Quantification of the impact of policies or plans (relative emissions)
- Novelties:
  - two modes – two perspectives on the GHG emissions
  - enables also consumption-based analyses (global GHG emissions)
  - utilization of local data
  - applicable in any scale of spatial planning in 32 European countries
  - comparable results enhancing exchange of best practises

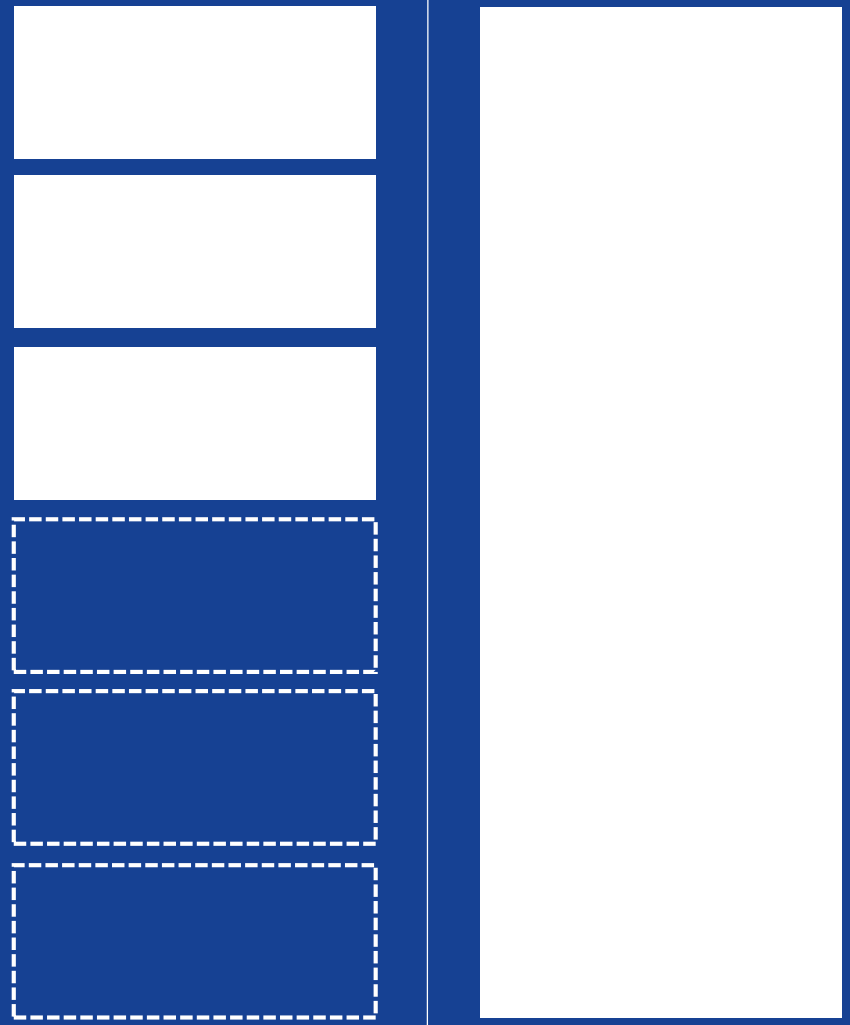
Two modes

Territorial mode

- **modules:**
  - **land-use change**
  - **energy use in buildings**
  - **transport**
  - **placeholders for new modules**

