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Final Report Phase 1

European Union Location Framework
Energy Pilot

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Abstract

The European Union is giving more and more emphasis to its energy policies, reinforcing a political commitment to very high energy savings, with the aim to achieve a more competitive, secure and sustainable European energy system. Increased energy efficiency is vital to achieve the challenging goals set for the future and energy efficiency constitutes one of the five dimensions of the European Commission's Energy Union Package**,** designed to enhance energy security, sustainability and competitiveness.

Within this policy context, this report focused on the 2010/31/EU Directive on the Energy Performance of Buildings and the 2012/27/EU Directive on Energy Efficiency, describing an initial set of pilot activities undertaken to enable and test the use of geospatial technologies in Digital Government processes and services related to energy efficiency EU policies, aiming to show, through a set of use cases, that accurate and interoperable location-based information can lower the barriers faced by government, companies and citizens involved in the energy efficiency policies' lifecycle.

The approach adopted is based on the INSPIRE Directive 2007/2/EC, establishing an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment, such as energy policies. The enabling role played by INSPIRE consists in the provision of common data models and common data access rules adopted by all EU MS and a roadmap to provide interoperable datasets of high relevance with energy efficiency.

The report has identified a series of next steps to be undertaken to achieve the expected benefits deriving from the use of interoperable location-based information within the analysed energy policy instruments and to solve the issues encountered.

1 Introduction

This technical report describes the initial activities undertaken and the results achieved in the frame of the Energy Pilot project[1] of the European Union Location Framework (EULF) action.

The EULF[2] is led by the European Commission Joint Research Centre and is part of the Interoperability Solutions for Public Administrations (ISA) Programme[3], run by DG Informatics (DIGIT). The EULF is a framework of recommendations, guidance and actions to improve the way location information is used in all public services across Europe, targeting benefits for businesses, citizens and government in key policy areas, such as Transport and Energy, through a series of pilot projects to apply, evaluate and contribute to the EULF. The EULF builds on the spatial data infrastructure for Europe being implemented by INSPIRE [1].

Regarding the EULF Energy Pilot, a feasibility study on "Location Data for buildings Related Energy Efficiency Policies" [2] was concluded in 2015. The main goal of the study was to describe how geo-location can increase the quality and the reliability of the data available to local and national energy policy-makers and help the alignment between the data requirements addressed by different energy related policies. The study made an initial analysis of the data flows relevant to the Energy Performance of Buildings Directive (EPBD) [3], the Energy Efficiency Directive (EED) [4] and the Covenant of Mayors initiative (CoM)[4], identified relevant INSPIRE data themes, and carried out an initial mapping exercise. Because of the variations in available data and the need to link data at different administrative levels, the study highlighted the need to properly combine data of different nature (e.g. calculated vs. measured, static vs. dynamic), and of different geographical scales (e.g. urban vs. regional vs. national).

A pilot mobilisation phase started in late 2015, with an initial kick-off workshop held at JRC/Ispra from 24-26 November 2015 [5] with participants from BE, DE, DK, ES, EL, IT, SE, TR and UK. The pilot will involve a series of cities and regions to demonstrate how an integrated data approach can be established for planning, implementation, monitoring and reporting for the multiple policies and initiatives, considering energy performance of buildings, energy consumption of buildings and energy production at local level. This will be done through:

- adoption of common structured data models (extending some INSPIRE core data models);
- use of common data access mechanisms (INSPIRE Network Services);
- re-use of (parts of) datasets for different planning, implementation, monitoring and reporting purposes;
- data access agreements to use the relevant data;
- development and application of relevant methodologies and models to fill data gaps;
- use of both centralised and distributed ICT infrastructures which make accessible the data needed to fulfil planning, implementation, monitoring and reporting requirements.

The pilot is being implemented and tested through a series of use cases, involving different stakeholders (public authorities at local and regional level), businesses working in the energy sector and citizens (building owners).

