Energy Performance of Buildings

Status and Strategy for using Dynamical Calculation Methods

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CITIES

TOWARDS 2030 and beyond

framework for climate and energy policies

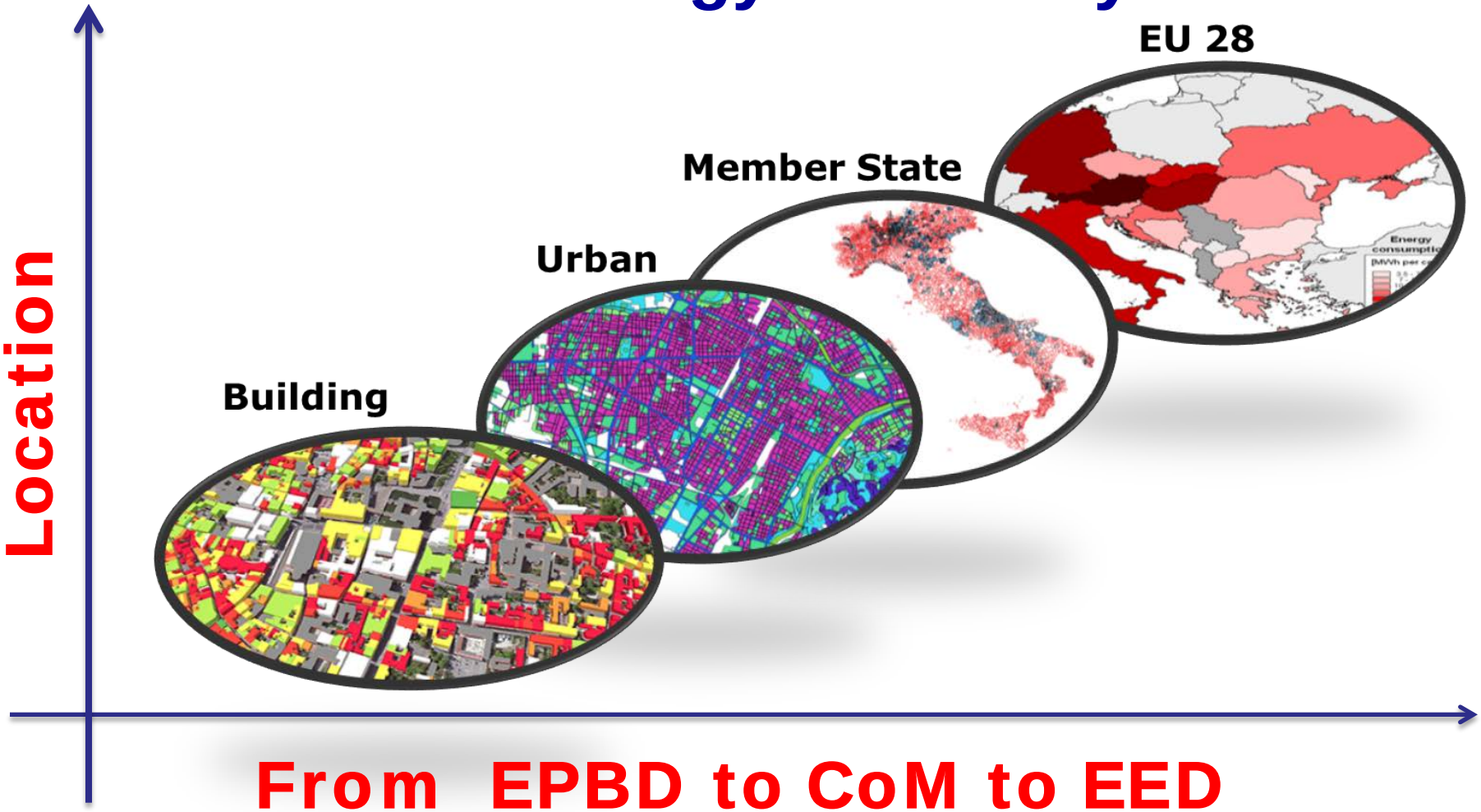
- EU economy and energy system more competitive, secure and sustainable
- towards a low-carbon economy (Roadmap 2050)
- reduce EU domestic greenhouse gas emissions by 40% below the 1990 level by 2030 (emissions by at least 80% by 2050)
- share of renewable energy to at least 27%
- 30% energy savings target for 2030 (EED)
- **Buildings** have a huge potential to contribute to these targets

CITIES RELEVANT EU LEGISLATION

Agreement on reduction of CO_2 emission

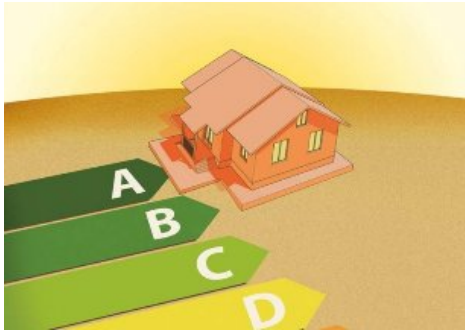
- Directive (89/106/EEC) Construction Products
- CPR (2011/305/EU) Construction Products Regulation
- Directive 2001/77/EC Directive on **Electricity** produced from **Renewable** Energy Sources
- Directive 2005/32/EC Directive on the **Eco-design** of Energy-using Products
- Directive 2012/27/EU **Energy Efficiency Directive**. *Supersedes the EESD Directive 2006/32/EC*
- Directive 2007/2/EC on an Infrastructure for **Spatial Information** in the European Community
- Directive 2009/28/EC Directive on the promotion of Energy from **Renewable Sources**
- Directive 2010/31/EU Directive on the Energy Performance of **Buildings** *(recast). 2012 COM*

