The European Commission's science and knowledge service

Joint Research Centre

Building Energy Use – assessment methods based on location data

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European Commission

OVERVIEW

- Building Energy and Location
- Energy and Cities
- Scalability
- Challenges for Research projects
- Validation of assessment methods
- Use Case 3 of the EULF Energy Pilot
- Use Case 4 of the EULF Energy Pilot
- Role of INSPIRE
- Input data

BACKGROUND

- Energy and Location
- European energy policy Directives
  - Directive 2010/31/EU - Energy Performance of Buildings – EPBD; efficient use of energy in buildings
  - Directive 2012/27/EU- Energy Efficiency Directive – EED; efficient energy systems
- European energy policy initiative
  - Covenant of Mayors (CoM), involving local and regional authorities
- European Union Location Framework (EULF) project ; INSPIRE Directive

OBJECTIVES

Energy and Cities project

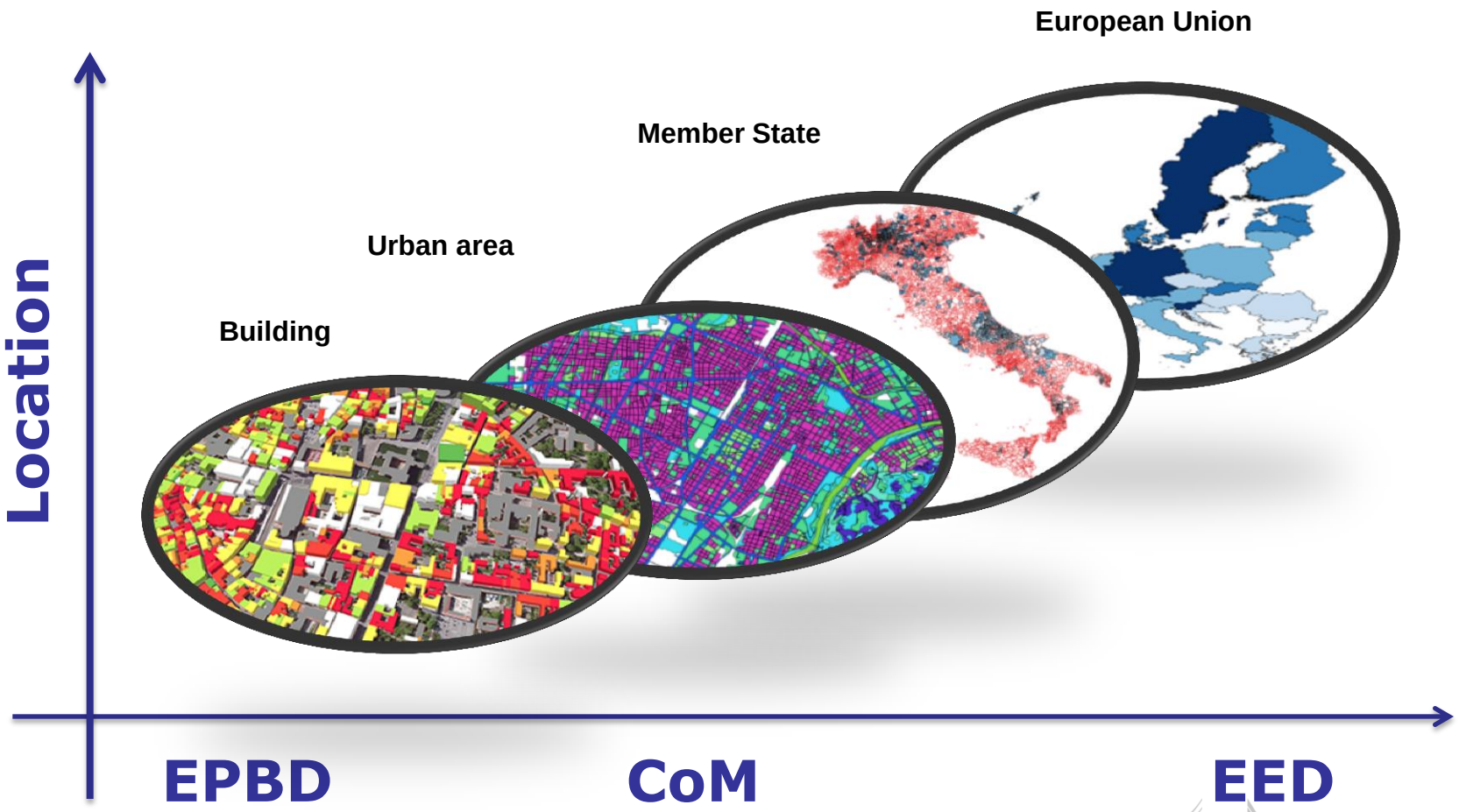
Assessment of energy use in the built environment by using geo-located data to improve the quality of input data