This technical report describes the initial activities undertaken and the results achieved in the first phase of the pilot (2016) and it is structured into five main sections:

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[1] https://joinup.ec.europa.eu/community/eulf/og_page/eulf-energy-pilot
[2] Information about the EULF, including links to publications and key events, can be found at http://ec.europa.eu/isa/actions/02-interoperability-architecture/2-13action_en.htm
[3] Information about ISA is available at http://ec.europa.eu/isa/
[4] http://www.covenantofmayors.eu/index_en.html

- Section 1 - "Introduction", which provides the policy context for the activities carried-out and reported in this document, a definition of the problem addressed, considerations regarding the partners being involved and the specific objectives to be targeted.
- Section 2 – "Methodology", which contains eight subsections, each of them describing the methodological steps followed to shape the Energy Pilot.
- Section 3 – "Expected benefits", which outlines the benefits expected from the Energy Pilot.
- Section 4 – "Issues identified", which describes the issues encountered during the execution of the activities during the first year, as well as the issues envisaged in future activities.
- Section 5 – "Conclusions and next steps", which synthetize the achievements reached and the lessons learned so far and outlines the pilot activities to be done in the future.

1.1 The policy context

The EU is giving more and more emphasis to its energy policies. Both the Energy Roadmap 2050[5] adopted by the European Commission in 2010 and the 2030 policy framework for climate and energy[6] proposed by the European Commission in 2014 reinforce a political commitment to very high energy savings, with the aim to achieve a more competitive, secure and sustainable European energy system. Increased energy efficiency is vital to achieve the challenging goals set for the future, and particularly the target of at least 27% reduction in the final energy consumption in 2030, compared to expected energy consumption for 2030. In addition, energy efficiency constitutes one of the five dimensions of the European Commission's Energy Union Package[7], designed to enhance energy security, sustainability and competitiveness.

Despite European energy policy is reflected in several directives, the pilot focused on two of them, regarding the efficient use of energy in the building sector (2010/31/EU Directive on Energy Performance of Buildings) and in the national level (2012/27/EU Directive on Energy Efficiency Directive).

Buildings are responsible for approximately 40% of the primary energy consumption in Europe and there is a vital need to improve energy efficiency through policies and innovative solutions. Data requirements set by the Energy Performance of Buildings Directive (EPBD) explicitly call for data accuracy at building level and, where necessary, in terms of building units. In particular, according to the EPBD,

- owners and tenants of commercial buildings should be encouraged to exchange information regarding actual energy consumption, in order to ensure that all the data are available to make informed decisions about necessary improvements,
- Member States shall report all input data and assumptions used for the cost-oprimal calculations and the results of those calculations,
- the prospective buyer and tenant of a building or building unit should, in the energy performance certificate, be given correct information about the energy performance of the building and practical advice on improving such performance,
- Member States shall take the necessary measures to inform the owners or tenants of buildings or building units of the different methods and practices that serve to enhance energy performance. Member States shall in particular provide information to the owners or tenants of buildings on energy performance certificates and inspection reports, their purpose and objectives, on cost-effective ways to improve

[5] http://ec.europa.eu/clima/policies/roadmap/index_en.htm
[6] http://ec.europa.eu/clima/policies/2030/index_en.htm
[7] http://ec.europa.eu/priorities/energy-union/index_en.htm

the energy performance of the building and, where appropriate, on financial instruments available to improve the energy performance of the building.

In addition, EPBD defines as nearly zero-energy building a building that "*has a very high energy performance and the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. Member States shall ensure that by 31 December 2020 all new buildings are nearly zero-energy buildings and after 31 December 2018 new buildings occupied and owned by public authorities are nearly zero-energy buildings*.

The Energy Efficiency Directive (EED), as stated in its Article 1, "*establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date.*" Buildings represent one of the EED sectors of intervention to increase efficiency in energy use, with public buildings playing an exemplary role. Particularly relevant for the pilot is the explicitly EED requirement asking Member States to ensure that obligated parties (energy distributors and/or retail energy sales companies) provide on request:

- aggregated statistical information on their final customers;
- current information on final customers' consumption, including, where applicable, load profiles, costumer segmentation and geographical location of customers, while preserving the integrity and confidentiality of private and commercially sensitive information in compliance with applicable Union laws.