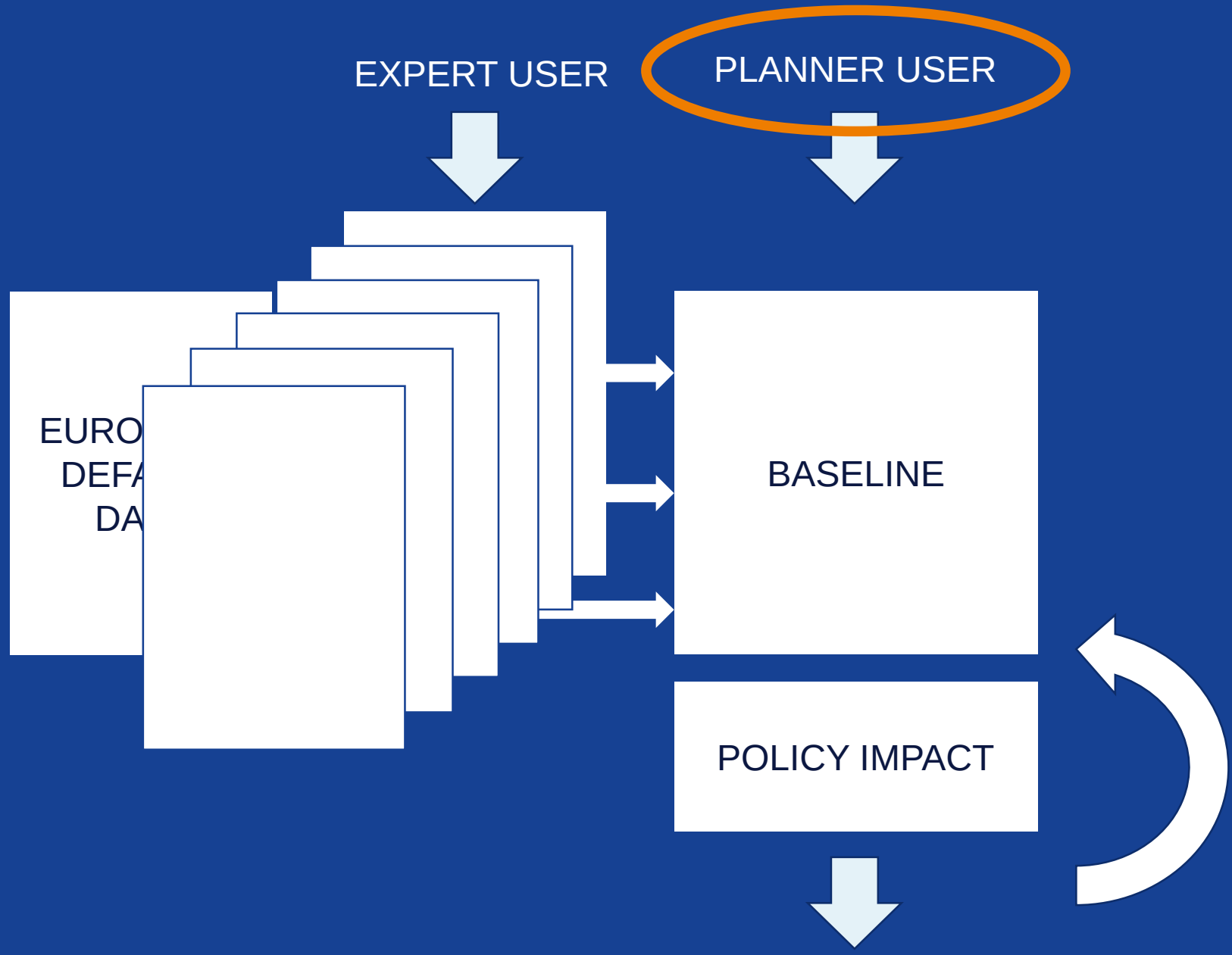
Consumption-based mode

- **sectors: all-inclusive**
- **Extended Environmental Input-Output method**



Three types of users

Planner user	**no specific knowledge on GHG quantification required** **GIS analysis skills helpful in land-use change quantification**
Expert user	**can create a local dataset that brings the data that is considered most relevant into the tool** **expertise on GHG quantification principles** **access to local datasets**
Developer user	**developer of additional or improved calculation modules** **open source Python code available in GitHub**


EXPERT USER
PLANNER USER
EURO
DEFA
DA
BASELINE
POLICY IMPACT
REPORTING

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 calculation modes: The territorial mode consists of sectoral calculation modules, which can quantify the direct greenhouse gas emissions within the borders of the area in concern. The consumption-based mode quantifies the global greenhouse gas emissions caused by the consumption of the residents in the area. The first step is to calculate the baseline emissions (absolute CO2e emissions). The second step is to quantify the impact of a plan or a policy (relative CO2e emissions). You can start the calculation without any expert knowledge on greenhouse gas quantification. For more accurate results, the experts in Your organisation can create a local dataset and upload it into the GGIA tool. This way the quantification applies the most accurate source data available and it can be aligned with the previous greenhouse gas analyses of Your area. GGIA enables the comparison of climate policies across the territories and cities of Europe. As the quantification results depend on the input values, ESPON EGTC cannot quarantee the authenticity of the results and cannot be held responsible for any decisions taken based on the results from the GGIA tool. GGIA is an open-source application. The source code is available in GitHub and ESPON EGTC welcomes all proposals on additional quantification modules and the proposals to improve the current calculation methods.

Start

ESPON GGIA TOOL

Territorial quantification

Start | Transport | Land-use change | Buildings | Consumption-based quantification | User-guide | Generate report

ASSESSMENT AREA INFORMATION

Please fill in the required basic information

Provide the basic information on the assessment area.

Year	2022
Country	Austria
Local Dataset	None
Population	100000

Save Reset

ESPON GGIA TOOL

Territorial quantification

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	Total area, ha	Soil area (mineral), ha	Soil area (organic), ha	Year of implementation
Cropland to Forest Land	0	0	0	2022
Grassland to Forest Land	0	0	0	2022
Wetlands to Forest Land	0	0	0	2022
Settlements to Forest Land	0	0	0	2022
Other land to Forest				

Land-Use Change	Total area, ha	Soil area (mineral), ha	Soil area (organic), ha	Year of implementation
Forest Land to Cropland	0	0	0	2022
Grassland to Cropland	0	0	0	2022
Wetlands to Cropland	0	0	0	2022
Settlements to Cropland	0	0	0	2022

4 GGIA tool methodology

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

  can be adjusted for policy quantification

  driving profiles included (street – road)
- Future projections as in *EU Reference Scenario 2015* (PRIMES model)

  regional scenarios can be applied through the local dataset function
- Default activity data is down-scaled from national statistics by population and settlement type.

Territorial approach – Land-use change

- IPCC methodology
- Land use categories

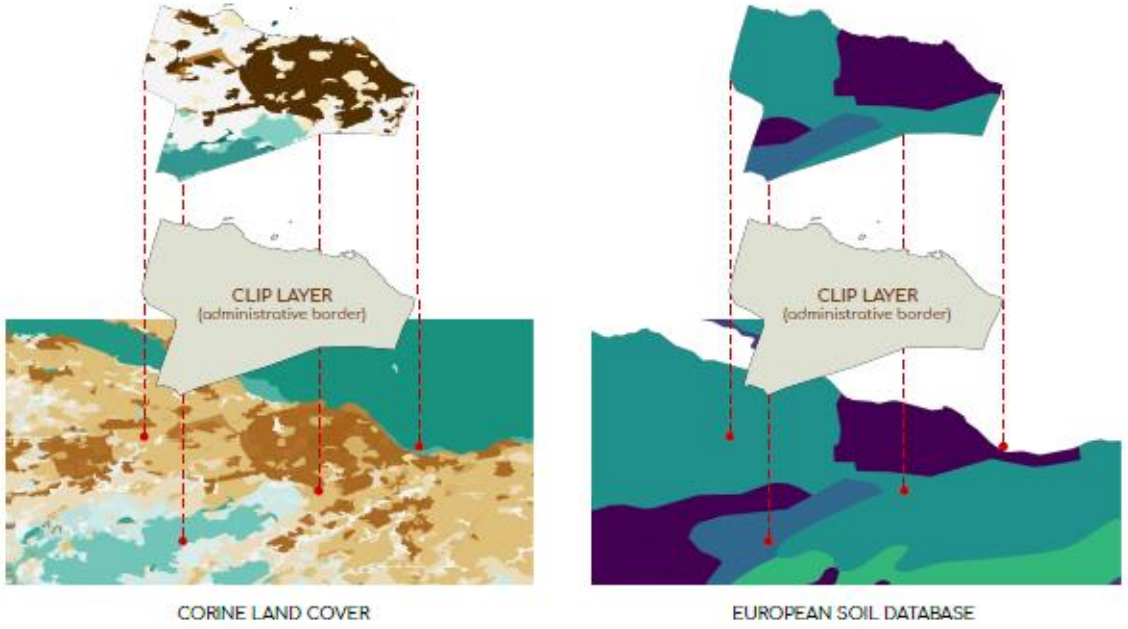
Land use categories	Carbon pools	
forest land	living biomass	aboveground
cropland		belowground
grassland	dead organic matter	dead wood
wetlands		litter
settlements (urban areas)	soil	mineral
other land		organic