1) to support policy-makers in reporting and monitoring of energy policies and initiatives and

2) to harmonise the monitoring and reporting of energy efficiency policies at different scales.

Method may support the whole policy life-cycle e.g. urban planning, implementation of measures for efficient renovation of buildings, etc.

ENERGY and CITIES



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SCALABILITY

INSPIRE offers the feature of scalability;

- from building to district / urban area up to M.S. level

INSPIRE offers the development of new applications

- Static building maps
- Creation of real time service
- Energy markets for electricity and gas

INSPIRE offers big data handling in manageable and protected way

INSPIRE offers usage of multiple databases (building stock, climate data, EPC data, utility data, etc.)

RELATIONS

Role of the INSPIRE is facilitating all parties

GOVernmental

- Decision makers – Directives, incentives -Planners
- Require data for decision making

INDustry

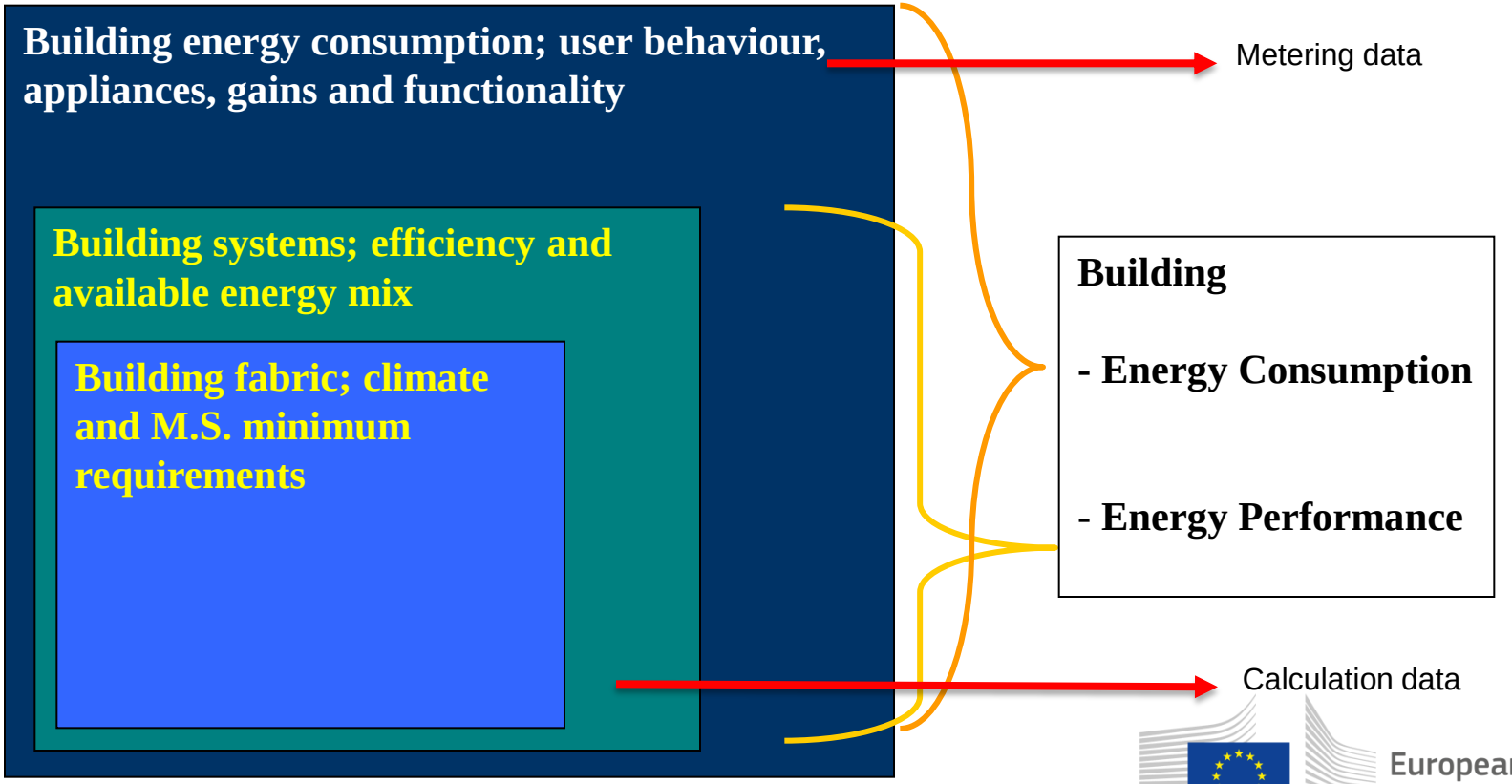
- Energy providers – infra structure – energy balancing
- Energy consuming products

