Building Energy and Location

Big Data Handling for Optimized Integration of Energy Systems in the Building Sector

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DG JRC

http://ec.europa.eu/dgs/jrc

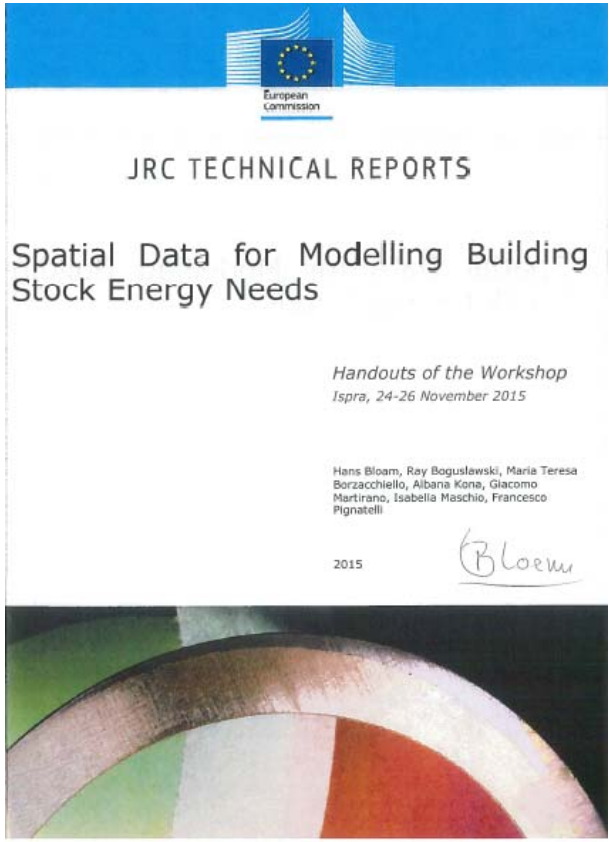
Serving society
Stimulating innovation
Supporting legislation

BACKGROUND

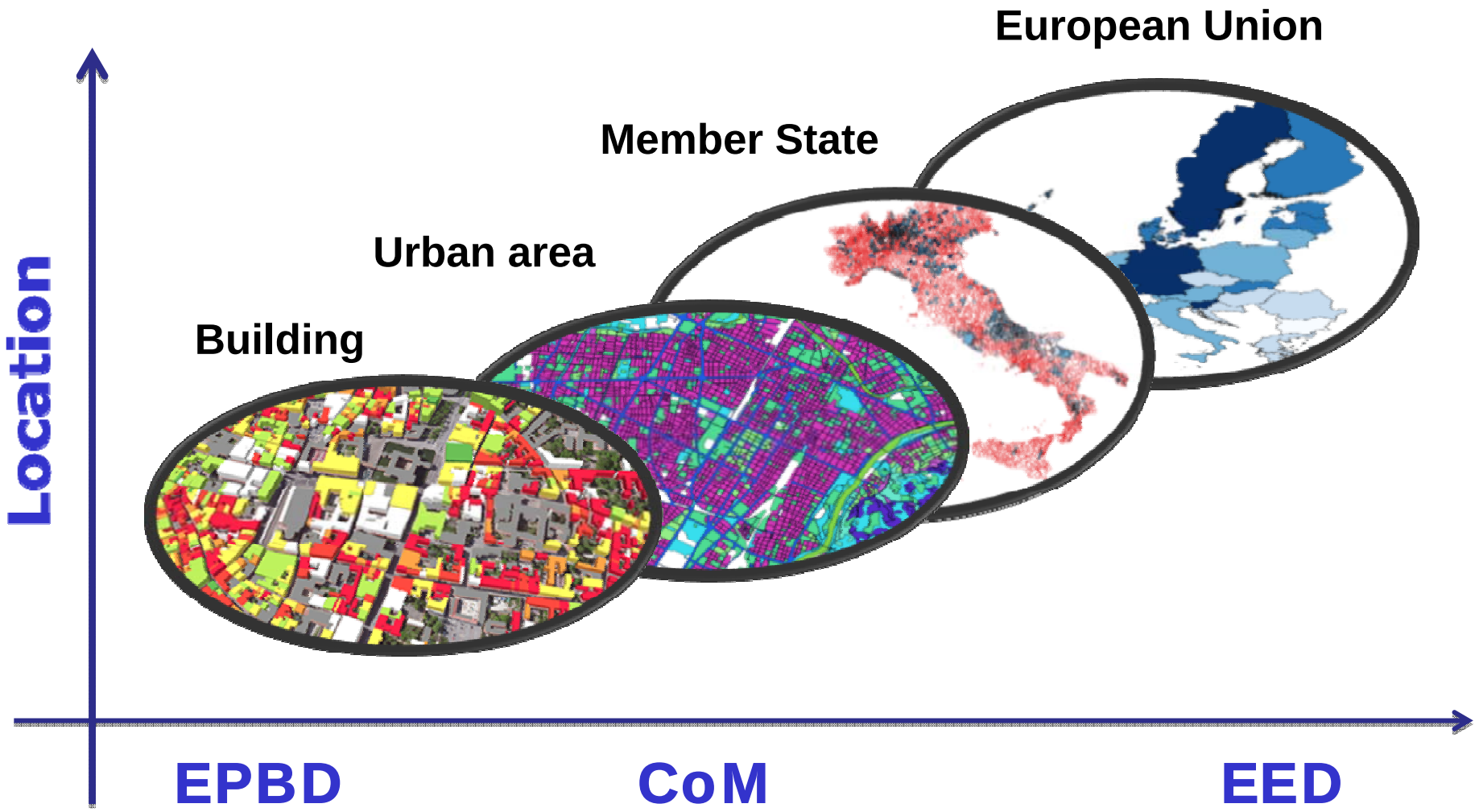
- Energy and Location
- European energy policy Directives
  - Directive 2010/31/EU - Energy Performance of Buildings – EPBD; efficient use of energy in buildings
  - Directive 2012/27/EU- Energy Efficiency Directive – EED; efficient energy systems
- European energy policy initiative
  - Covenant of Mayors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

SUMMARY

- EULF Feasibility Study “Location Data for Buildings related Energy Efficiency Policies”
  - main objectives, achievements and conclusions
- The role of INSPIRE in the EULF Energy Pilot
  - what INSPIRE will deliver, what can be delivered and by when?
- Workshop on “**Spatial data for modelling building stock energy needs**” 23-25 Nov 2015
- Upcoming Workshop on "**Methodologies for energy performance assessment based on location data**" 5-7 July 2016