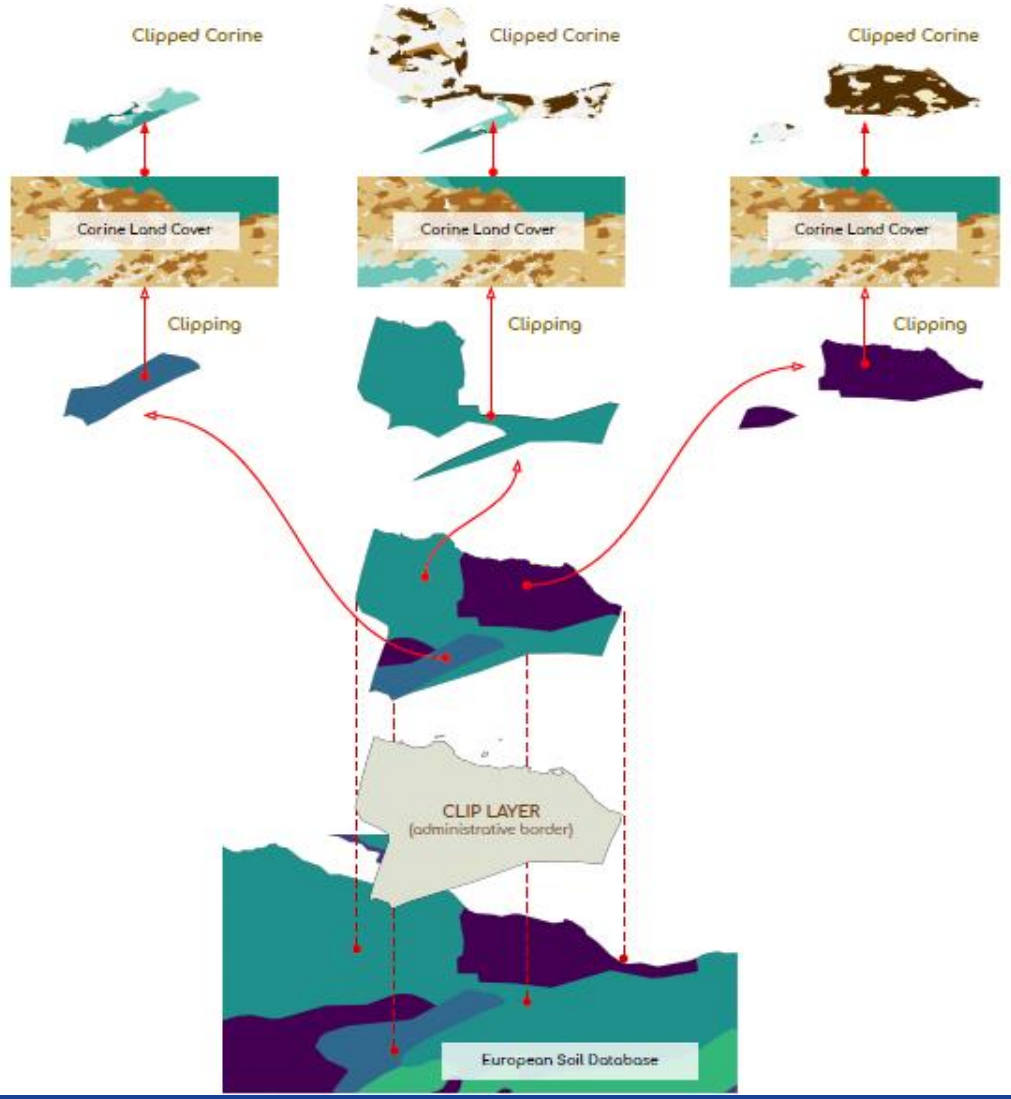
- Carbon-Stock-Change (CSC) factors from the CRF tables of national inventory reports (NIR) for 32 European countries + FAO FRA data for deforestation.
- Requires an analysis of land use types within the area of assessment, for example with CORINE CLC and European Soil Database (applicable across Europe).