END-user

- Energy consumers – comfort - energy bill to pay
- Product buyers – investing in renovation

ENERGY AND BUILDINGS

Relation of energy consumption and energy performance of a building



Energy Performance of Buildings

EPB Directive 2010/31/EU article 2:

The 'energy performance of a building' means the ***calculated*** *or* ***measured*** *amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting;*

INSPIRE *offers a third,* ***holistic*** *approach using administrative databases*

BIG DATA HANDLING

Requirements for input data

- Interval of observations, number of signals and variables

Requirements for output data

- Data-series, value, map

Methodology to taking into account the requirements

Dedicated methods, models and tools

Uncertainty of data (In- and Output)

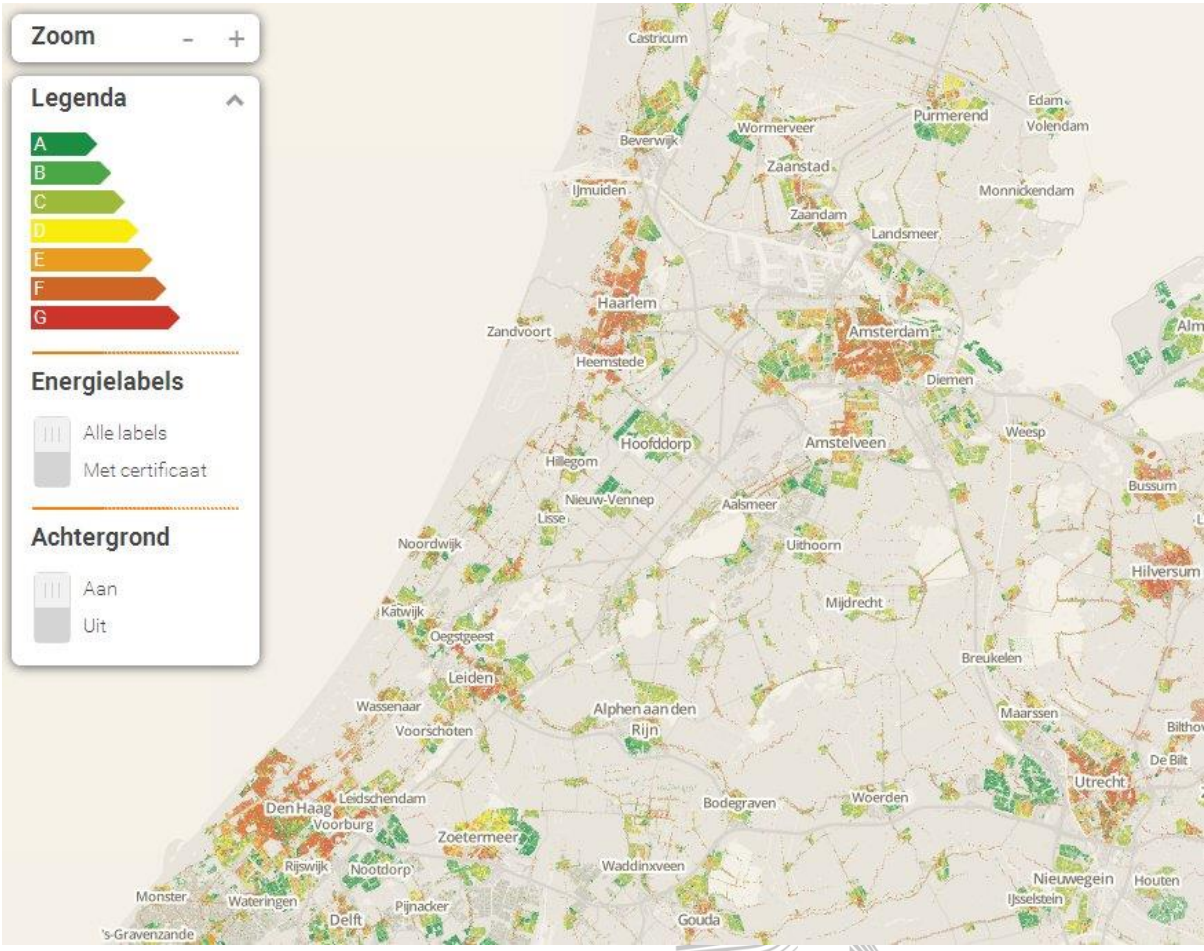
INSPIRE and Energy & Buildings

Cadaster

Administrative information on building stock

Age, type, location, construction, usage

(Energy systems, Family composition)



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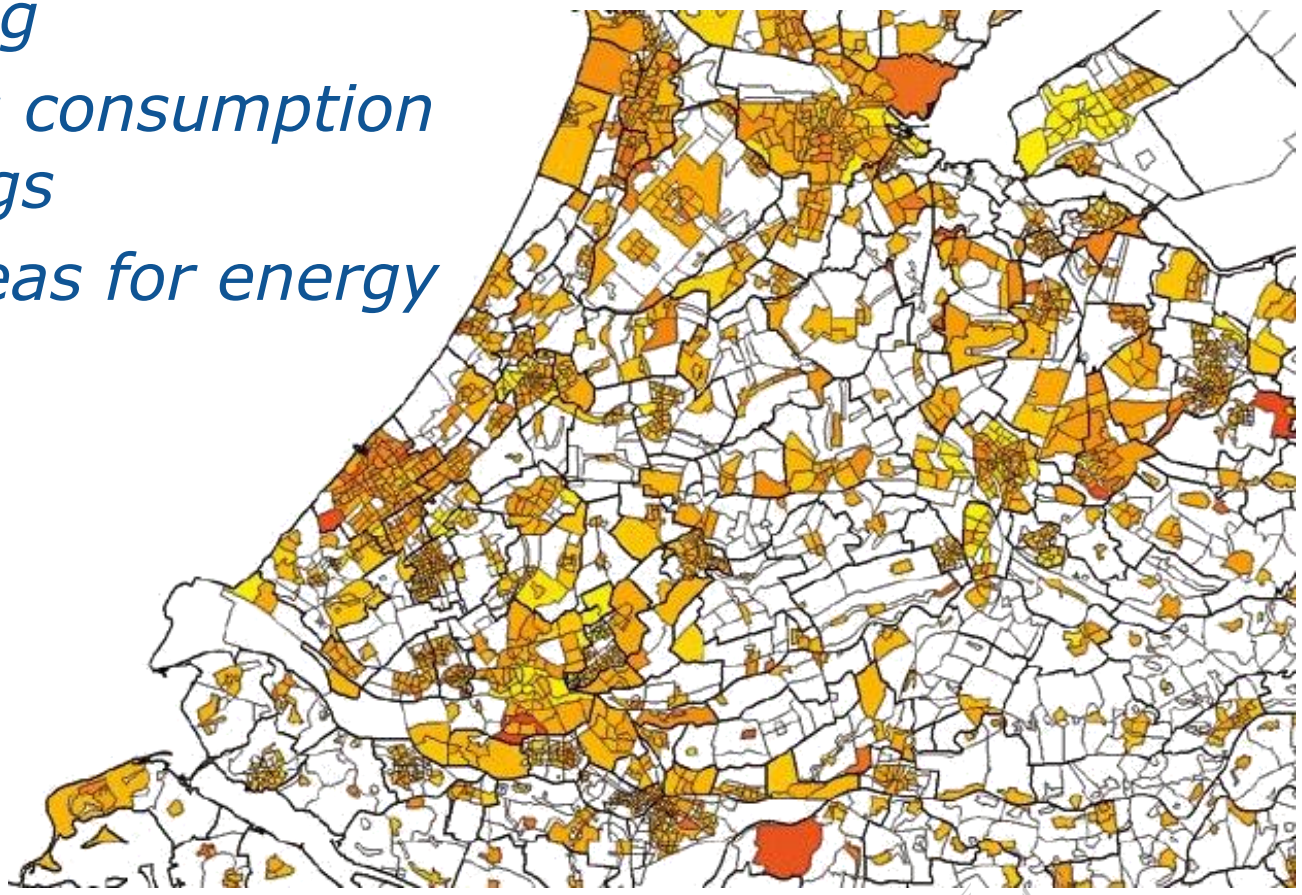
Energy, Buildings and Location