ENERGY and CITIES



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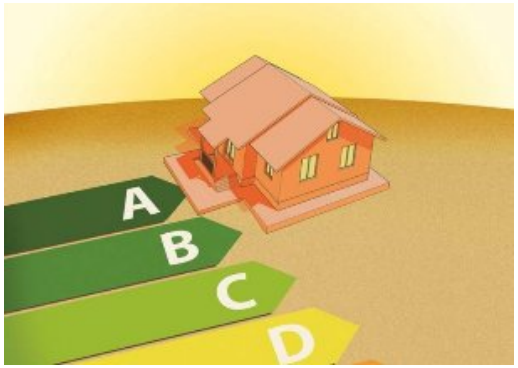
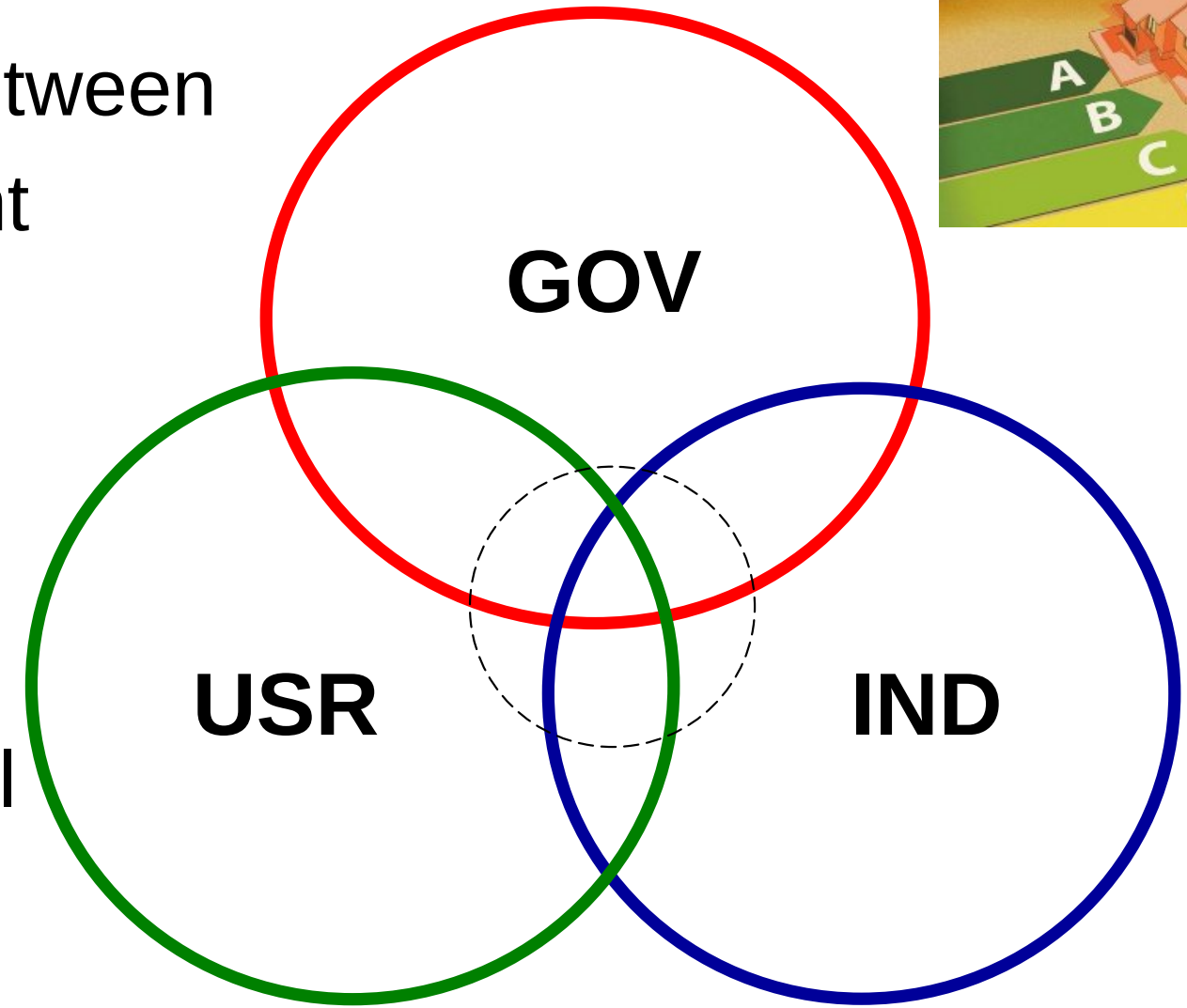
Parties Involved



Interaction between

- Government
- Industry
- End-user

- Politics
- Commercial
- Private



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.

BIG DATA - BUILDING STOCK

BPIE Europe's buildings under the microscope;
a country-by-country review of the energy performance of buildings (2011)

> 200 million dwellings in EU-28

Over 75% of building stock is older than 25 years (near estimation).

Averaged final energy consumption data

- Residential 185 kWh/m^2
- Non-Residential 280 kWh/m^2

25.4.2007 EN Official Journal of the European Union L 108/1

INSPIRE Directive

I

(Acts adopted under the EC Treaty/Euratom Treaty whose publication is obligatory)

DIRECTIVES

DIRECTIVE 2007/2/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 14 March 2007

establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

- General rules to establish an infrastructure for spatial information in Europe
  - Community environmental policies
  - Policies or activities which impact on the environment
- To be based on SDIs and LMOs established and operated by the Member States
- Does not require collection of new spatial data
- Scope:
  - Spatial data held by or on behalf of a public authority
  - 34 Spatial Data Themes laid down in 3 Annexes
- Entry into force 15 May 2007

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 175(1) thereof,

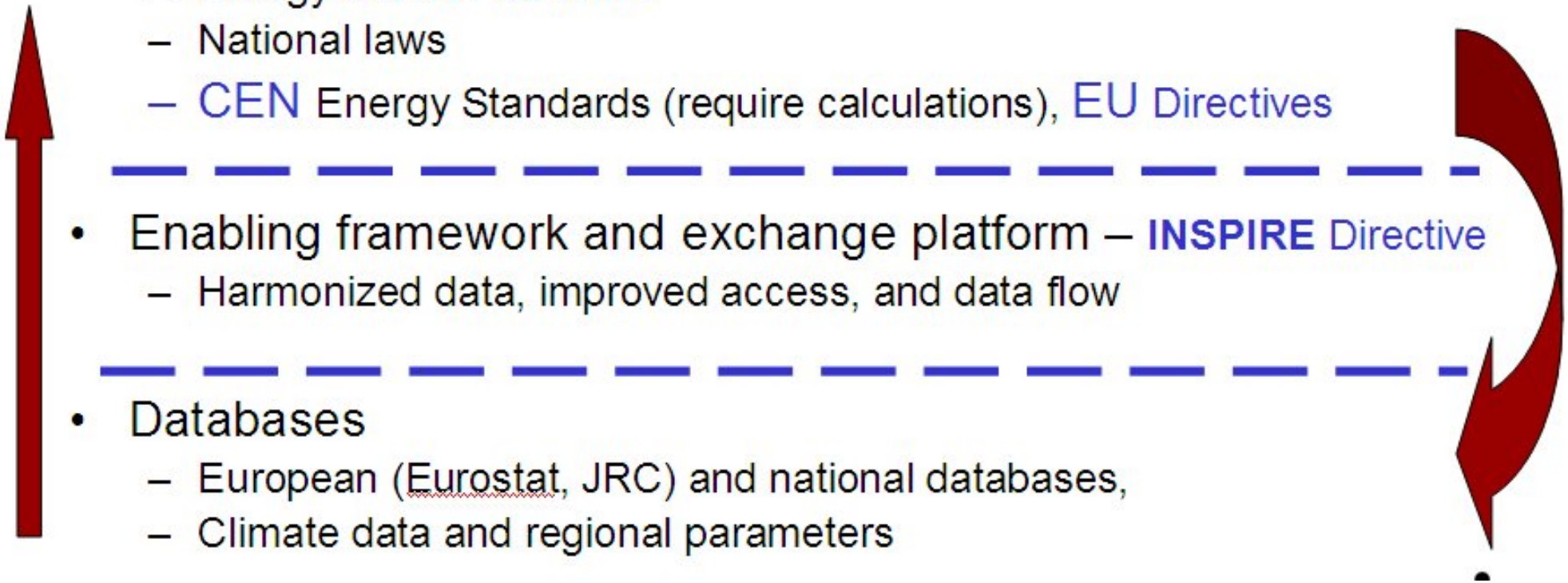
integration it is necessary to establish a measure of coordination between the users and providers of the information so that information and knowledge from different sectors can be combined.