Example of GIS-based land use analysis combining the data layers from

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*
  - Local values can be applied in a local dataset
- Applies a simple modelling of buildings stock (annual demolition rate, annual rate of new construction)
- Expected decarbonisation of national grid electricity included
  - Default scenario as in *the EU Reference Scenario 2016* (PRIMES modelling)
  - Local scenario can be applied in a local dataset

Consumption-based approach

- EEIO (Extended Environmental Input-Output) approach
- Two main datasets
  - Exiobase
    - technical coefficient matrix
    - final demand vector
    - environmental extensions
  - Household Budget Survey (HBS)
- Future projections are based on *the EU Reference Scenario 2016* (PRIMES modelling)
- Provides a holistic estimate on the global GHG emissions for the consumption of the residents in the assessment area

5 Pilot Case Studies

Four pilot case studies

- **Meath County (IE)**
- **City of Edinburgh (UK)**
- **Rathlin Island (UK)**
- **Region of Kymenlaakso (FI)**

land

MDPI

Article

Territorial and Consumption-Based Greenhouse Gas Emissions Assessments: Implications for Spatial Planning Policies

Kimmo Lylykangas [1,2], Rebecca Cachia [3], Damiano Cerrone [1,4], Kaie Kriiska [5,6], Ulrich Norbisrath [1,7], Peter R. Walke [5,8], Anssi Joutsiniemi [9,*] and Jukka Heinonen [2,*]

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* Correspondence: heinonen@hi.is

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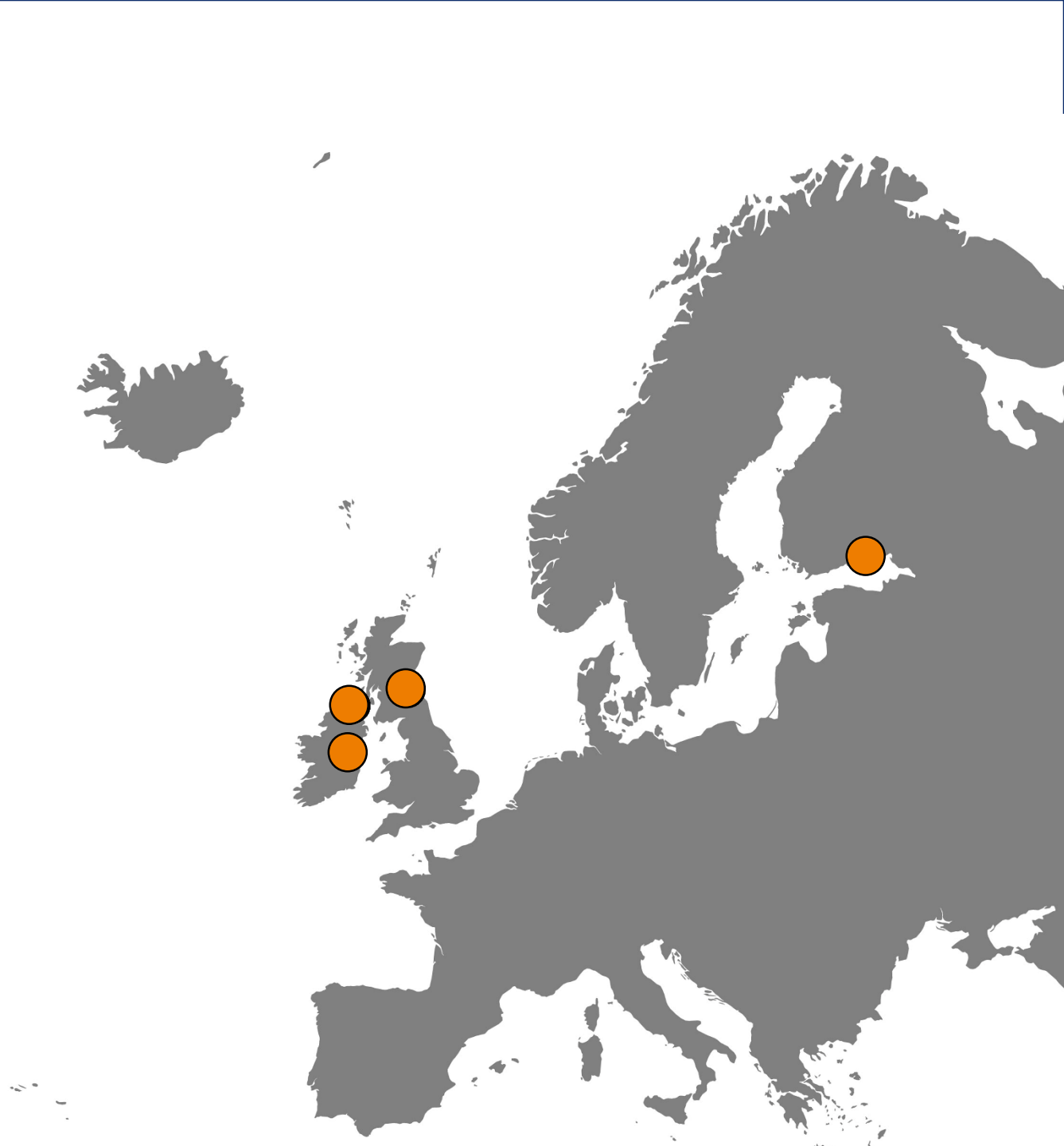
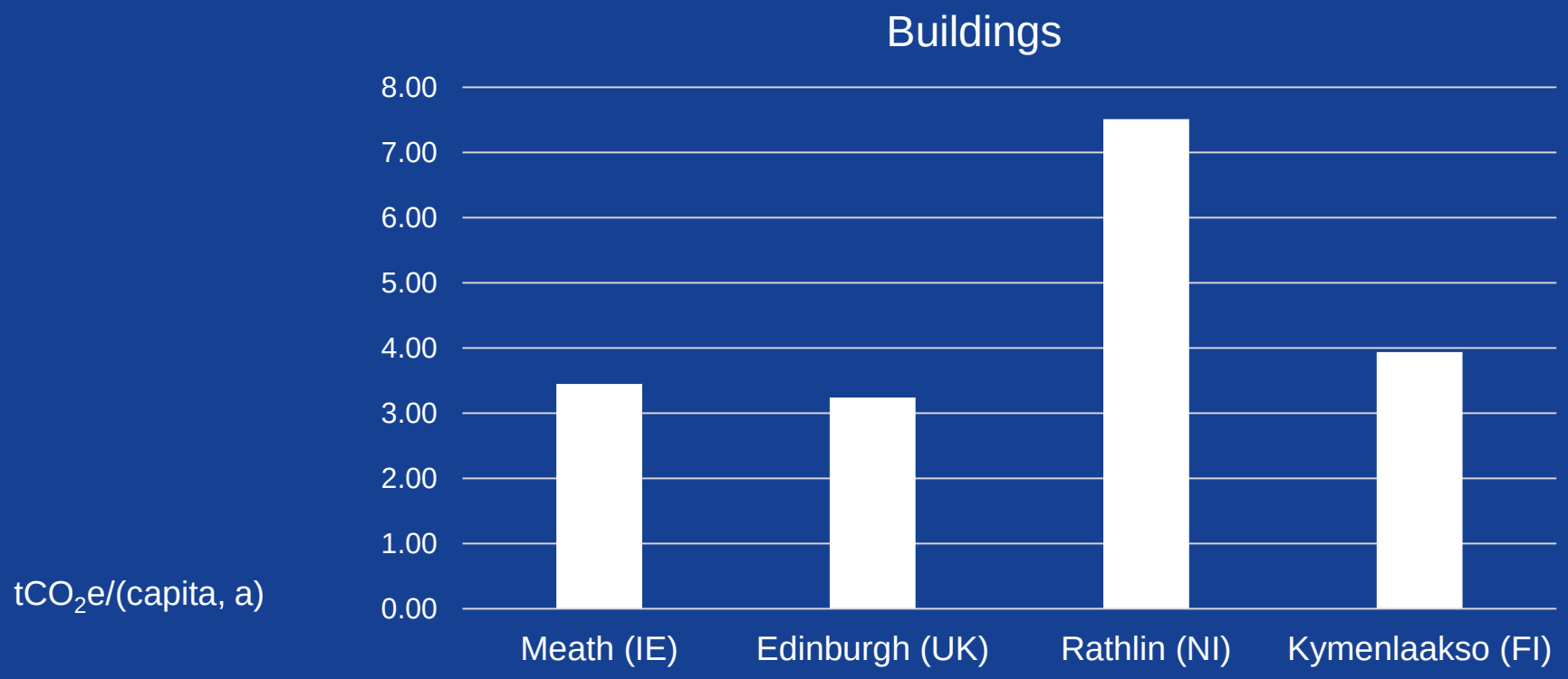