Location and Energy Efficiency Policies



From EPBD to CoM to EED

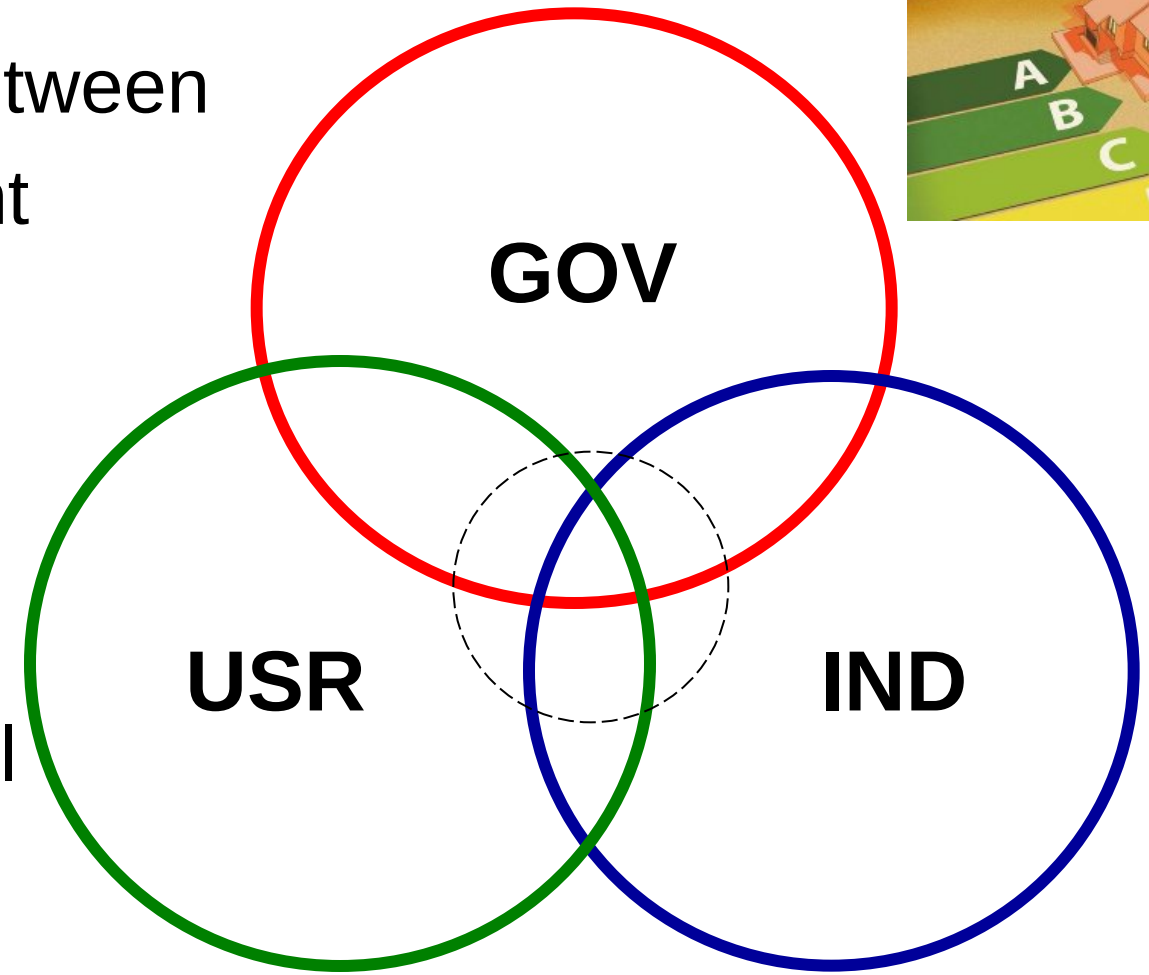
Parties Involved



Interaction between

- Government
- Industry
- End-user

- Politics
- Commercial
- Private



Energy Performance of Buildings

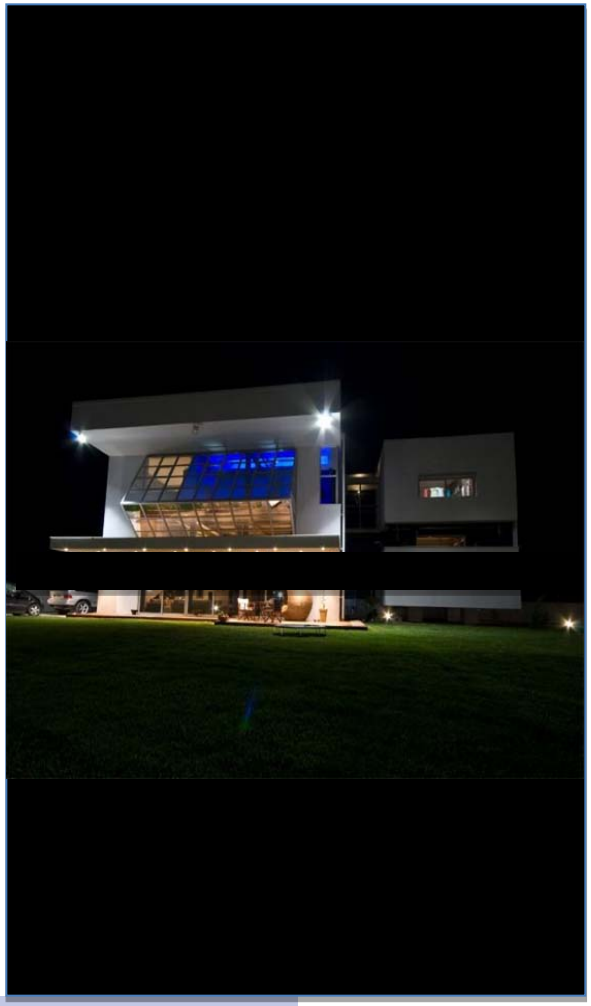
Directive 2010/31/EU article 2:

*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;*

BUILDING

- A protected enclosure (space/volume) taking into account its boundaries; climate, energy infra-structure and functionality.
- Key element in the energy infra structure
- For energy assessment the envelope is the most important part. It separates indoor- (volume) from outdoor environment.
- In terms of energy consumption:
  - Building needs; minimum requirements
  - Operational needs; apparatus, etc.
  - Occupancy/functionality energy needs