(2) The Sixth Environment Action Programme adopted by

E&L

SYNERGY and HARMONISATION

- Applications – Energy calculation, flows, grid
  - Energy Performance for Buildings Directive
  - Construction Product Directive
  - Energy Service Directive
  - National laws
  - CEN Energy Standards (require calculations), EU Directives
- Enabling framework and exchange platform – **INSPIRE** Directive
  - Harmonized data, improved access, and data flow
- Databases
  - European (Eurostat, JRC) and national databases,
  - Climate data and regional parameters



INSPIRE Thematic Scope

Annex I

1. Coordinate reference systems
2. Geographical grid systems
3. Geographical names
4. Administrative units
5. Addresses
6. Cadastral parcels
7. Transport networks
8. Hydrography
9. Protected sites

Annex II

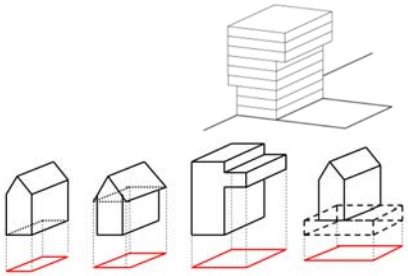
1. Elevation
2. Ortho-imagery
3. Land cover
4. Geology

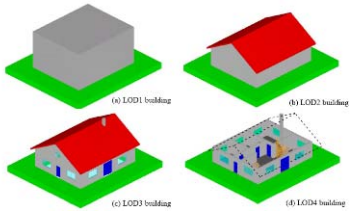
Annex III

1. Statistical units
2. Buildings
3. Soil
4. Land use
5. Human health and safety
6. Utility and governmental services
7. Environmental monitoring facilities
8. Production and industrial facilities
9. Agricultural and aquaculture facilities
10. Population distribution – demography
11. Area management/ restriction/regulation zones & reporting units
12. Natural risk zones
13. Atmospheric conditions
14. Meteorological geographical features
15. Oceanographic geographical features
16. Sea regions
17. Bio-geographical regions
18. Habitats and biotopes
19. Species distribution
20. Energy Resources
21. Mineral resources

How INSPIRE is relevant for building energy assessment ?

- One relevant theme: **Building**
- Current state of the data specifications:
  - Representations for buildings, building parts, openings, texture, etc.
  - 2D, 3D representations



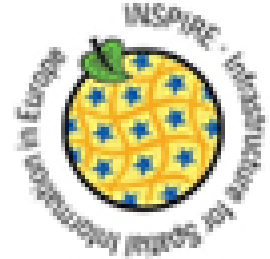


  - Many thematic information, some may be relevant for building assessment (material of construction, etc.)
- **INSPIRE** could become a major data resource for building energy assessment

INSPIRE CONFERENCE

Conference

aims to show how the implementation of INSPIRE contributes to the European Interoperability Framework and the EU's digital economy in general.



Dedicated Workshop :

The enabling role of accurate and high-quality location data to support the lifecycle of EU energy efficiency policies

http://inspire.ec.europa.eu/events/conferences/inspire_2016

Energy Performance of Buildings

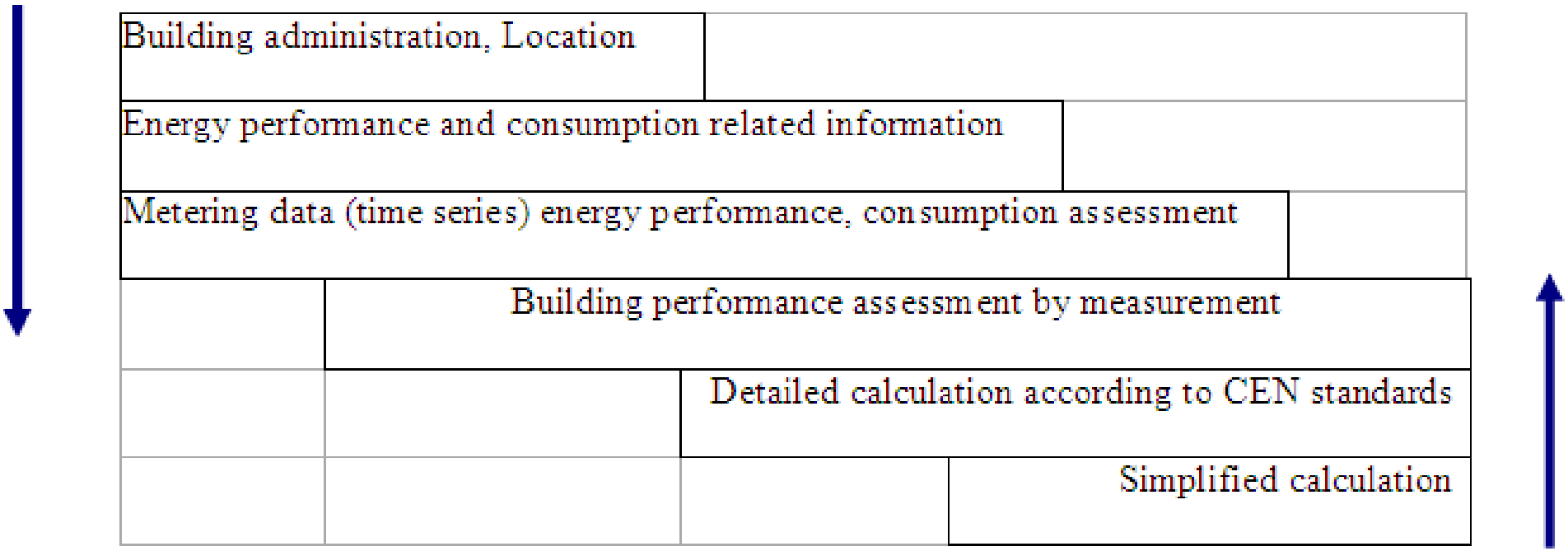
EPBDirective 2010/31/EU article 2:

*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;*

Energy Performance Assessment

Calculation and Measurement

Top – Down approach (empirical – databases, metering)



Bottom – Up approach (Calculation)

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Top-Down and Bottom-Up levels