A further important initiative considered in the pilot is the Covenant of Mayors, a mainstream European movement involving local and regional authorities, voluntarily committing to increase energy efficiency and use of renewable energy sources in their territories. The Covenant signatories aim to meet or exceed the European Union 20% CO2 reduction objective by 2020. Over 7200 local authorities to date have signed the Covenant, representing more than 225 million inhabitants, at the end of January 2017. Municipalities have to submit a Sustainable Energy Action Plan (SEAP) identifying the measures planned in order to reach the target.

Table 1 lists and compares key features of EPBD, EED and CoM relevant to the scope of the pilot and having direct or indirect relation with location information.

Table 1: *Key features of main energy efficiency policies relevant to the pilot*

	EPBD	EED	CoM
Data reporting level	Building / Building Unit	National	Urban
Scope	Energy efficiency (Buildings, Building Units)	Energy efficiency (Buildings, Transport, Energy transformation, transmission and distribution, Products and services purchased by public bodies)	Energy efficiency (Buildings, Transport, Waste, Water, Public lighting)
Coverage	National	National	Cities and urban areas
Countries	EU	EU	EU + other countries

	EPBD	EED	CoM
Source of data	Public authorities (e.g. cadaster) Building owners Building designers, constructors Energy auditors	Energy distribution companies Energy retailers	Local and regional governments Energy Service Companies Statistical offices
Method of data collection	Empirical (top down) Measured or calculated (bottom up)	Measured, anonymised and aggregated	Measured or calculated
What is being measured	Energy performance	Energy efficiency, as "ratio of input to output energy"	Energy consumption converted to emissions
Requirement	Mandated	Mandated	Voluntary
Key dates / targets	New building stock to be near zero energy in 2020	Energy distributors/sales companies have to achieve 1.5% energy savings annually 3% of public buildings must be renovated annually	Beyond 2020 targets (at least 20% C02 reduction by 2020)
Planning instrument		National Energy Efficiency Action Plans (NEAP)	Sustainable Energy Action Plans (SEAP)

1.2 Problem statement

Accessing high quality, interoperable and reusable location information, the different actors involved in the different energy policies steps, ranging from policy anticipation, to development, implementation, monitoring, reporting, assessment and review, will increase efficiency and effectiveness of many business processes in which they are involved. Section 2.1 provides a non-exhaustive list of business processes contained in the energy policies analysed and requiring the availability of location information.

In general, many analyses, plans and reports required by the analysed energy directives and initiatives are based on data of insufficient quality and not easily re-usable, for the following reasons:

- regarding the insufficient quality, there is a lack of data available at building unit level, which represents the most detailed geographical scale for the purposes of the pilot. This lack has a twofold impact:
    - it lowers the effectiveness of the energy policies at local level (e.g. interventions to improve energy efficiency of the building stock at district level which are not supported by a detailed and accurate status at building level);
    - it makes difficult to scale-up at district, city or regional level (which is the reporting level most often required by the energy policies and initiatives) the few and scattered information available at building or building unit level. Therefore, spatial data required at district, city or regional scale are often derived from data available at coarser geographical scale, e.g.

national, using statistical algorithms and weighting factors, e.g. population distribution, leading to insufficient reliability of the elaborated data.

- Regarding low re-usability, very often the spatial data available in the analyses, plans and reports are non-structured, are in different formats (e.g. pdf documents), not accessible (e.g. through web services) and sometimes with restrictions and limitation on use. The consequent poor level of interoperability is another factor weakening the effectiveness of the energy policies, e.g. preventing easy deeper analyses, comparisons and benchmarking.

The Evaluation of the EPBD, within the framework of the revision of the Directive as part of the "Clean Energy for All Europeans Package" highlighted that due to the diversity and disaggregation of the buildings sector, it remains challenging to acquire good data on building characteristics, energy use, and financial implications of renovation in terms of cost savings or asset values. This lack of data has negative consequences on the market perception of the cost-effective energy saving potential of the EU building stock, on enforcement tracking, on monitoring and evaluation.