Abstract: The quantification of greenhouse gas (GHG) emissions is increasingly important in spatial planning for regions, cities, and areas. The combination of territorial and consumption-based accounting (CBA) approaches can currently be considered best practice for calculating GHG emissions at sub-national levels, in terms of informing local decision-making about the different climate impacts of spatial planning policies, both within the boundaries of a given region and for the inhabitants of that region. This study introduces four European case studies that were conducted using the two quantification approaches to assess the climate impacts of locally relevant planning policies. The case studies represent different scales of spatial planning, different European planning systems, and different situations in terms of data availability. Territorial results are not suitable for inter-regional comparison, but rather for internal monitoring, while CBA allows for comparison and provides a comprehensive picture of the global carbon footprint of residents, however, with indications that are more difficult to link to spatial planning decisions. Assessing impacts, and in particular interpreting results, requires both methodological understanding and knowledge of the local context. The results of the case studies show that setting climate targets and monitoring the success of climate action through a single net emissions figure can give false indications. The study shows that the two approaches to quantifying GHG emissions provide complementary perspectives on GHG emissions at the sub-national level and thus provide a more thorough understanding of the GHG emission patterns associated with spatial planning policies. The identification of the regional differences in GHG emission sources and mitigation potentials are the main functions of sub-national GHG inventories and the impact assessment for spatial planning. Harmonization of the data collection for sub-national GHG inventories and the transparency of underlying assumptions would greatly support the coherence of climate action and the implications to spatial planning.