Energy Performance Assessment Classification of approaches

Holistic

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

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

Measurement

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

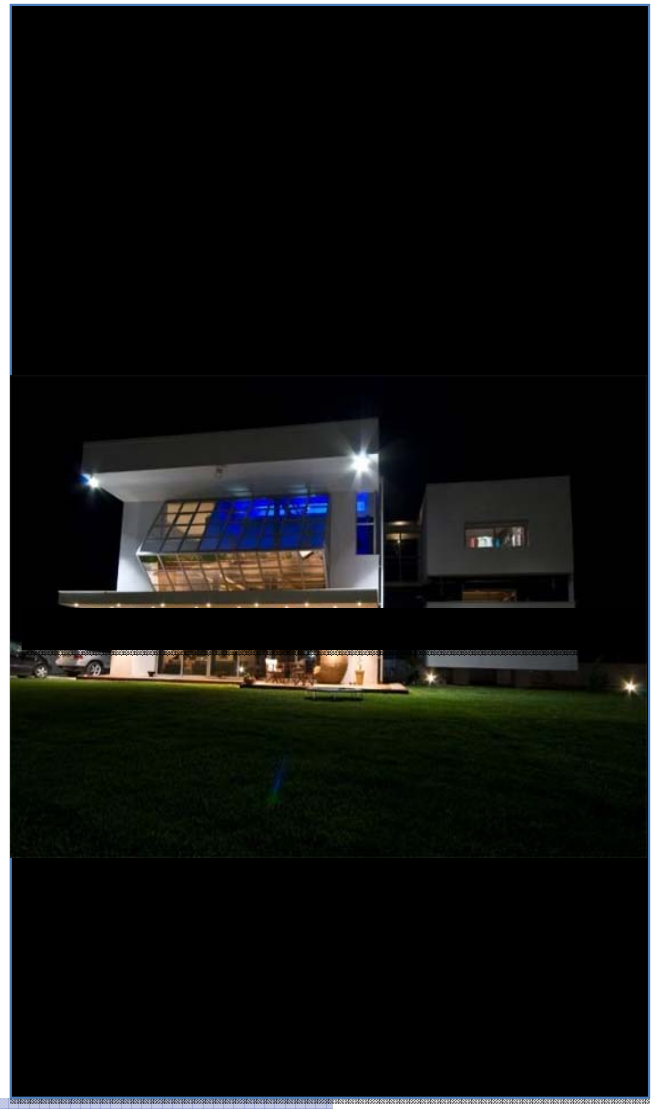
Approach 4 : Building performance assessment based on **measured data**

Calculation

Approach 5 : Detailed calculation according **standardized calculations**

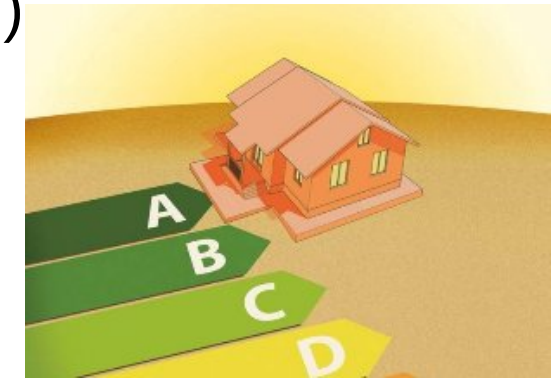
Approach 6 : **Simplified calculation** method

PHILOSOPHY



The philosophy, TRIAS ENERGETICA that supports the reduction of energy consumption in building sector is presented in three priority steps:

1. Energy **saving** (improve insulation),
2. Increase energy **efficiency** (building installations),
3. Use **renewable energy** resources (solar energy, bio-energy, etc.)



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APPROACHES

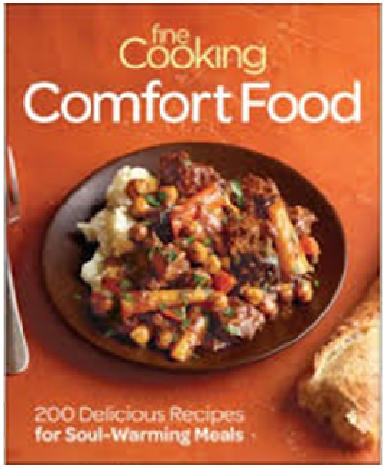
Data, Input

Methodology

Tools

Result, Output

Required ingredients

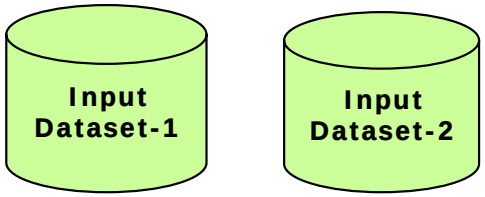


Methodologies (e.g. recipes)

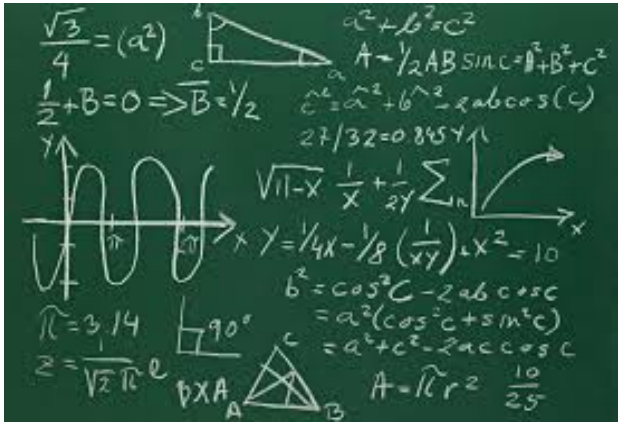
Tools

Result

APPROACHES



Data



Methodologies/models/
algorithms/maths

Tools

Result

1. Simplified method based on administrative data

Holistic assessment

Based on building administrative data like,

- year of construction,
- type of building,
- size (surface area or floor area),
- geo-location.

Cross-reference listing of buildings

Approach 1

Simplified method based on **administrative data**

- **Input** requirements: minimum information is location, age, size and type
- **Method:** cross reference list of buildings
- **Tools**: software for linking databases and filtering required input
- **Output**: energy label for each dwelling
- **Target**: decision makers, market