Indeed, there is a lack of quality data on the actual effect of energy efficiency policies on the building stock across EU Member States and regions. A better understanding of the effectiveness of policy measures and of market support mechanisms is necessary to steer an improvement in the depth and rate of buildings' renovation.

For this reason, the Commission used external expertise to assist the setting up of the EU Building Stock Observatory to monitor the energy performance in buildings. This resulted in the development of a list of relevant indicators, a methodology for data collection and a website which is integrated in DG Energy's website which contains a database, a datamapper and factsheets. Data provided in the Observatory will contribute to the improvement of the way the building sector is being considered in economic modelling of energy efficiency policy options. During the first phase of the EU Building Stock Observatory operation, it was identified data gaps and limitations to the data collection, aggregation and comparison across EU Member States.

1.3 Partners

The description of a partnering approach identified to establish relationships with the partners to be involved in the pilot use cases, together with an initial list of candidate partners is provided in section 2.6.

1.4 Objectives

The main pilot objective is to use location data to support stakeholders engaged in energy policies' lifecycle, aiming to show the benefits of an integrated approach for the different lifecycle steps, such as reporting, monitoring and planning.

Multiple aspects of energy (e.g. energy performance of buildings, energy efficiency, energy saving and energy consumption from building up to district, city, regional, national and EU level, renewable/non renewable energy production at local level) will be handled by means of:

- the adoption of common structured data models (extending few INSPIRE core data models) and of common data access mechanisms (INSPIRE Network Services);
- the re-use of (parts of) datasets for different reporting, monitoring or planning purposes;
- the use of both centralized and distributed ICT infrastructures which make accessible data needed to fulfil reporting, monitoring and planning requirements.

One pilot specific objective is to leverage location data at building level to scale-up, by means of appropriate methodologies, the assessment of energy needs from buildings to district to urban to regional up to MS level, as schematically shown in ***Figure 1***.