PHILOSOPHY

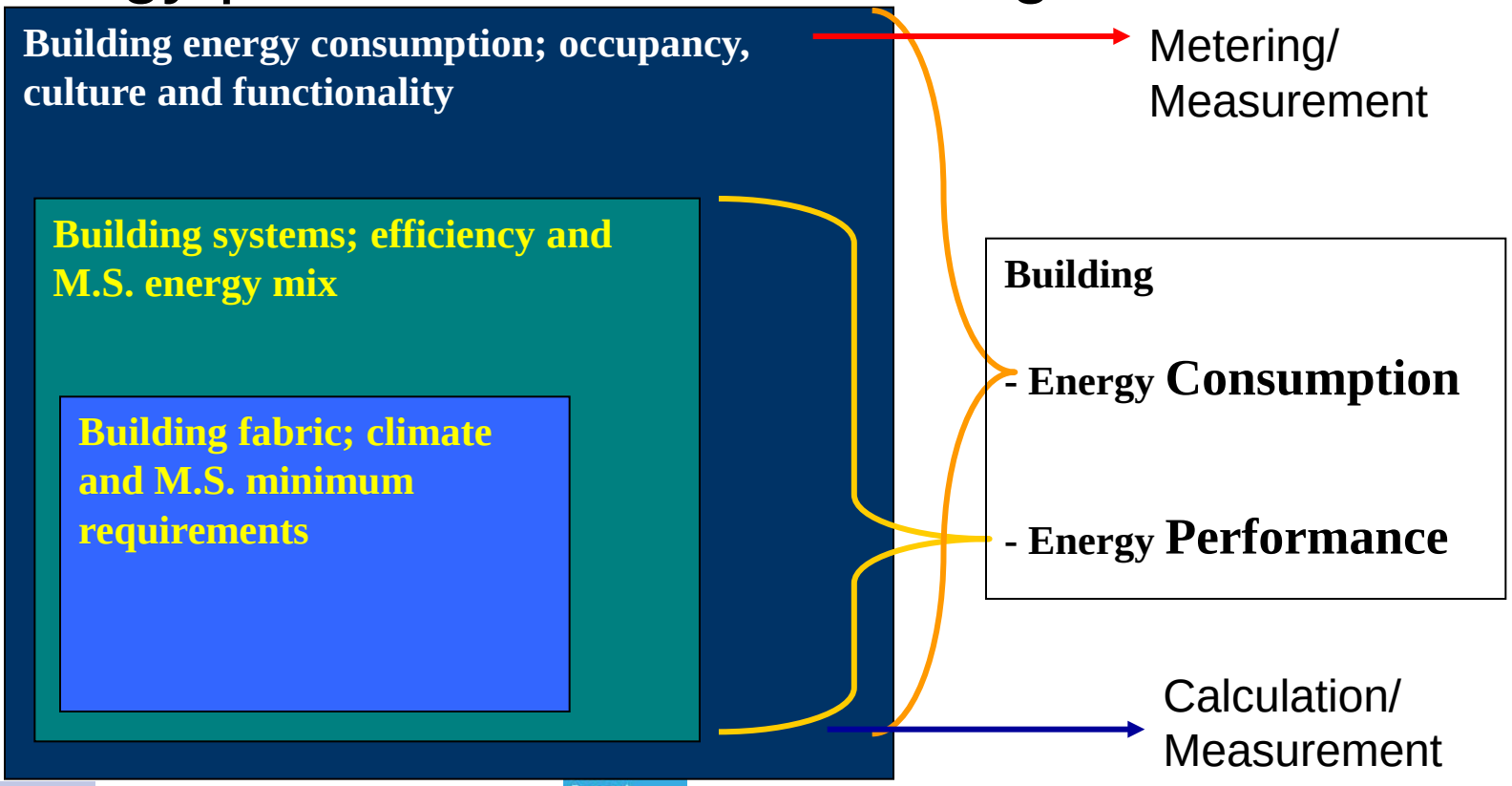


The philosophy, TRIAS ENERGETICA that supports the reduction of energy consumption in building sector is presented in three priority steps:

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

ENERGY AND BUILDINGS

Relation of energy consumption and energy performance of a building



EUROSTAT

2013 data; Total 1666 Mtoe ; 2/3 for consumption

Buildings (households and tertiary) 39.7%; 444 Mtoe

Households 291 Mtoe (delivered to residential buildings)

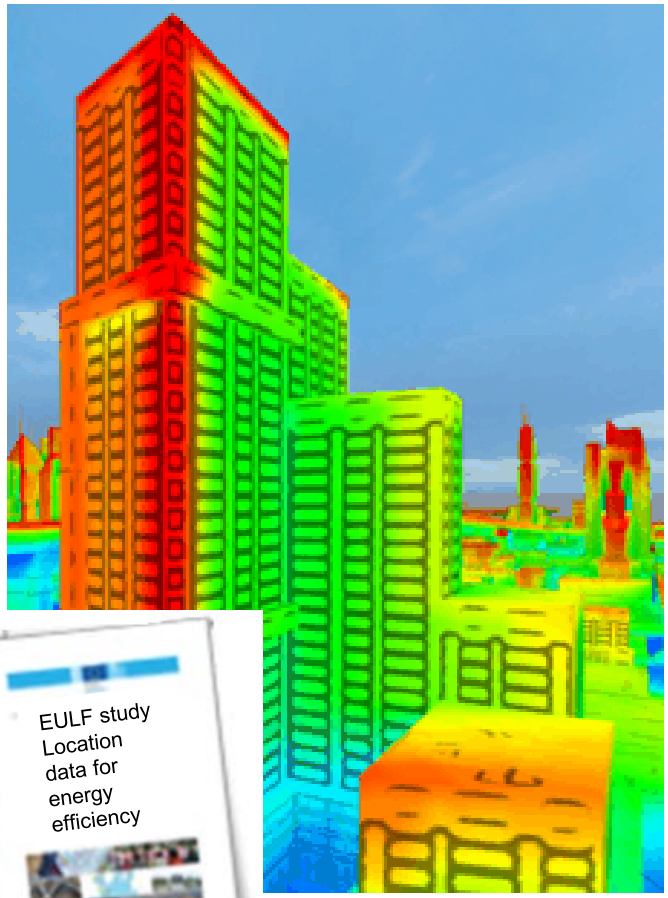
Gas	**37.4% (35.9)**	**+**
Electricity	**24.0% (24.1)**	
Heat	**7.6% (7.0)**	**+**
Oil	**13.0% (16.3)**	**-**
Solid	**3.4% (3.5)**	
Renewables	**14.6% (11.4)**	**+**