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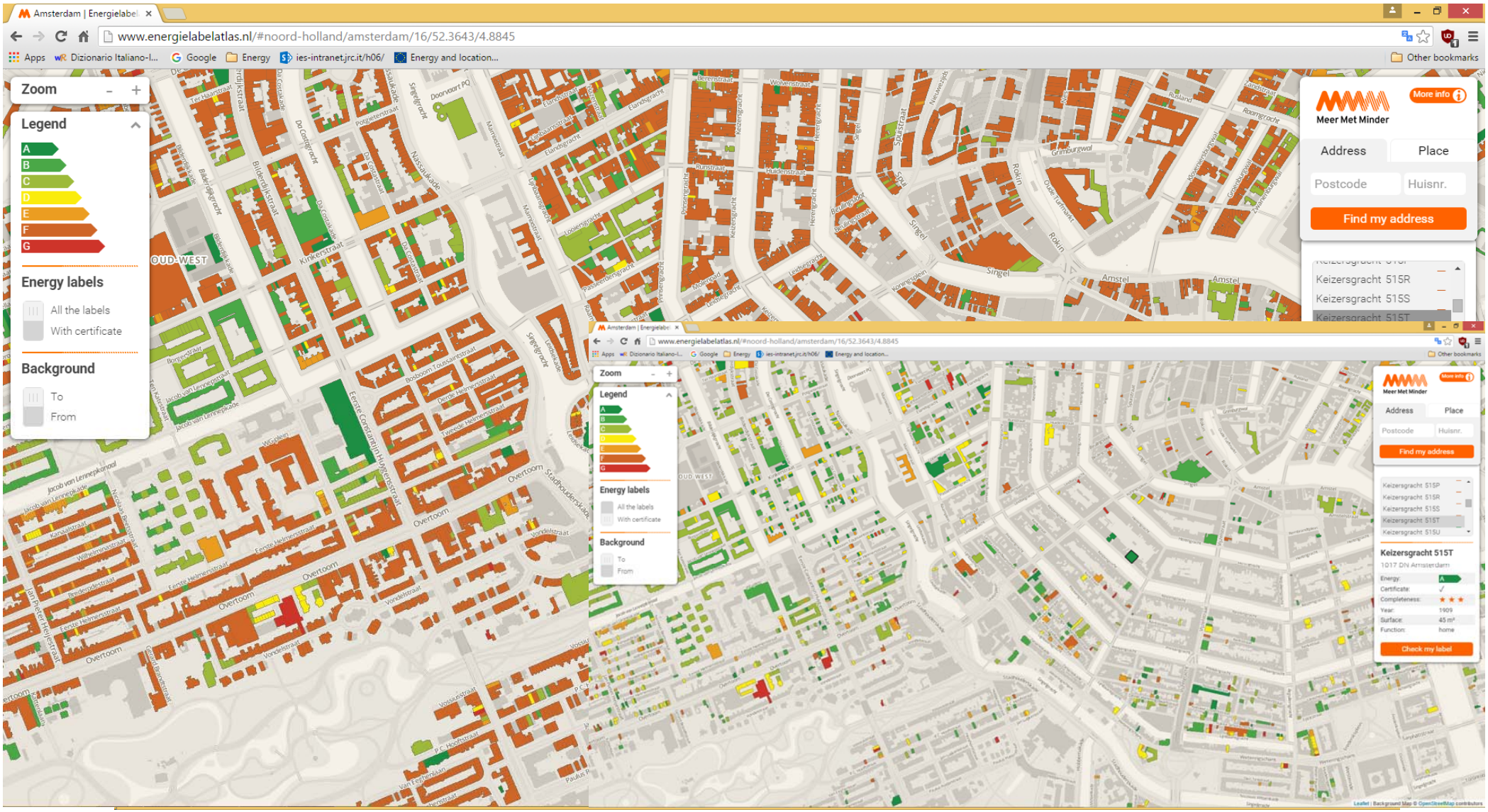

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2. Climate and consumer information included

Extension of approach 1 but for which additional data is coming from climate and end-user feedback.

End-user information may be linked to annual energy billing for a correlation indicator of in- and outdoor climate.

Geo-location data may be used for selection of energy resources (renewable) or energy infra-structure and providers

Approach 2

Climate and consumer information included (feedback)

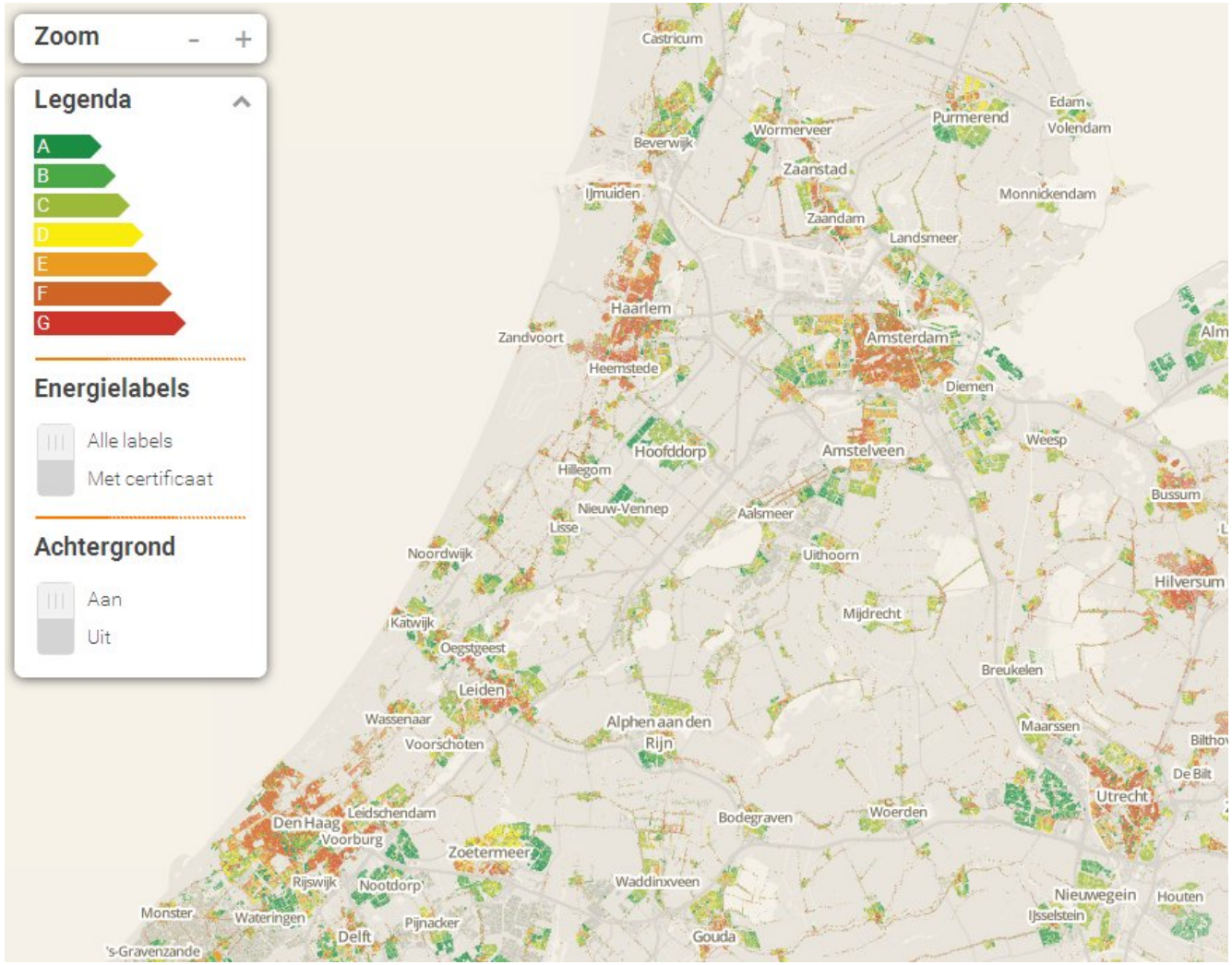
- **Input** requirements: minimum information is location, age, size and type.
- **Extended input**: climate, resources, renovation, qualitative insulation levels and building systems. If possible annual energy consumption data, family composition, etc.
- **Method**: cross reference list of buildings; cross reference list for building energy systems, resources and usage profiles. Feedback from consumer.
- **Tools**: software for linking databases and filtering required input. Parameter adjustment
- **Output**: energy performance indicator for dwelling
- **Target**: decision makers, market, private

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

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3. Energy consumption and performance data

Further extension of approach 2

Metering data (daily or even hourly interval)

A combined statistical and analysis method might be applied to distinguish

- building energy needs (real climate and building fabric related) from
- end-user energy consumption (behavioural aspect).

