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Joint Research Centre

Methodologies for energy performance assessment of buildings based on location data – Use Cases

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The EU policy context

The EU is giving more and more emphasis to its energy policy, whose strategy and actions are included in the **Energy Union Package** and the 2030 Framework for Climate and Energy.

Buildings in which people live and work are responsible for an important portion of the **energy consumption** in Europe (40%).

Several policies and initiatives aim at improving the energy performance of buildings and to collect data of sufficient quality on the effect of energy efficiency policies on building stock across Europe.





Focus on Buildings

According to studies conducted by BPIE (Buildings Performance Institute Europe):

Buildings are responsible for the 40% of final energy consumption

- Over 75% of building stock is older than 25 years
- Averaged final energy consumption data: 185 kWh/m² for residential buildings and 280 kWh/m² for non-residential buildings
- Deep renovation of buildings could cut 36% of their energy consumption by 2030





ENERGY and CITIES

Objectives of the 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.





Scale-up methodologies

Aim: use location data to support stakeholders engaged in energy policies' lifecycle



To leverage location-based data at building level as enabling factor to scale-up the methodologies to assess energy consumption and performance from local to urban to district to regional to MS level as required by the European Directives in the field of energy efficiency





Feasibility Study

JRC concluded a Feasibility Study "Location Data for Buildings related Energy Efficiency Policies" in 2015

- Identified an approach to compare different methodologies to support EPBD, EED and CoM policy instruments, based on the re-use of INSPIRE components
- Made an initial analysis of the data flows relevant to EPBD, EED and CoM, has identified the relevant INSPIRE data themes best fitting for purpose and has made an initial mapping exercise
- Outlined scope and content of a full pilot project, started in 2016



JRC TECHNICAL REPORT



Location data for buildings related energy efficiency policies

European Union Location Framework (EULF) Project Feasibility Study

Hans Bloem, Ray Boguzlawski, Maria Teresa Borzacchiello, Piergiorgio Cipriano, Albana Kona, Giacomo Martirano, Isabella Maschio, Francesco Pignatelli 2015

Report EUR 27411 EN











Introduction: The Energy pilot Project

The **Energy Pilot project** involves a series of cities and regions to demonstrate how *an integrated data approach can be established* for planning, implementing, monitoring and reporting for policies and initiatives. The pilot will be implemented and tested through a series of use cases:

Use Case 1 - INSPIRE harmonisation of existing energy performance certificate (EPC) datasets and creation of a web application for accessing them

Use Case 2 - Benchmark of different Energy Performance Labelling of buildings

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

Use Case 4 - Supporting Energy Efficiency driven renovation planning of the building stock at local level

Use Case 5 - Supporting integrated energy planning and monitoring at urban/local level (SEAP BEI/MEI)

Use Case 6 - Supporting the design and implementation of a regional energy strategy



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.)





Costs & Benefits





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)



Top-Down and Bottom-Up levels

Energy Performance Assessment Classification of approaches

Holisticlinks to INSPIREApproach 1 : Simplified method based on administrative dataApproach 2 : Climate and consumer information included

Measurementlinks to IEA EBC Annex 71Approach 3 : Energy consumption and performance dataApproach 4 : Building performance assessment based on
measured data

Calculationlinks to the EPBDApproach 5 : Not standardised or reduced calculation methodApproach 6 : Detailed calculation according to EPBD standards





Survey on Buildings datasets discoverable in the INSPIRE geoportal



JRC TECHNICAL REPORTS

Buildings related datasets accessible through the INSPIRE geoportal

European Union Location Framework (EULF) Project Energy Pilot

Giacomo Martirano, Maria Teresa Borzacchiello, Ray Boguslawski, Francesco Pignatelli (JRC H06 Unit), Paolo Zangheri, Daniele Paci, Isabella Maschio, Paolo Bertoldi (JRC F07 Unit)

2016





How INSPIRE can support the energy efficiency policies lifecycle: results of an analysis made on accessibility of buildings related datasets discoverable in the INSPIRE geoportal

THE CONTEXT

The EU is giving more and more emphasis to its energy policy, whose strategy and actions are included in the Energy Union Package and the 2030 Framework for Climate and Energy, Buildings in which people live and work are responsible for an important portion of the energy consumption in Europe and there are a series of policies and initiatives that are aiming at improving their energy performances and to collect data of sufficient quality on the effect of energy efficiency policies on building stock across Europe. On the other hand, Buildings is one of the data themes addressed by INSPIRE This study aims to assess the extent to which the buildings related datasets which European Member States are sharing following INSPIRE provisions are of good quality and can serve the purposes of the initiatives related to energy efficiency of buildings



THE FINAL RECOMMENDATIONS

Some recommendations can be addressed to INSPIRE implementers working in energy thematic communities, in order to better address their efforts in fulfilling on-going and future INSPIRE obligations:

- to properly extend existing INSPIRE BU data models in order to take into account the data modelling requirements coming from Energy policies, considering both existing similar activities (e.g. citygml Energy ADE initiative and GeoSmartCity EU project) and the rules for INSPIRE Data Specifications extension
- · to use these extended data model as target data model in as many as possible data harmonization processes related to energy efficiency of buildings, in order to improve data interoperability at EU level;
- to use the voidable properties of the INSPIRE data models only when the relevant information is actually not available; · to carefully compile relevant metadata elements, such as lineage and resource locator, in order to document and share relevant data processing activities and therefore facilitate their reuse.