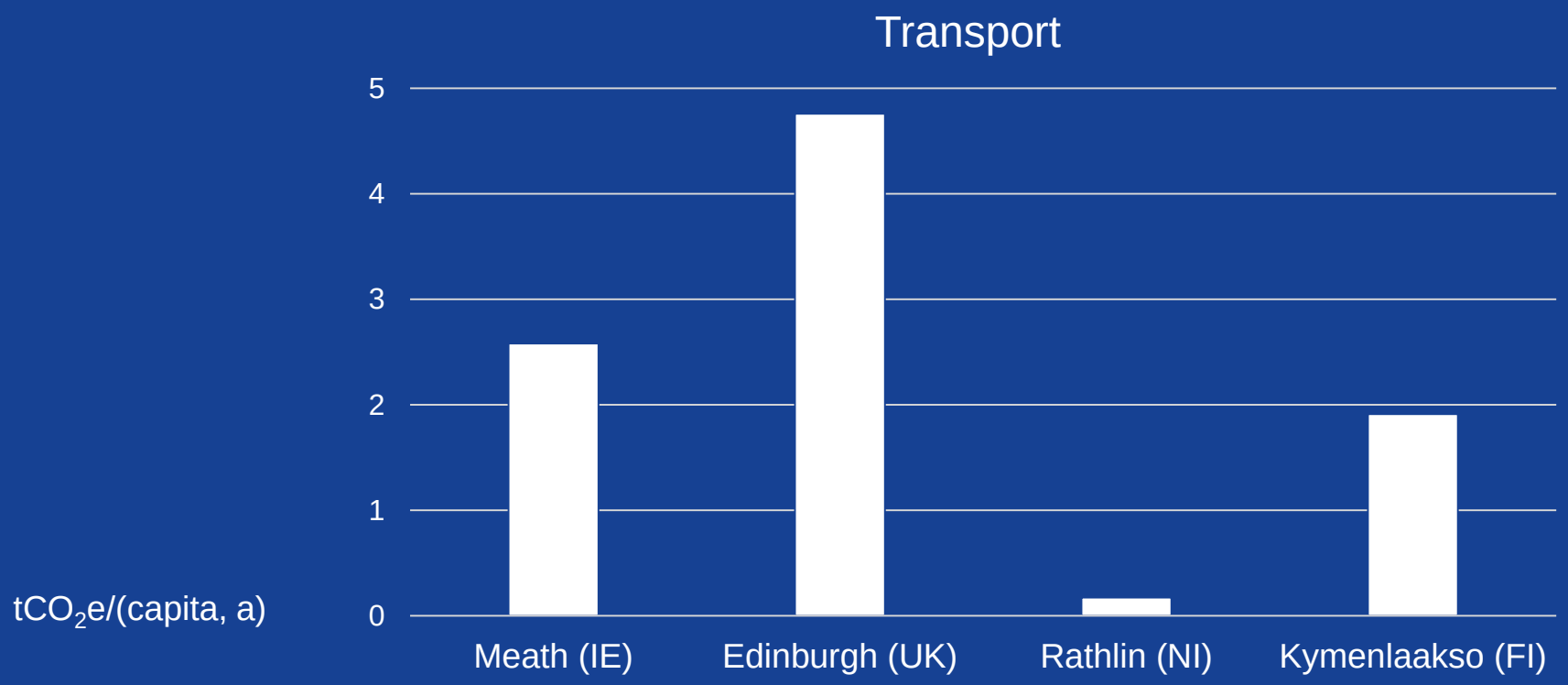
Keywords: climate action; GHG quantification; spatial planning; carbon neutrality; territorial GHG accounting; consumption-based GHG accounting