Space heating; ¾ of delivered energy

Saving potential still in improving insulation of the envelop (roof, walls, windows, air-tightness)

75% of building stock for renovation

Location Data for Energy Efficiency Policies Feasibility study



- Focus on Energy Efficiency
- Collaboration among JRC Units dealing with different topics:
  - IET (F07) - *Covenant of Mayors*, *Energy Efficiency in Smart Cities, Energy Performance of Buildings Directive*
  - IES (H06) – *EULF, INSPIRE*
- The goal of this study is to verify how location data can support energy efficiency policies

WHY DYNAMIC METHODOLOGY

Dynamic takes into account aspect of time

- Building Energy Needs – building fabric
  - Envelope heat transfer due to difference between in- and out environments **CLIMATE**
- Building Energy Systems – efficiency
  - Technology and available energy mix
  - Fuel switching and storage **RE electricity**
- End-use energy consumption – Occupants
  - Management and control, appliances, gains, presence **USER behaviour**

VARIABILITY

- Time aspects (hourly to building life time)
- Energy resources (climate, natural, variable)
- Electricity has to be consumed or stored
- User behaviour, use patterns
- Physical (from construction element to cluster of buildings)
- Member State policy (incentives, regulation)
- Economic evaluation (market, energy price)
- Natural borders (energy market, dumping)
- Industry (products, innovation, standards)

Strategies for Energy Savings

- **Building needs Energy Providers** or
- **Energy Providers require Buildings**

Reasoning:

Optimise the Balance for …..

Energy ? Emissions ? Economics ?

Energy Providers are a part of industry and hence have a commercial attitude

Energy Systems:

Conversion of energy carriers into required energy needs (as defined by the EPBD)

WHERE DYNAMIC METHODOLOGY

Dynamic analysis and prediction techniques

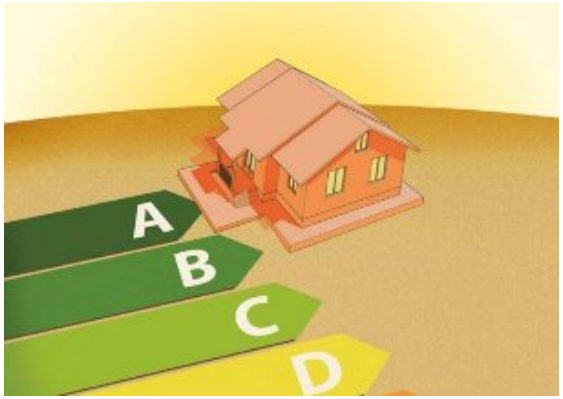
- Building Energy Needs – building fabric
  - In the building for smooth comfort control (thermal mass)
  - Communication with end-user as well as the energy provider
- Building Energy Systems – efficiency
  - Energy providers for network management
  - Intelligent metering environments
- End-use energy consumption – Occupants
  - Management and control, communication with appliances, local storage (electricity)

Energy Efficiency in Buildings

Building Energy Systems

Conversion of energy carriers into required energy needs (as defined by the EPBD)

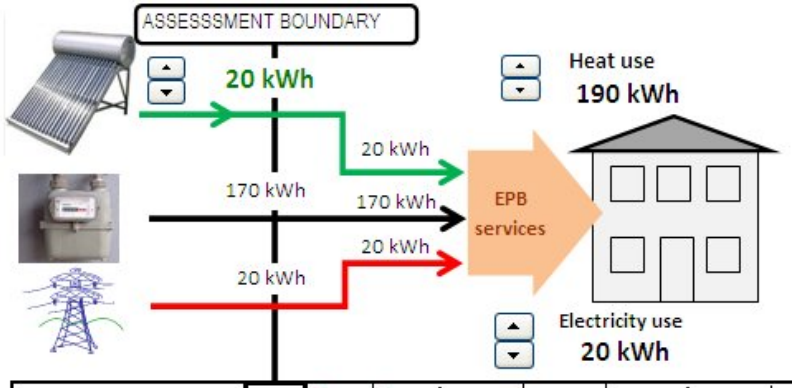
Some Member States allow the surplus to be delivered to the energy infra structure, in particular for electricity



See EN15603 Annex A and B

Option: Kexp

CEN Buildings & Energy Standards



		E	fPnren	fPren	EPnren	EPren	Eptot	RER	RER
		kWh			kWh	kWh	kWh	tot	nrb-os
+ Delivered energy	TS	20	0.0	1.0	0	20	20		
+ Delivered energy	Grid	20	2.0	0.5	40	10	50		
+ Delivered energy	Gas	170	1.1	0.0	187	0	187		
TOTAL STEP A					*227*	*30*	*257*	*0.12*	*0.08*

Kexp	1.0							
TOTAL STEP A					227	30	257	
+ Exported energy								
- Avoided grid gen		0	2.0	0.5	0	0	0	
Energy performance					227	30	257	0.12
Energy available ext.								

Primary energy factors	fPnren	fPren	fPtot
Thermal solar	0.00	1.00	1.00
Grid electricity	2.00	0.50	2.50
Gas	1.10	0.00	1.10

<-- Click on the selection arrows to inc

<-- Click on the selection arrows to inc

<-- input the desired kexp value

<-- input the desired weighting factor
<-- input the desired weighting factor
<-- input the desired weighting factor

CEN Default Options

K_{exp} for exporting

OCCUPANCY BEHAVIOUR

Rather unknown phenomena

(according to several publications and organisations; becomes significant with high energy performance buildings)

More research needed:

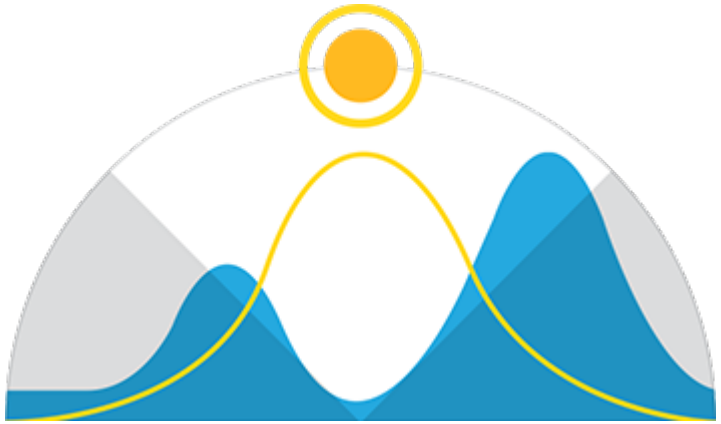
- Top-down approach
  - Final energy consumption data
  - Identification techniques
- Bottom-up research
  - Aspects related to behaviour
  - Living-work, transport, etc.
- Daily energy flow patterns
  - Buildings and community areas

Energy Investment Curve

http://www.thecrowd.me/launching-energy-investment-curve

Decision making for Occupants

PV on my roof or garden
or
PV from the grid?