Geo-mapping

Average gas consumption in dwellings

Target areas for energy reduction



BRIDGING the GAP

EPBD related energy standards

The GAP; which GAP

Calculation (design of buildings)

Measurement (measurement of energy performance and /of consumption)

Standardization (CEN, ISO)

- TC371 *Energy Performance of Buildings*
- TC89 *Thermal Performance of Buildings and Building Components*
- *TC's related to EPBD (ventilation, light, ...)*

Top-Down and Bottom-Up levels

Energy Performance Assessment Classification of approaches

Holistic *links to INSPIRE*

Approach 1 : Simplified method based on **administrative data**

Approach 2 : **Climate and consumer information** included

Measurement *links to IEA EBC Annex 71*

Approach 3 : Energy **consumption and performance** data

Approach 4 : Building performance assessment based on **measured data**

Calculation *links to the EPBD*

Approach 5 : Not standardised or **reduced calculation** method

Approach 6 : Detailed calculation according to EPBD **standards**

VALIDATION OF METHODS

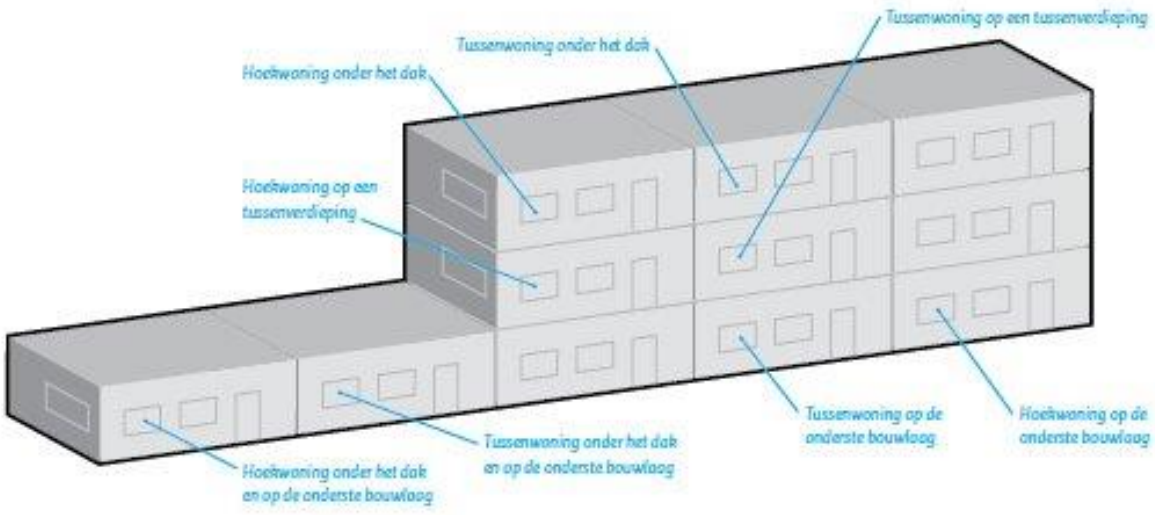
The relation between input and output is defined by the method that encompasses one or more models. Methods are developed on the available input data.