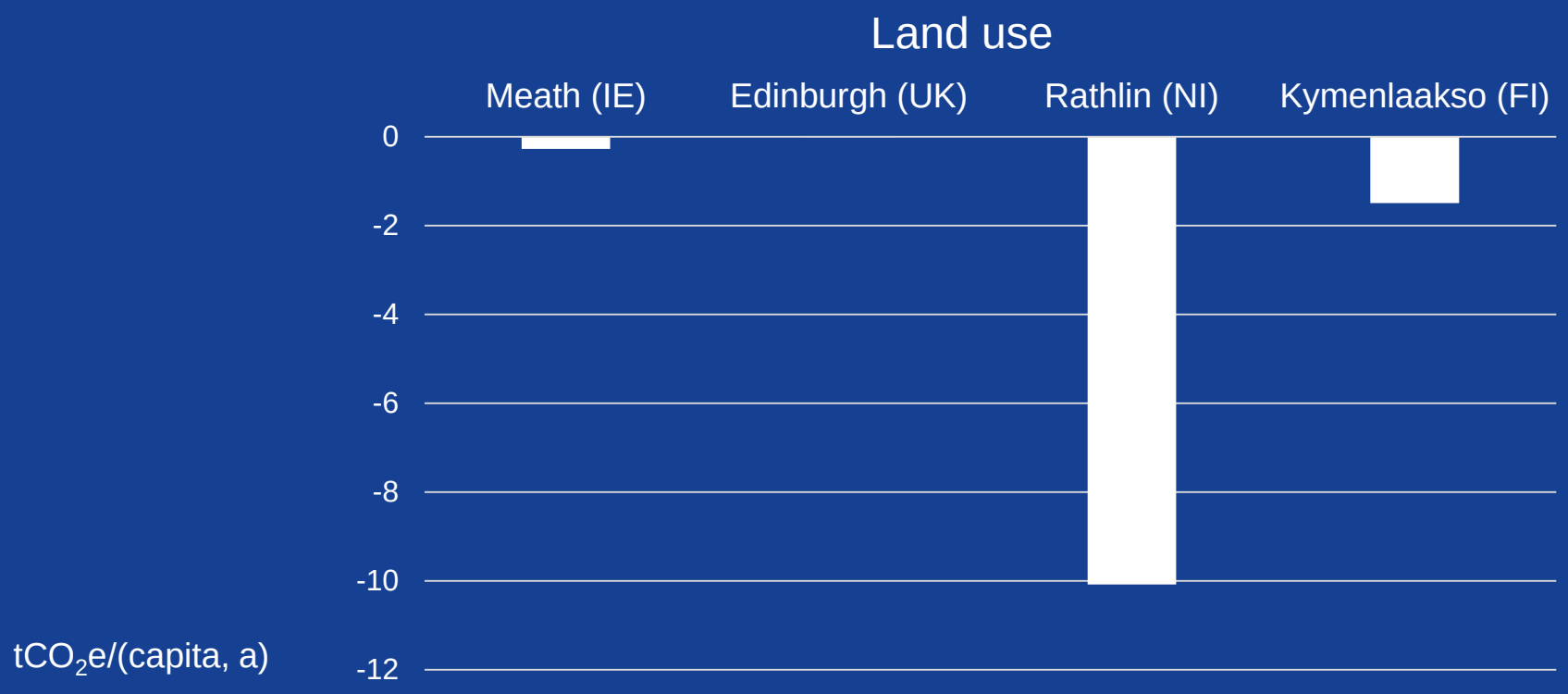
Territorial quantification - Buildings



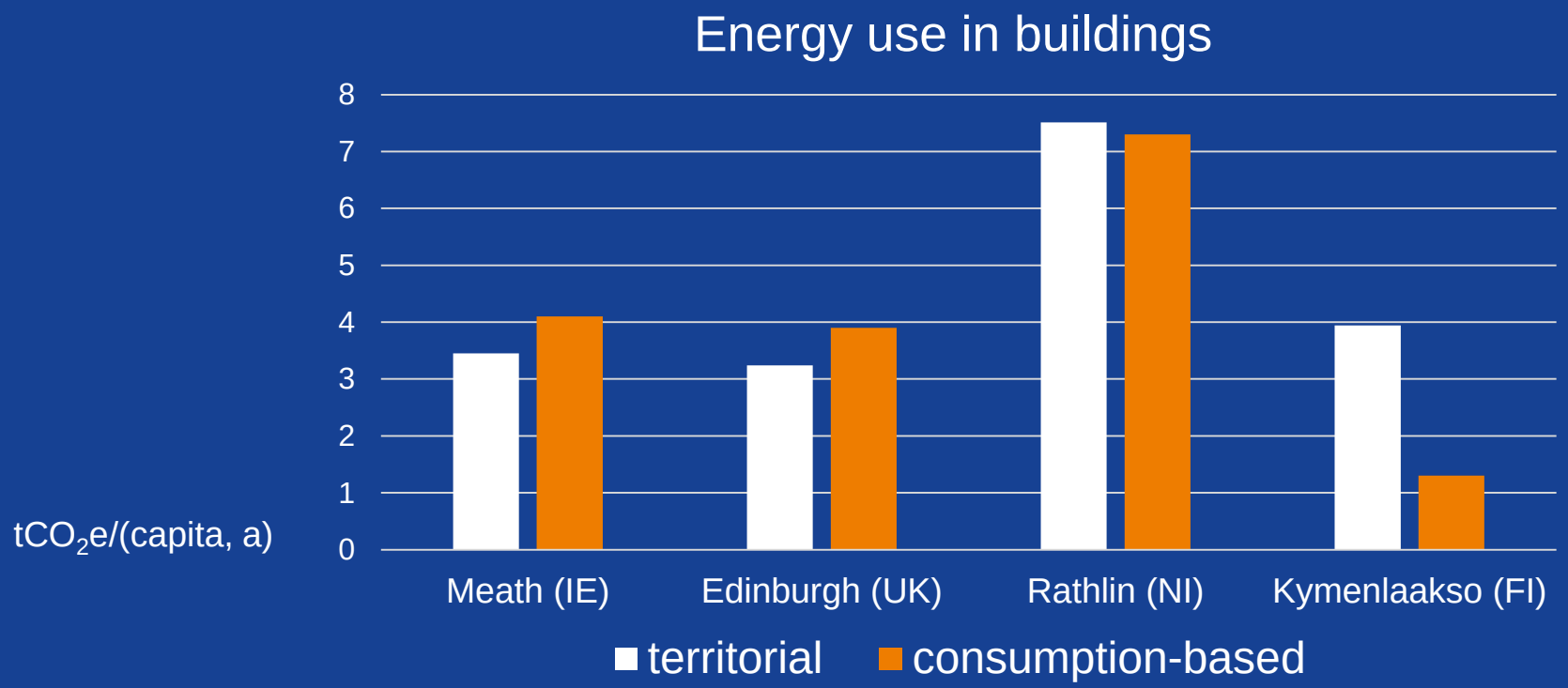
Territorial quantification - Transport



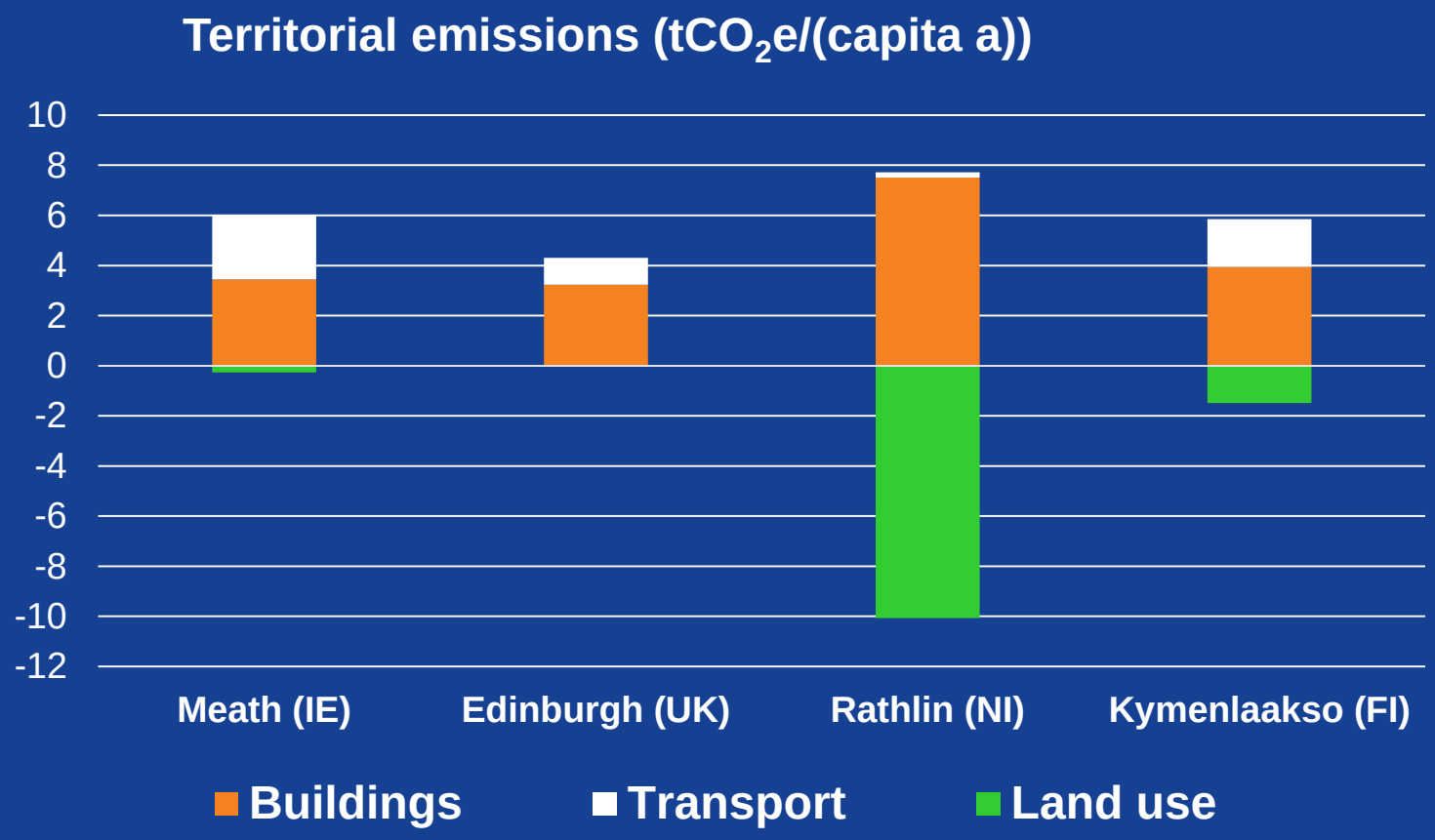
Territorial quantification – Land use



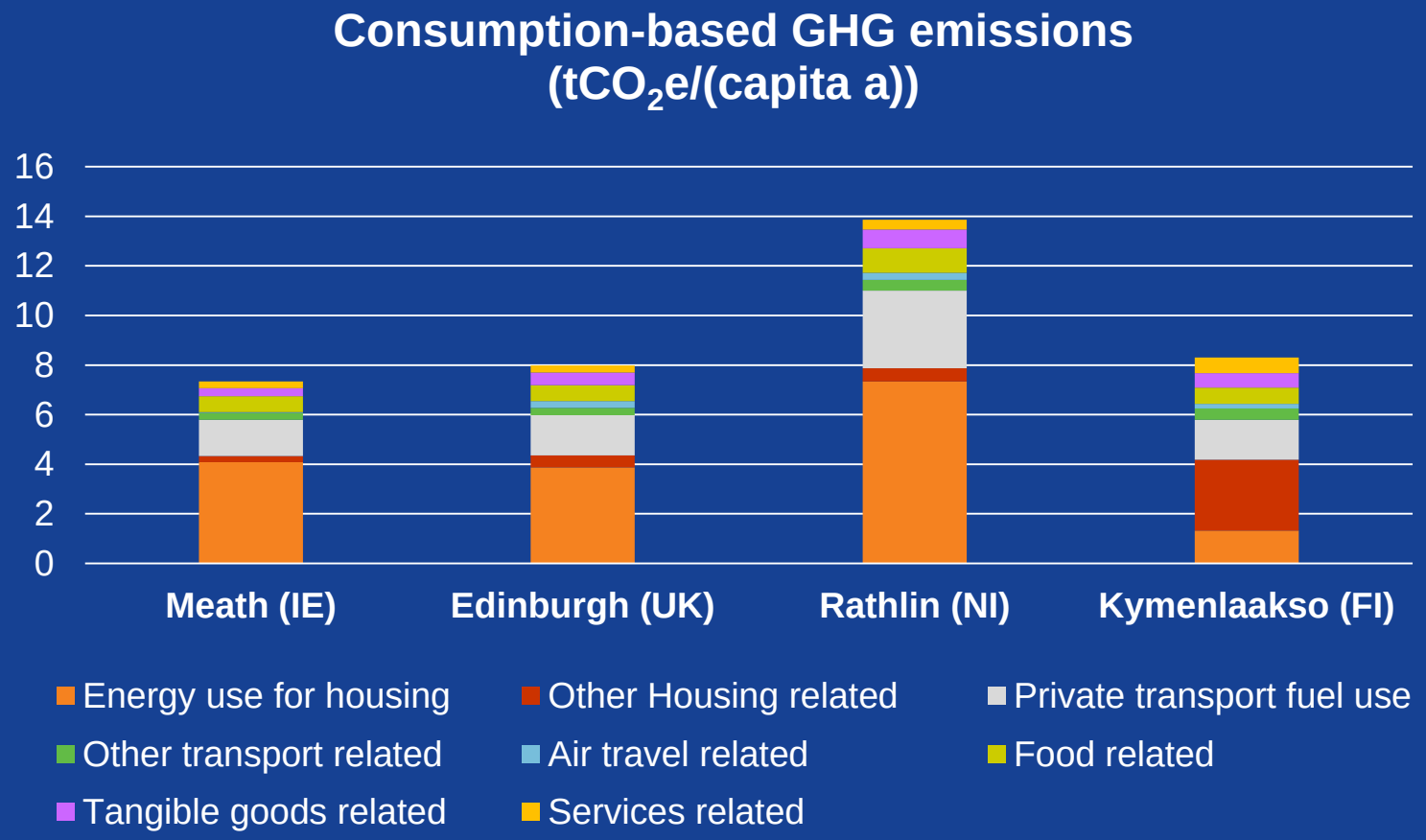
Two perspectives on GHG emissions – territorial and consumption-based



RESULTS territorial total



RESULTS consumption-based total



Other contributions underway

- **Various approaches to GHG accounting: ghg.ee**
- **Journal articles under preparation:**
  - **Dream of a European method – the potential of harmonisation**
  - **Greenhouse gas quantification in urban digital twins**
  - **Bottom-up GHG quantification of embodied (construction material) emissions**

Check out the ESPON GGIA tool at http://ggiatool.espon.eu/

ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

Thank you for your attention

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http://ggiatool.espon.eu/