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Survey on Buildings datasets discoverable in the INSPIRE geoportal

E GEOPORTAL







Survey on Buildings datasets discoverable in the INSPIRE geoportal



ES GML dataset classified by means of building height attribute





Survey on Buildings datasets discoverable in the INSPIRE geoportal

Main conclusions

- Usefulness of the INSPIRE geoportal to discover building-related datasets which fit for the Energy Pilot and the DG Energy's EU Building Stock Observatory purposes.
- Reusability of the methodology applied.
- Formulation of some recommendations that can be addressed to INSPIRE implementers working in energy thematic communities, in order to better address their efforts in fulfilling on-going and future INSPIRE obligations.





Energy Efficiency and Location

The overall objective of this task was to provide an in-depth study of projects and initiatives useful to support the Energy Pilot project activities.

The main focus has been on the analysis of relevant initiatives dealing with energy efficiency and the use of location data, starting from the list of examples mentioned in the JRC report on "Location data for buildings related energy efficiency policies"



https://ec.europa.eu/jrc/en/publication/location-data-buildings-related-energyefficiency-policies



Methodology

The selection of relevant initiatives was focused on H2020 projects from the full detailed dataset available on the EU open data portal.

The EU open data portal represents an actual and neutral view about new initiatives, without any bias derived from subjective knowledge.

The selection has been performed considering all **7574 projects** funded in H2020 with starting dates ranging from January 2014 until September 2017.



https://data.europa.eu/euodp/en/data/dataset/cordisH2020projects



Findings

From the full list of 7574 project, **91 have been identified** and have been mapped against one or more **Use Cases** defined for the EULF Energy Pilot

Use Case	Description	No. of relevant H2020 projects identified	
UC1	INSPIRE Harmonization of existing Energy Performance Certificate datasets	5	
UC2	Implementing different buildings' Energy Performance Labelling schemes	34	
UC3	Energy Performance of Buildings with dynamic measured data	28	
UC4	Supporting building's energy efficiency driven refurbishment planning at local level	18	
UC5	Supporting integrated energy planning and monitoring at urban/local level (SEAP BEI/MEI)	17	
UC6	Supporting the design and implementation of a regional energy strategy	33	



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Findings

... number of H2020 funded projects fitting the EULF Energy Pilot Approaches

Approach	Description	No. of relevant H2020 projects identified
1	Simplified method based on administrative data	11
2	1 + Climate and consumer information included	38
3	2 + Energy consumption and performance data	28
4	Building performance assessment based on measured data	15
5	Detailed calculation according to standardized calculations	0
6	Simplified calculation method	1
n.a.	(Not applicable)	15





Links with JRC Energy pilot

From the list of 91 projects, **34** of them are directly (or indirectly) related to the **Use Case 2**, which aims to benchmark different schemes (algorithms) already defined to estimate the **Energy Performance Label**, at building scale, and (possibly) to implement a reference proof of concept using standard interface.

For this reason, a further deeper analysis (**step2**) was done and 18 projects have been identified (out of the 34 related to UC2).

A further step (**step3**) was to identify projects with a direct connection with the Use Case 2, analyzing the resources available on the web site as well.





Conclusions & Recommendations

Consider the recommendations on "data modelling", suggested during the second international workshop organized by JRC in 2016 on "Methodologies for energy performance assessment based on location data" (Ispra, September 2016).

It is important to take into deeper consideration the concepts and the semantics already defined in the **CityGML Energy ADE**, during the extensions of the INSPIRE data models foreseen in the Energy Pilot, in order to better facilitate the interoperability between different data models.

H2020 projects like TRIBE or SWIMming



Data: different levels of detail for the description of the buildings





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

Aim

The aim of Use Case 3 is to develop a methodology to assess the energy performance of buildings identifying climate dependent energy and end-user energy.

➤ The results obtained from the application of the methodology will support decision-making process for refurbishment, renovation and management of building energy flows.

The final aim of the Use case will be the scaling up of the energy use in buildings to district level and beyond, by proper implementation of geolocation data.



DESIGN versus REALITY





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

Objectives

To analyse/compare existing methods to assess the energy performance of buildings with dynamic measured data from metering and in-situ measurements

➢ To define requirements for input data, including interval of observations

➢ To validate the selected methods with measured data from field experimental work or from metering readings (e.g. electricity, heat, gas and water) and link the different data sources to an uncertainty assessment

To up-scale with a proper implementation on the INSPIRE Directive

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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





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