Calculation techniques are dynamic

Optimise energy demand to climate as well as user behaviour.

Approach 3

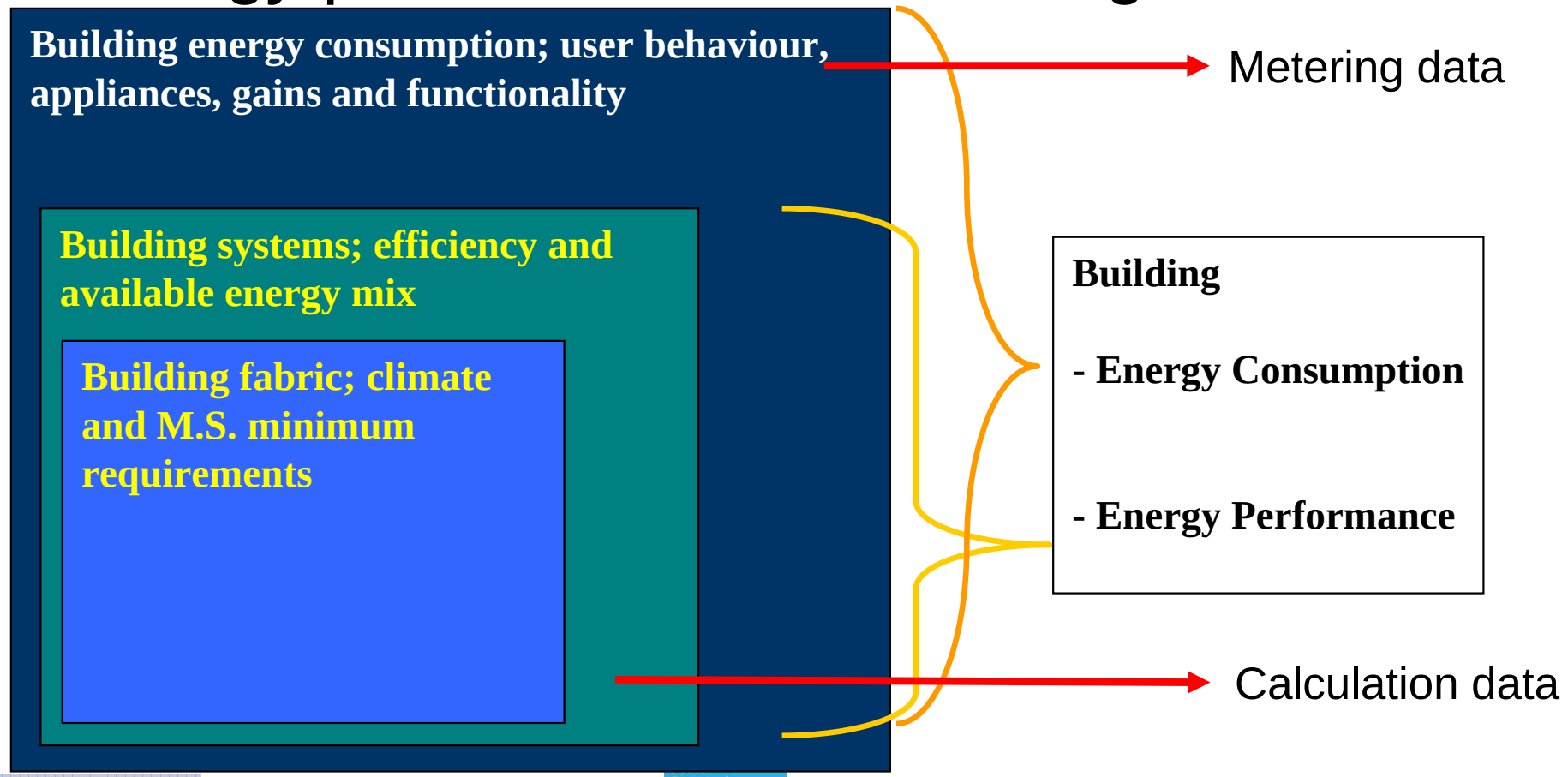
Energy **consumption and performance** data, including metering data. *Requires research and further development.*

- **Input** requirements: regular readings from gas, electricity, water, heat and other resources. Regularity can be hourly, daily or other frequent meter readings. Climate data.

  Basic information as under approach 1 or 6, possibly with input from approach 2 or even 5.
- **Method**: distinguish building performance data and user consumption by means of correlation techniques (statistical or mathematical)
- **Tools**: dedicated software environments to deal with dynamic calculation rules and statistics, including conversion to reference climate conditions.
- **Output**: high quality data (values) on energy performance and consumption for the specific dwelling

ENERGY AND BUILDINGS

Relation of energy consumption and energy performance of a building



Buildings and Energy

- Needs – building fabric *(Performance)*
  - Quality issue; speed/time; CO2/m3 or kWh/m2
- Systems – building systems *Efficiency*
  - Unit-less expression (%, rendement, COP)
- Occupants – energy *Consumption*
  - Control, appliances, family composition; MWh
- EPB defined energy usage:
  - Heating, Cooling, Ventilation, Hot Water, Light
  - Expressions of performance: kWh, CO2, …

PROPOSED METHODOLOGY

- Use metering data (electricity, gas, water, …)
- Split building related energy use from occupant energy consumption
  - EPB energy use; heating, cooling, ventilation, DHW and light
  - Non-EPB energy use; appliances, gains, behaviour
- Combine statistical and dynamic methods
  - Time series analysis
  - Hidden Markov Modelling

METERING

Metering for billing

- “smart- meters” for more frequent readings
- serves the provider in particular electricity

For optimising energy balance

- Water, gas, district-heat, electricity

Towards intelligent environments

Provider(s), ESCO, in the building

4. Building performance assessment based on measured data

In-situ measurement by means of co-heating.

The important energy flows, e.g. thermal transfer through the envelop and by an air tightness measurement.

Measurements by infra-red camera observations or other specific measurements.