- Validation of the method and models
- Quality issue of input data (interval of observations)
- Required output (static map, value, data series)
- Uncertainty assessment

REFERENCE BUILDINGS

Woningtype	Bouwperiode		
	Aantal bouwperioden	Aantal subtypen	Aantal type totaal
Vrijstaande woning	4	1	4
2 onder 1 kap woning	4	1	4
Rijwoning	5	2	10
Maisonnettewoning	4	8	32
Galerijwoning	4	8	32
Portiekwoning	5	8	40
(Overig) flatwoning	4	8	32
Totaal	30		154

In de onderstaande figuur ziet u de namen van de subtypen bij de meergezinswoningen.
Enkele subtypen komen in de praktijk erg weinig voor. Dit geldt voor de 'Tussenwoning onder het dak en op de onderste bouwlaag' en de 'Hoekwoning onder het dak en op de onderste bouwlaag'.



Reference buildings and dwellings are required for validation of methodologies

Reference climate should offer the context for comparison of energy efficient measures

Picture source; Agentschap, NL

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WHAT IS A BUILDING ?

According to :

EPBD - Building energy performance (HCVWL)

Nearly Zero Energy Building!!!

EED – Energy Reduction and consumption

Annual progress reporting by M.S.

Covenant of Mayors - Different aspects

SECAP and bi-annual reporting

INSPIRE - Facilitation of data requirements

CityGML – based on geo information

Can the desired input and output be harmonised? and give results as requested by different target groups

DIFFERENT DIMENSIONS

Scaling issue; note that:

- EPBD is for individual building
- EED is for public and tertiary sector buildings
- CoM is for local government - all buildings

Could location based data from administrations give the required information to support Energy Policy? YES, but ……

Could IEA EBC-Annex 71 generate data and results that would support up-scaling to urban level?

6 Use Cases of the EULF Energy Pilot

Use Case **1** – **INSPIRE Harmonization of existing Energy Performance Certificate datasets** and creation of a web application for accessing them

Use Case **2** – Implementing **different buildings' Energy Performance Labelling**, including crowd sourcing data

Use Case **3** - Energy Performance of buildings with **dynamic measured data**

Use Case **4** - To support buildings' energy efficiency driven **refurbishment planning at local level**

Use Case **5** – To support **integrated energy planning and monitoring** at urban/local level (SEAP BEI/MEI)

Use Case **6** – Support the design and implementation of a **regional energy strategy**

EULF Energy Pilot Use Case 3

- **Aim**: To support policy makers to design and implement Energy Efficiency driven renovation plans of building stock at urban level.
- **Description**: By in-situ measurements or real energy consumption data of a building, obtaining the collection of real data for the estimation of building energy needs and user energy consumption:
  - for building stock renovation planning and cost optimality assessment;
  - to enable building owners to assess the energy saving potential related to the building and to local conditions (e.g. climate);
  - validation of scaling-up models (from building to urban level) in different climatic conditions and with different characteristics of the building stock.

IN-SITU MEASUREMENT

Two approaches can be distinguished;

- Both approaches require climate data from the site or a nearby weather station.
- Both approaches require a conversion to reference climate data

1. Co-Heating

CEN TC89 WG13 is developing a standard

2. Metering data

- Electricity, gas, heat, water, …
- Regular readings with intervals ranging from a few minutes up to daily values

OCCUPANCY BEHAVIOUR

Rather unknown phenomena

(according to several publications and organisations;

becomes significant with high energy performance buildings)

More research needed:

Top-down approach

- Final energy consumption data
- Identification techniques

Bottom-up research

- Aspects related to behaviour
- Living-work, transport, etc.

Daily energy flow patterns

- Buildings and community areas

PROPOSED METHODOLOGY

Use metering data (electricity, gas, heat, water, …)
Advantage is that a growing amount of data is coming available and hence improved accuracy.
Split building related energy use from occupant energy consumption

- EPB energy use; heating, cooling, ventilation, DHW and light
- Non-EPB energy use; appliances, gains, behavior, …

Combine statistical and dynamic methods

- Time series analysis
- Hidden Markov Modelling

Hidden Markov Models for indirect classification of occupant behavior; in Sustainable Cities and Society 27 (2016).