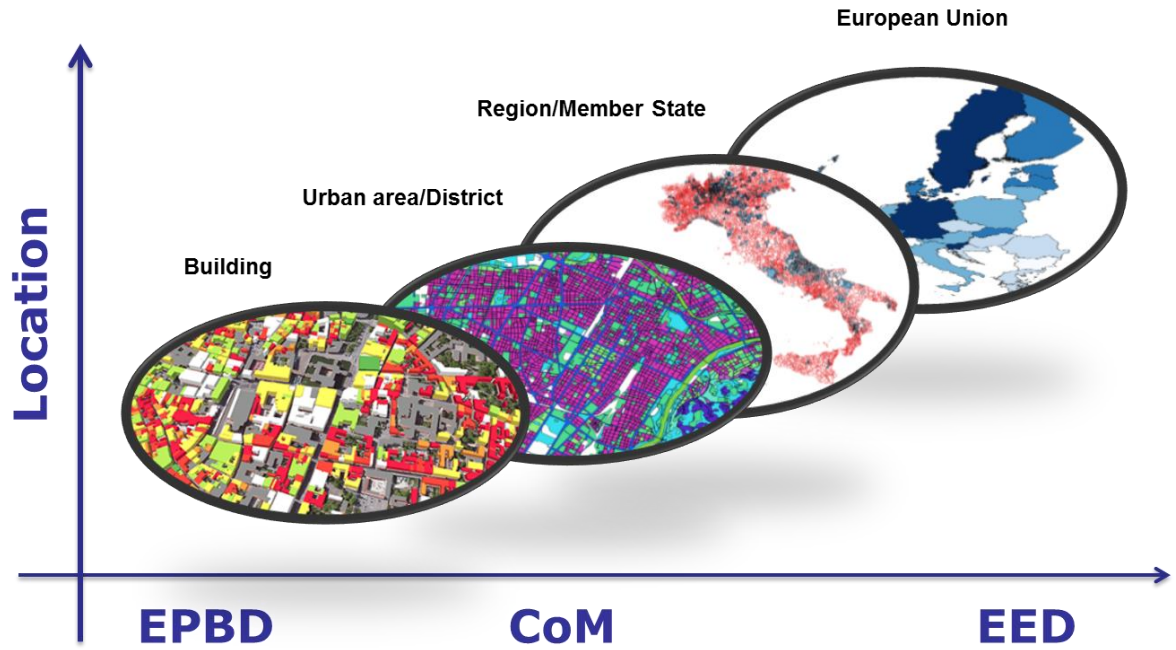

Figure 1 *– Location-enabled scale-up of energy efficiency methodologies*

The pilot is being implemented and tested through a series of use cases, which aim at covering as much comprehensively as possible the wide spectrum of the energy policies related business processes that can be enabled and supported by location information. A common paradigm, based on the assessment of data, methodologies and tools needed to produce the expected results, will be applied to all use cases, as depicted in ***Figure 2*** and described in section 2.4.

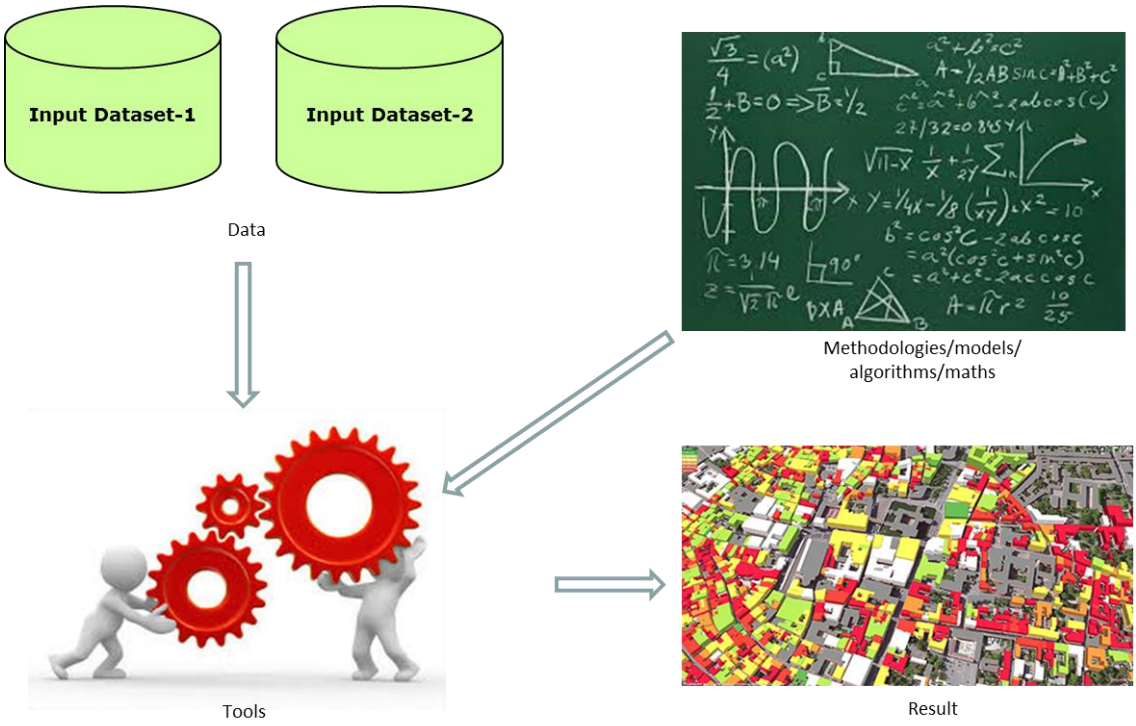

Figure 2 *– Data-methodologies-tool paradigm*

1.5 Target audience

The target audience for this document is represented by the different actors involved in the different steps of the energy policies lifecycle, ranging from policy anticipation, to development, implementation, monitoring, reporting, assessment and review. They should be primarily interested to see how the pilot can contribute to increase the effectiveness and efficiency of the location-related business processes contained in the energy policies instruments and in which they are involved.

Because the pilot is being implemented and tested by means of a series of use cases addressing specific topics and issues, the documents produced for each use case will target more specific users groups. A provisional list of primary users identified for each use case is provide in Section 2.4.7.

Moreover, the document can provide guidance to thematic communities aiming at developing pilots applying the INSPIRE principles in domains not strictly addressed by the current INSPIRE data themes.