Connecting to district heat
or
Solar thermal for space heating and hot water

Building Electricity storage
PowerWall by TESLA

BOUNDARIES

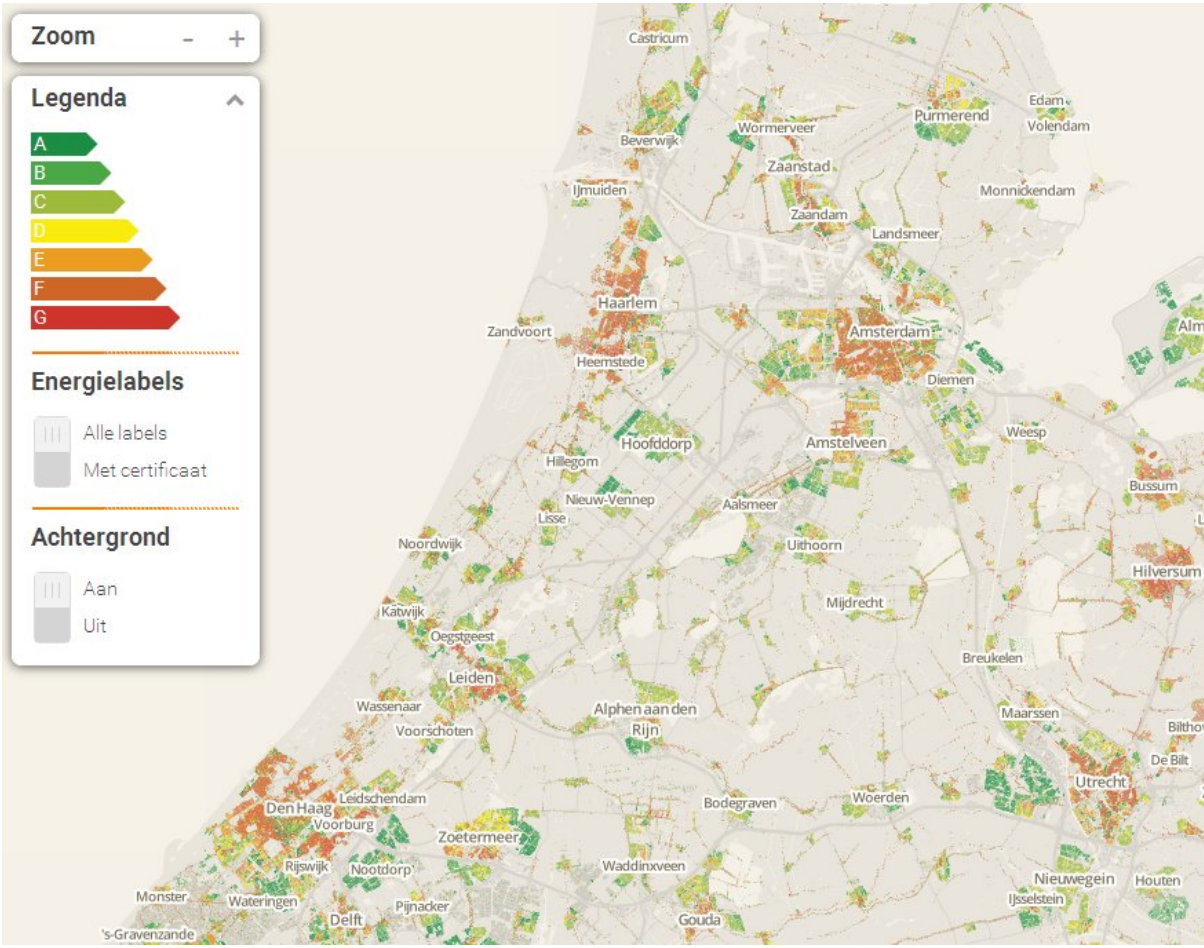
- Energy resources (natural, variable)
- Economic evaluation (market, energy price)
- Physical (construction element to cluster of buildings)
- Member State policy (incentives, regulation)
- Natural borders
- Industry (innovation, standards)
- Time aspects (hourly to building life time)
- Balancing Demand and Supply

INSPIRE and Energy & Buildings

Cadaster

Administrative information on building stock

- Age, type, location, construction, usage
- Energy, systems,
- Family Composition



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

METERING DATA

Separate from readings the part related to

Energy for building performance

(as defined by EPB: heating, cooling, ventilation, hot water and light)

Occupancy energy consumption

(appliances, gains, behaviour, non EPB)