Obtained information is site and local weather conditions correlated and require a proper conversion to obtain energy performance value

Approach 4

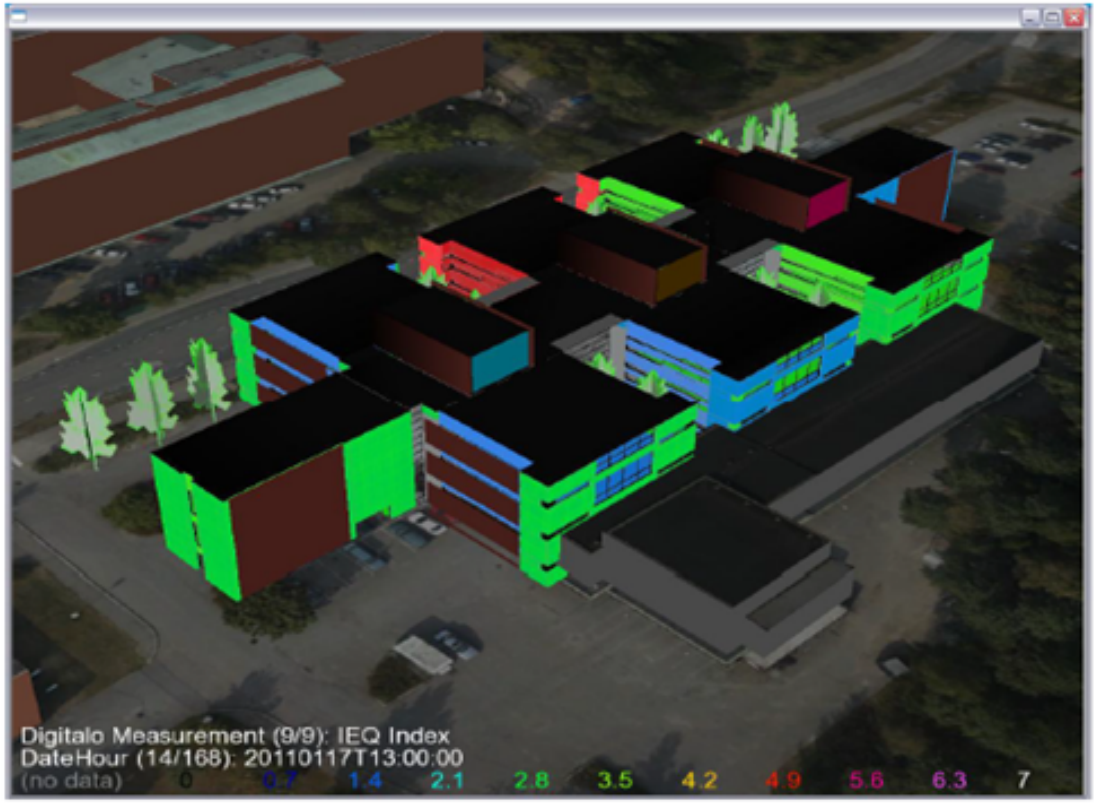
Building performance assessment based on **measured data**

- **Input** requirements: Measurement data from co-heating experimental set-up from ventilation (infiltration) and heat transfer based on an agreed measurement method. Measurements may include tracer gas measurements as well as infra-red measurements to assess details about thermal losses through the building envelop.
- **Method**: an agreed/ harmonized measurement set-up based on envelop thermal transfer.
- **Tools**: data treatment software and energy performance assessment including conversion to reference climate conditions.
- **Output**: energy performance indicator for the specific dwelling.
- **Target**: building owner. Housing market.

DESIGN and REAL PERFORMANCE

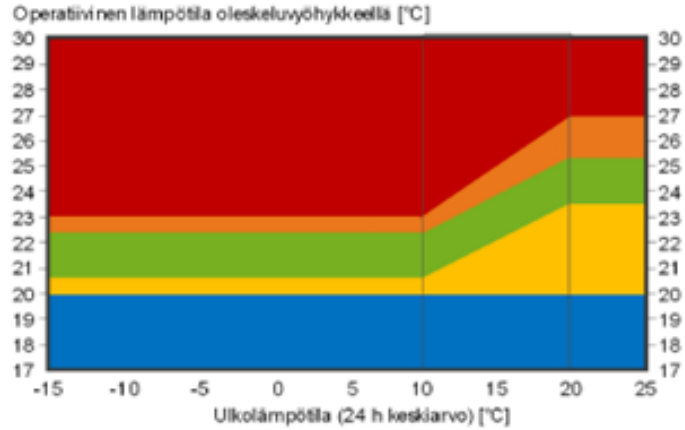
- Simulation software coupled to real data

- Comfortable room temperature = green; red = too hot, blue = too cold



IEQ index (temperature/CO_2/etc.)

Target values of temperature (FiSIAQ Cat S2)



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BUILDING SIMULATION

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5. Detailed calculation according standardized calculations

Detailed calculation rules for the building.

Requires hourly or monthly data for the assessment.

These calculation rules are described in standards, CEN or national standards.

Dynamic calculation assessment takes into account variable climate data as well as thermal mass of the building.

Reference is made to the Overarching standard EN 15603 and the technical report EN 15615

Approach 5

Detailed calculation according **standardized calculations**

- **Input**: See CEN standard EN15603 and related EPBD energy standards. ISO EPB standards numbering from ISO 52000.
- **Method**: Hourly and monthly calculation methods are provided, for example the calculation of energy needs for heating and cooling: ISO 52016-1 (a) (hourly method) and ISO 52016-1 (b) monthly method with correlation factors.
- **Tools**: Dedicated software tools. Plenty available!!!
- **Output**: Value. Energy Performance Indicator and Primary Energy Factor

BRIDGING the GAP

EPBD related energy standards

The GAP; which GAP

- Calculation (design of buildings)
- Measurement (measurement of consumption)

Standards

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

6. Simplified calculation method

Based on annual data;

The physical building is simplified to its volume and to the climate exposed envelop area. Climate data can be simplified to annual HDD (older buildings).

A more detailed assessment can be made based on monthly climate data and details of the envelop, such as window area, orientation to include impact of solar radiation and ventilation for air quality requirements.

Impact of thermal mass may be taken into account

Approach 6

Simplified calculation method

- **Input** requirements: minimum information is volume, floor area, exposed envelope area, air change per hour (ACH) and reference climate for the location.
- **Method**: assessment of thermal transfer through envelop by means of thermal conductance and by ventilation as well as solar gains. Impact of wind could be included
- Tools: software for calculating thermal transfer through building envelop
- Output: energy performance indicator for each dwelling in kW/m2
- Target: private, planners

SCALING

	APPROACHES					
	Holistic		Measurement		Calculation	
SCALING	Administrative	Feedback	Metering	Co-heat	Simplified	Standards
Building(s)	X	X	X	X	X	X
Urban area	X	x	X	x	X	x
City	X		X		X	
Country	X		X		X	

Methods and models will be tested on Use Cases

Issues are:

requirements for input data, uncertainty, presentation of results.