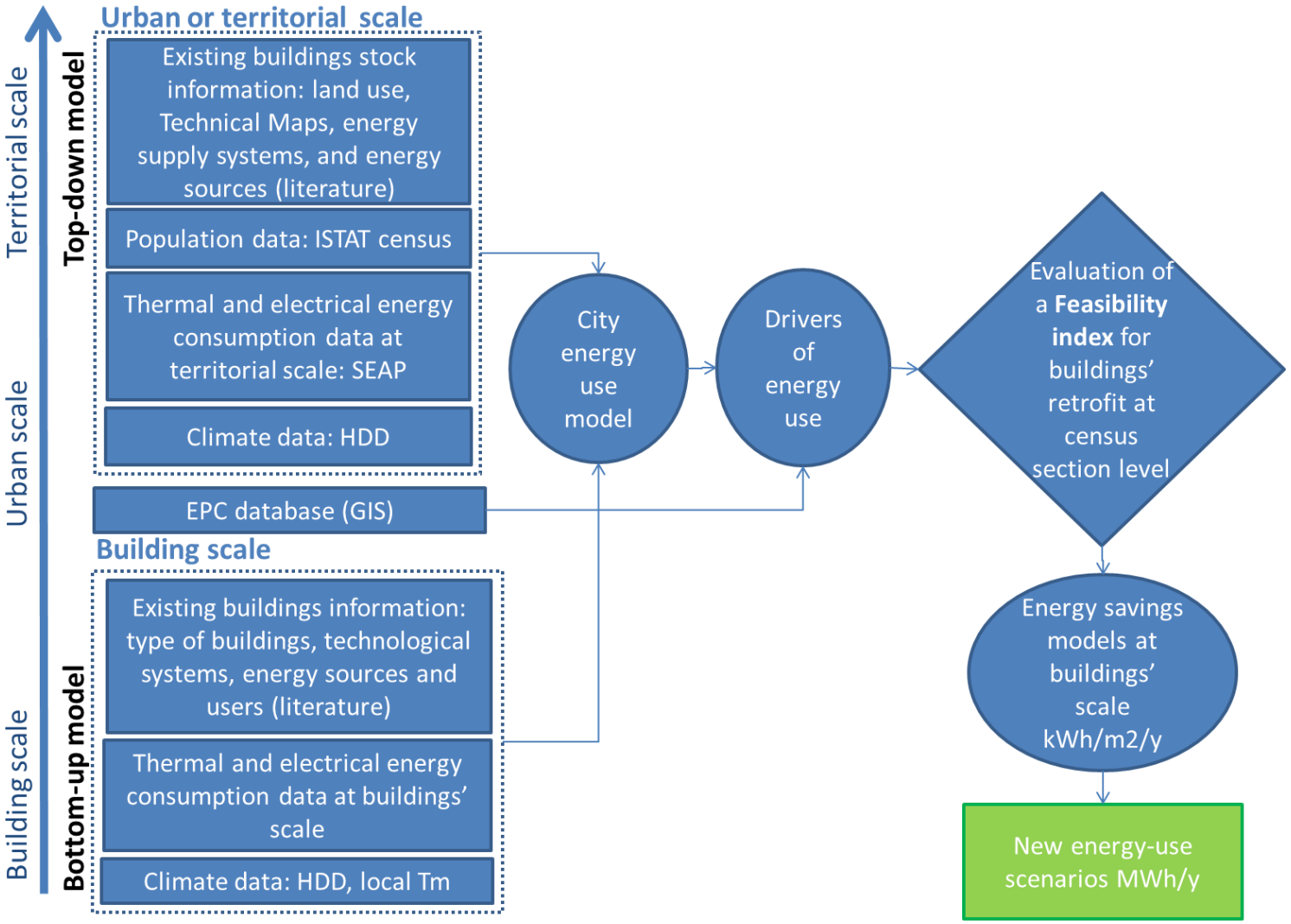
J. Liisberg, J. K. Møller, J. Bloem, J. Cipriano, G. Mor, H. Madsen

EULF Energy Pilot Use Case 4

- **Aim**: To support policy makers to design and implement Energy Efficiency driven renovation plans of building stock at urban level.
- **Description**: Use of existing models, from bottom-up to top-down approach, for the estimation of energy needs at urban level, based on real energy consumption data of a sample of buildings:

  - for building stock renovation planning and prioritization of interventions, e.g. by class of buildings and/or geographical area of interventions
  - to enable Public Authorities (e.g. Municipalities) to assess the energy saving potential related to the building stock and to local conditions (e.g. climate);
  - to allow reuse of scaling-up models (from building to urban level) in different climatic conditions and with different characteristics of the building stock.

Energy Efficiency driven retrofit planning



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THANK YOU

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