Towards intelligent environments

Toon, Cuby, etc. devices with ICT

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, …)*

EBC

IEA EBC Annex 58

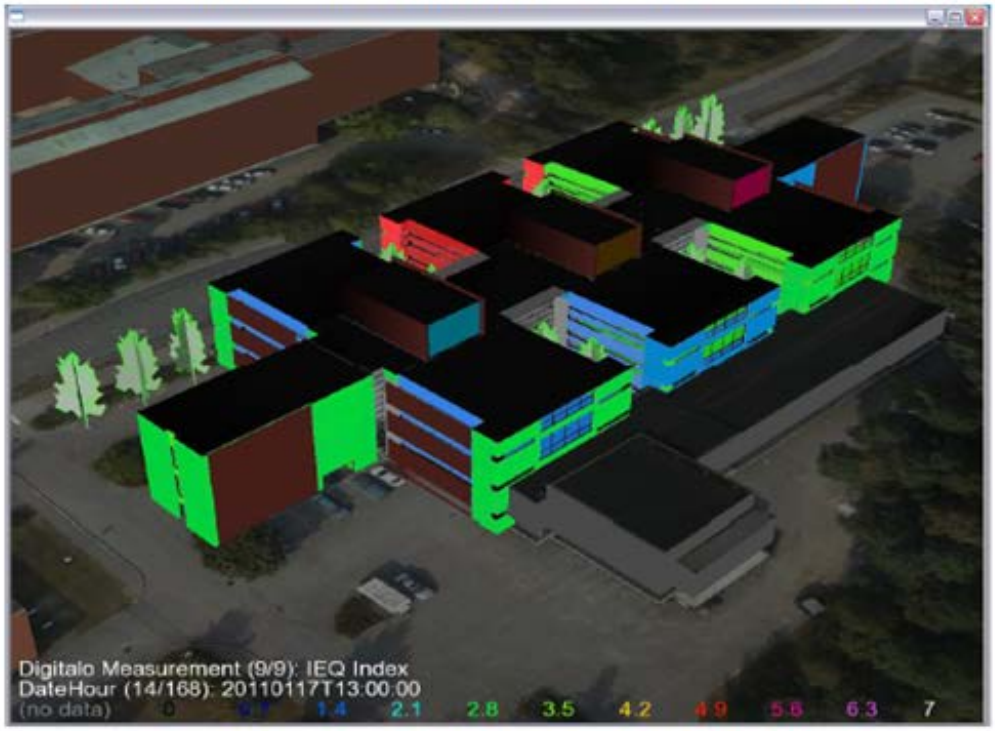
Reliable building energy performance characterisation based on full scale dynamic measurements

Joint Research Centre

DESIGN and REAL PERFORMANCE

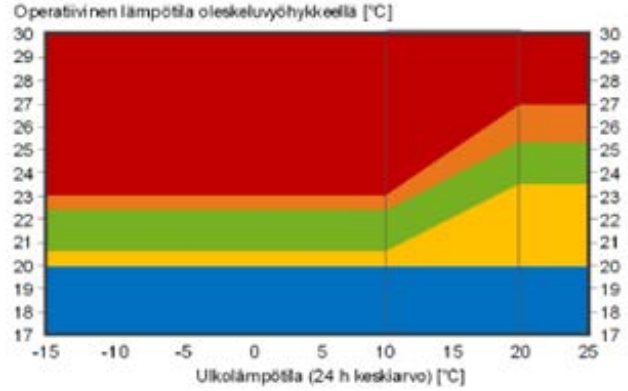
- Simulation software coupled to real data

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

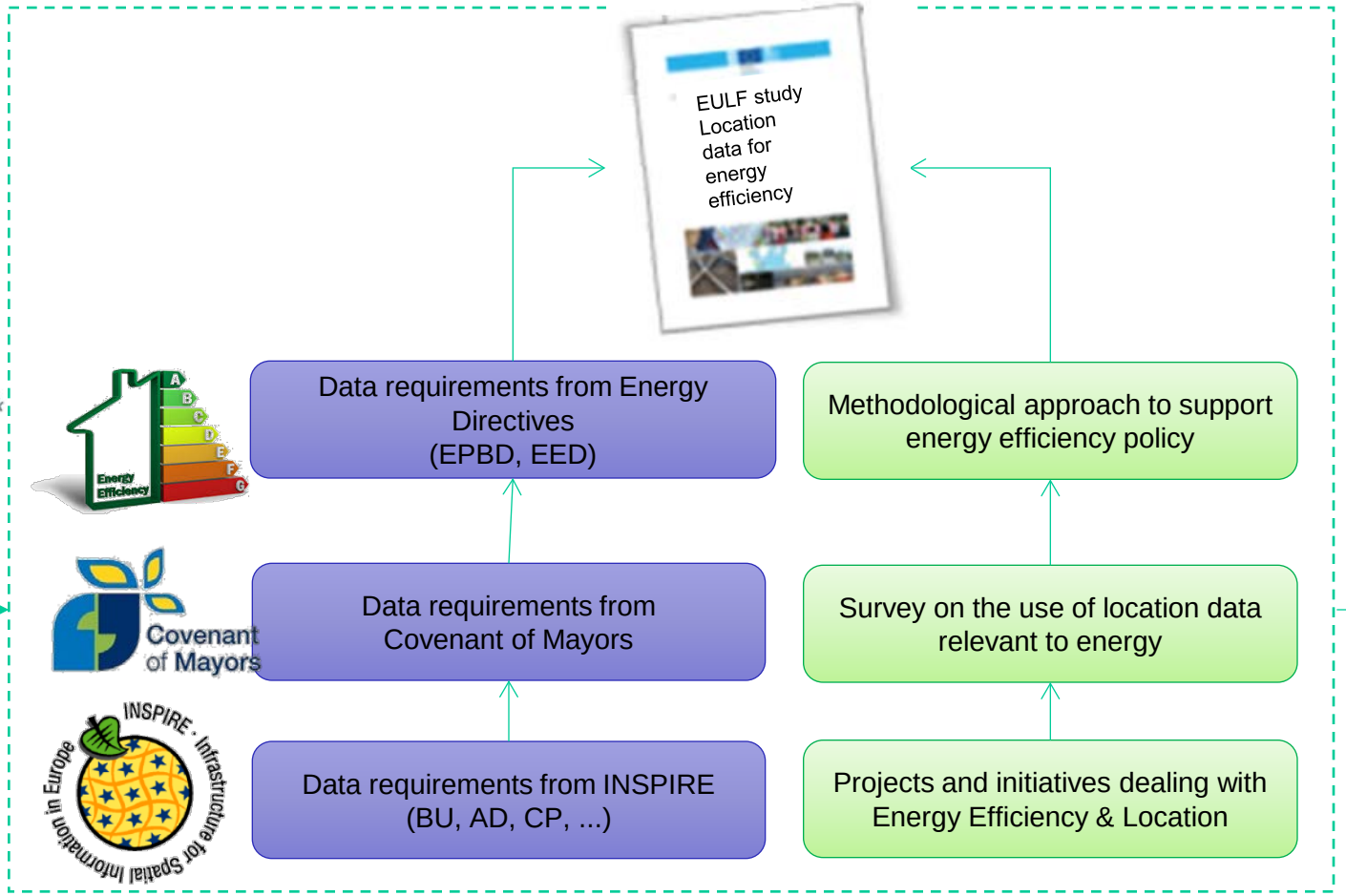


IEQ index (temperature/CO_2/etc.)