The 6 Use Cases

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

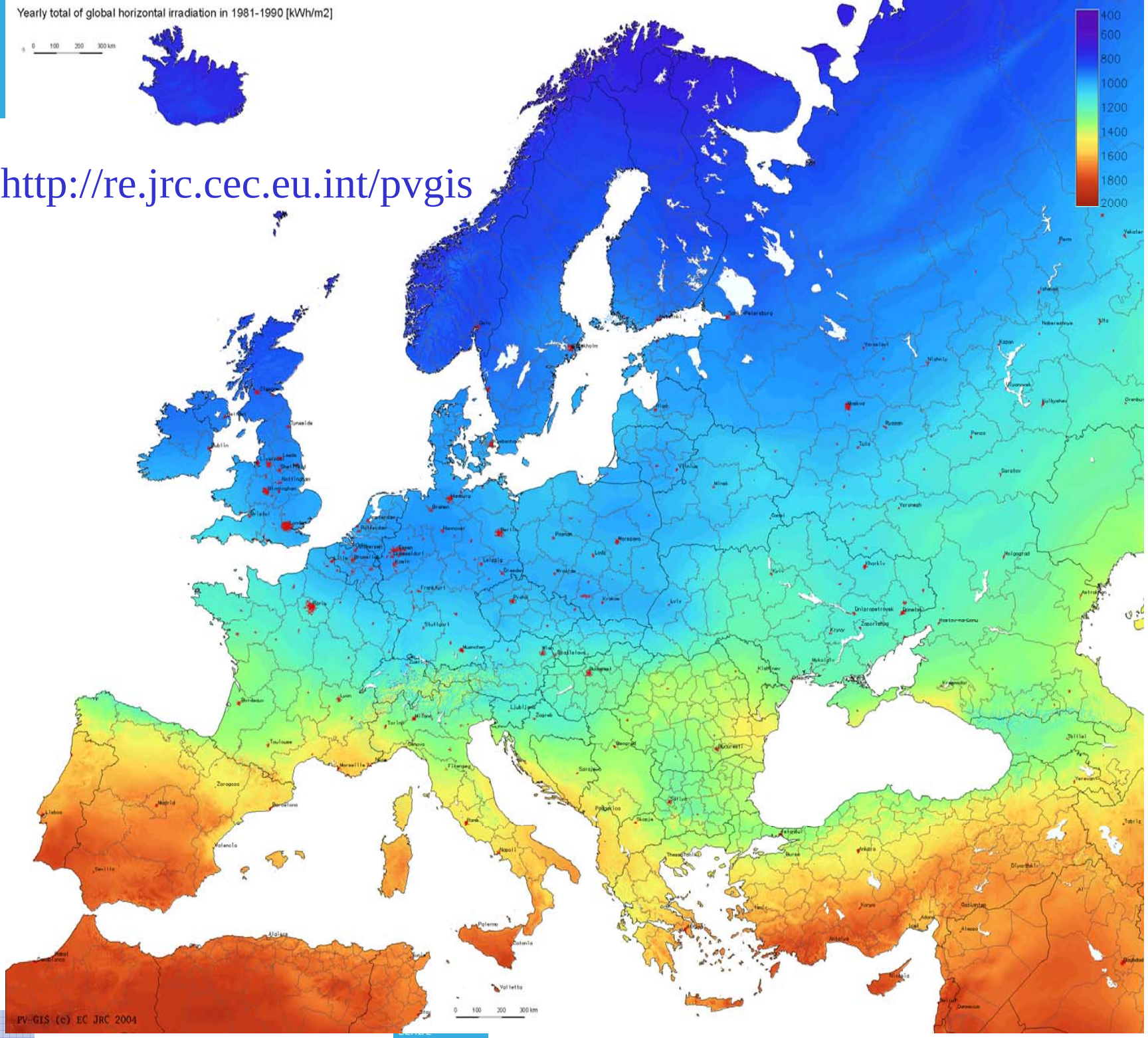
Use Case **2** – Implementing **different buildings' Energy Performance Labelling**, including crowd sourcing data

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**



Web-site http://re.jrc.cec.eu.int/pvgis

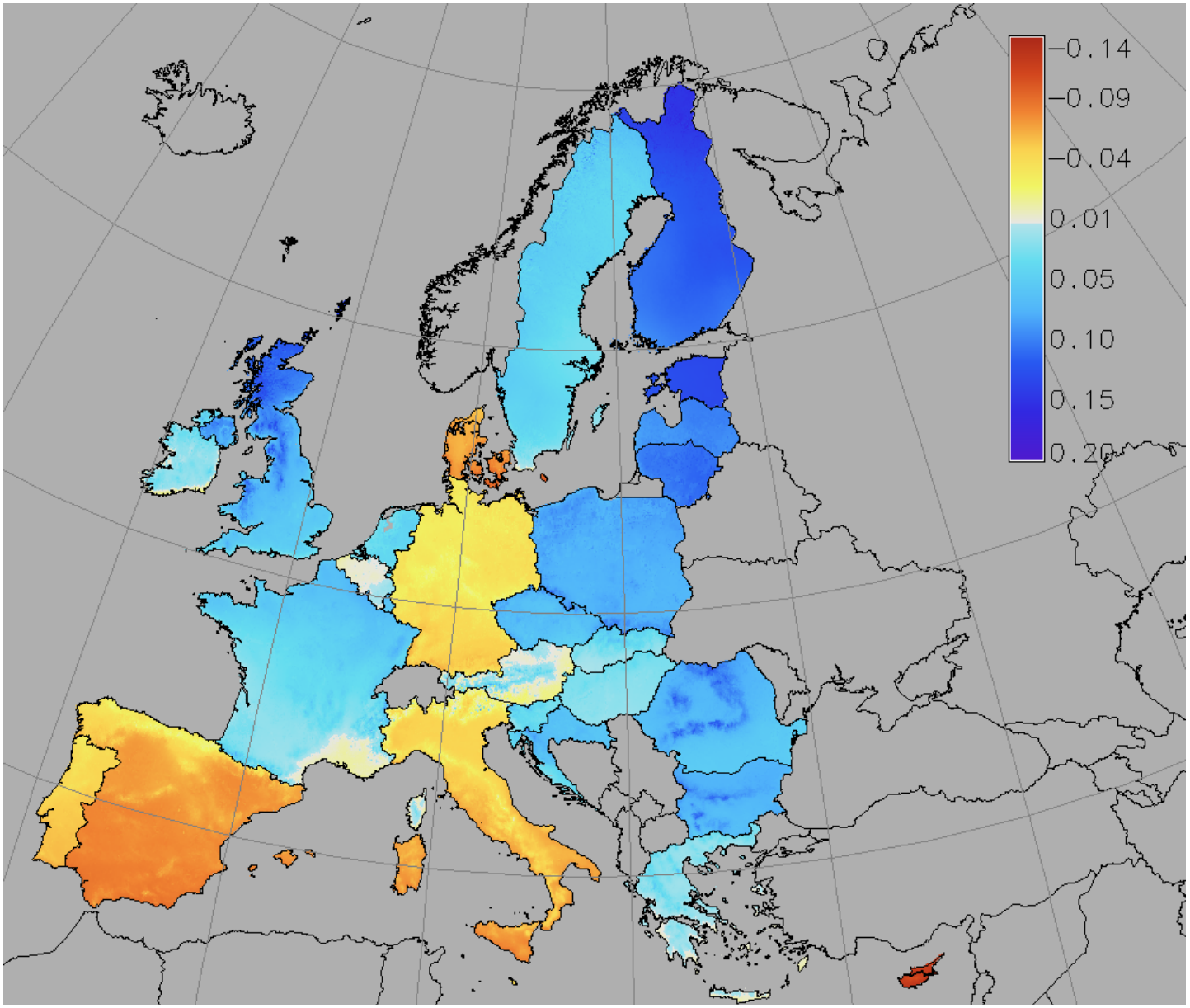
GIS-RAD

Climate

calculation

parameters

and data



Difference to Household Electricity Prices

€/kWh

System Cost: 2300 €/Wp

O&M per year: 1%

Capital Rate: 5%

Households 2.5<Consumption<5MWh/y, 2nd semester 2011. Sources: European Commission Market Observatory for Energy; JRC PV-GIS

THANK YOU

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