Target values of temperature (FiSIAQ Cat S2)



Energy feasibility study report



EULF Blueprint

EULF Blueprint

Analysis of data requirements from INSPIRE and Energy Directives

Analysis of usage of geodata about energy

Security of Energy Supply – Super Grids

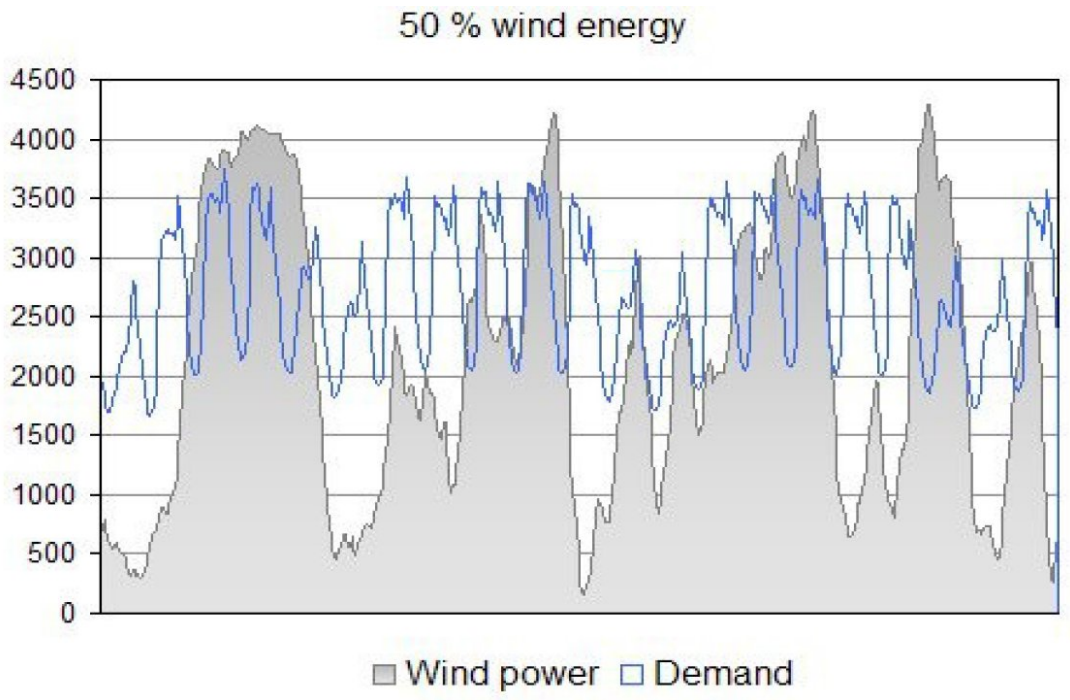
- JRC contribution:
- Communication on smart grids (202/2011)
- Standards (Mandate 490)
- European Industrial Initiative on Electricity Grids (SETIS)
- Smart Grids Task Force (DG ENER)
- Industry:
  - MEDGRID
  - Eurelectric
  - ENTSOE

RENEWABLE ENERGY INTEGRATION

- In Denmark wind power counts for about 50% of the total power.
- Balancing problem

- IMM has tools for:
  - Wind power forecasting
  - Solar power forecasting
  - Optimal planning
  - www.enfor.dk

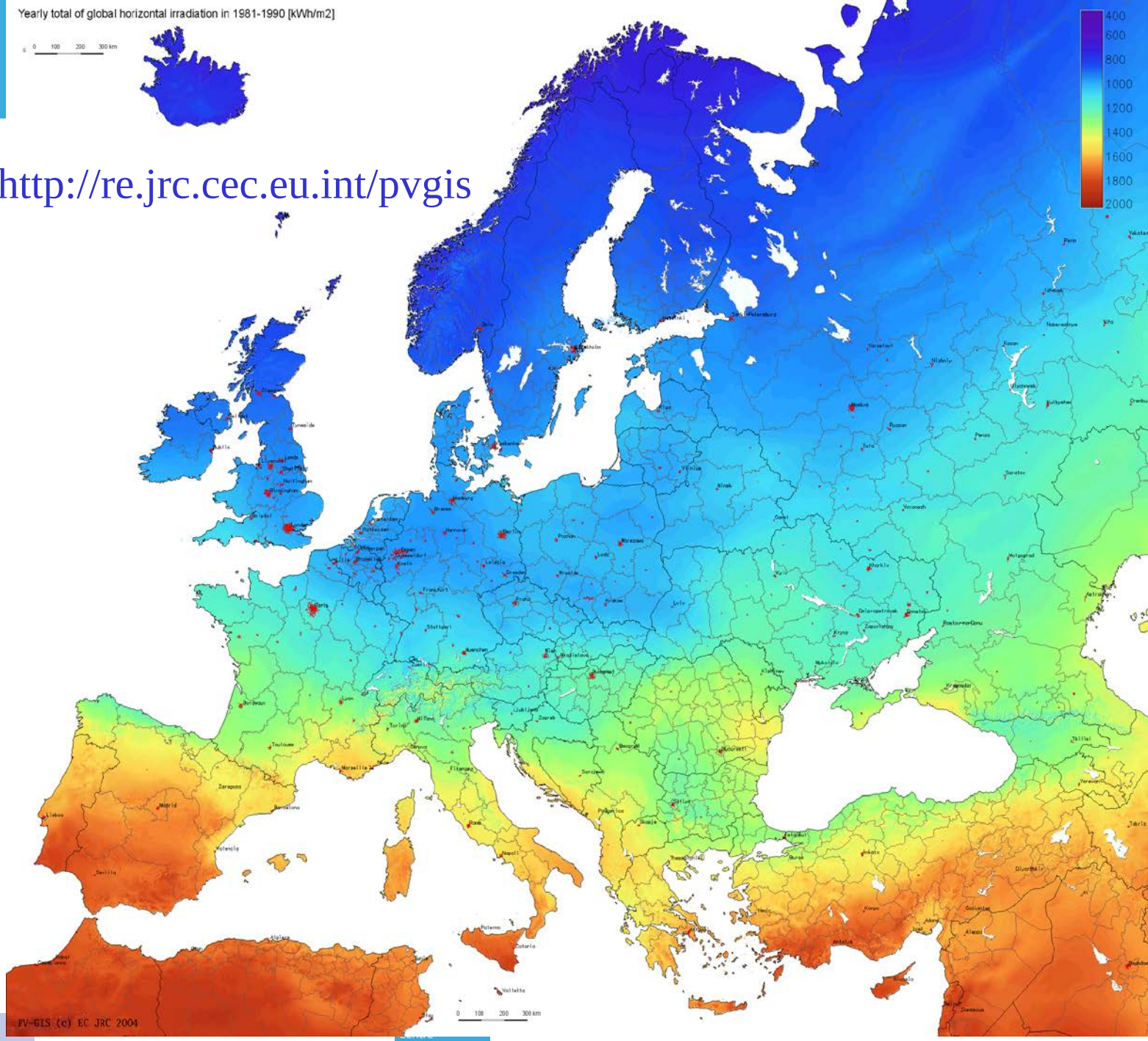
- Total power and wind power 2013 :

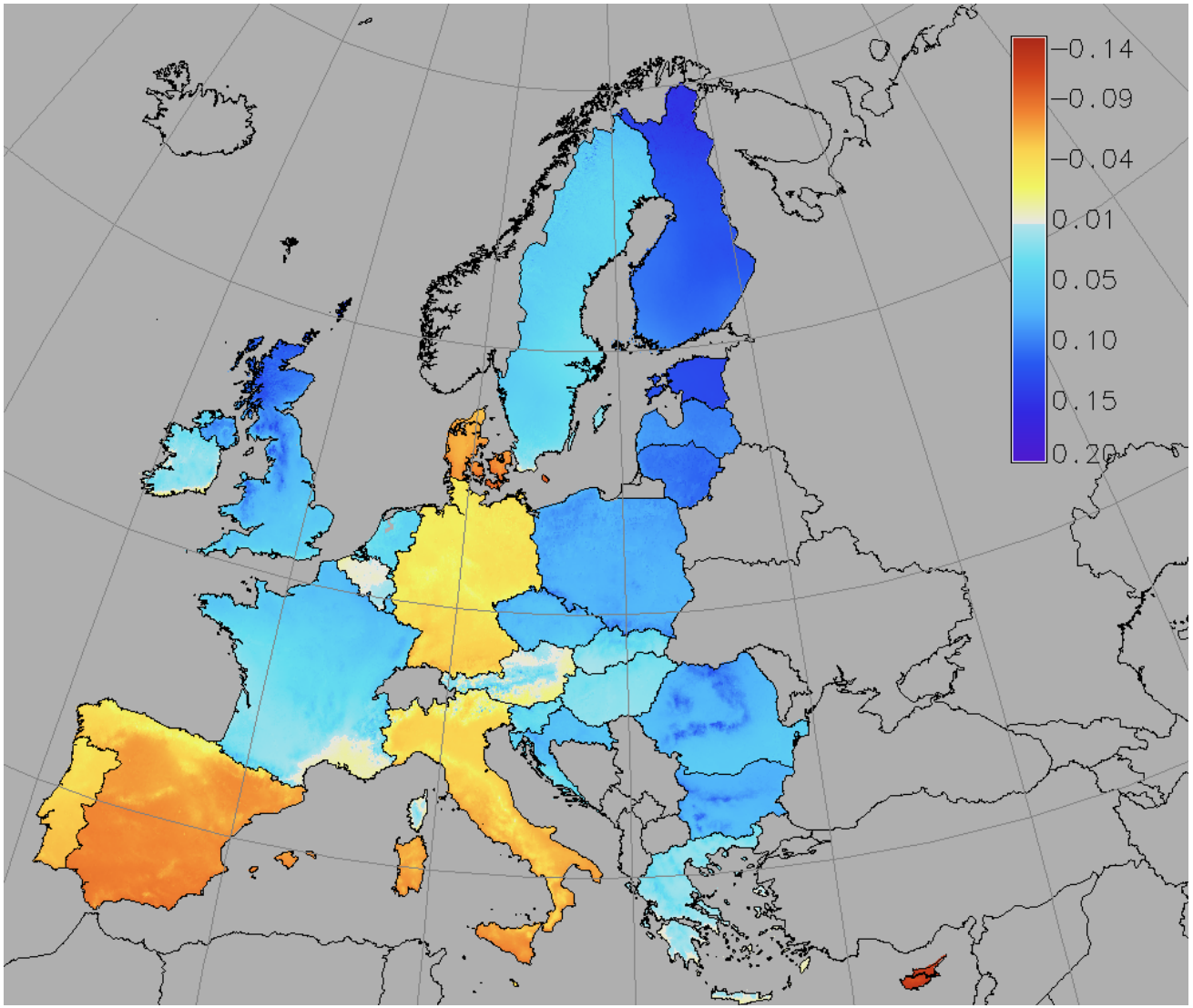


Web-site http://re.jrc.cec.eu.int/pvgis

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

A Future for Energy and Buildings

Balancing at which level? Building or community or city?

- Nearly-Zero Energy Building
  - Assessment boundaries for time and space
  - Thermal and electrical energy annual balance
  - **Balance** of Demand, Supply and Storage
- Energy
  - Energy performance and consumption, GHG emissions (reduce)
- Building
  - From CPR (products) to EPBD (performance) to overall design
  - Traditionally consumes energy for Heating, Cooling, Ventilation, Water and Light
  - Now are requested to produce energy ?

- **ICT** becomes an essential part of energy management
- **Urban area** (beyond the EPBD and other energy Directives)

THANK YOU

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