2 Methodology

Figure 3 schematises the activities carried out in the frame of the Energy Pilot in 2016. A public deliverable exists for the activities bounded by a red thick box. More details are provided in the following sections.

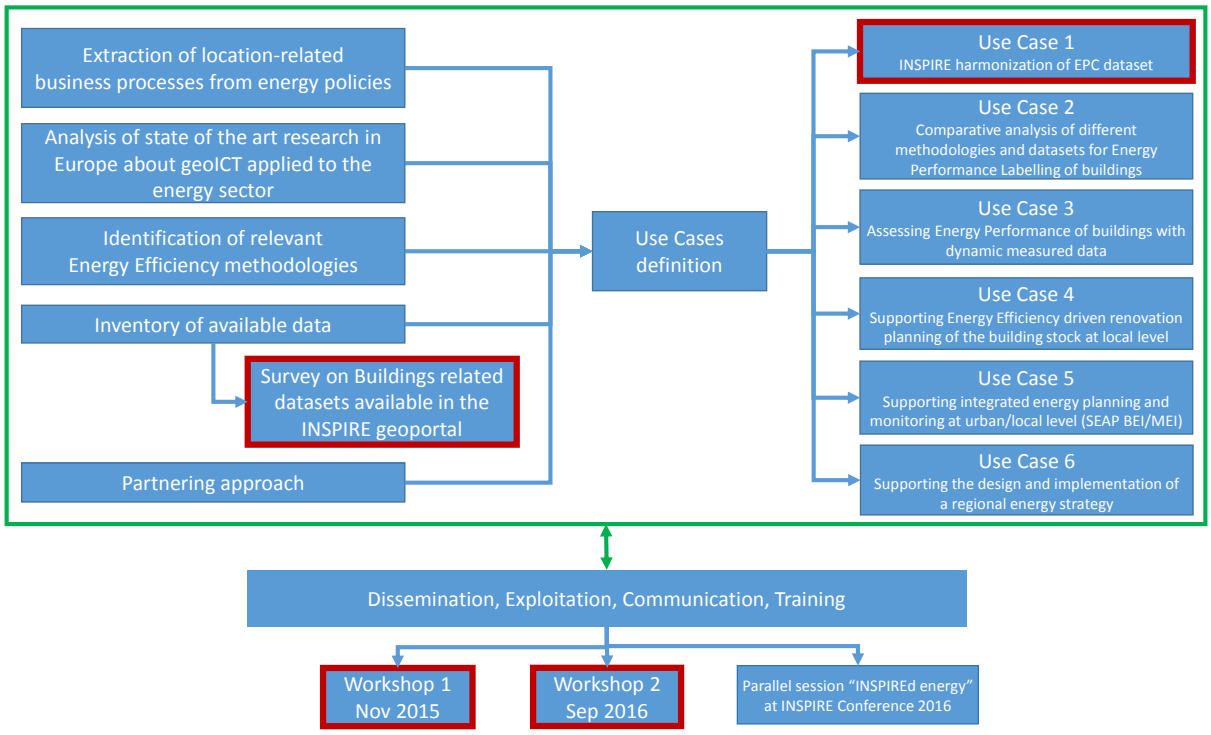

Figure 3 *– Energy Pilot activities carried out in 2016*

2.1 Location-related business processes contained in energy policies

An initial exercise has been made, consisting in analysing the three main energy policy instruments considered so far in the pilot, namely EPBD, EED and CoM, and extracting from them text referring to location-related business processes, potentially relevant for the pilot purposes.

Two kind of sources of information have been considered: informal text available in documents and/or websites and the original legal text contained in the Directives.

Sixteen references have been identified and summarised in ***Table 2***.

Even though the analysis cannot be considered exhaustive, it shows that the energy policies/instruments analysed contain several business processes based on location information.

***Table 2** – Location-related business processes contained in energy policies*

BP-ID	Informal text referring to location-related BPs	Reference policy document	URL of the informal text	Excerpt from policy document text referring to location-related BPs	Part of the reference policy document
BP_01	Energy performance certificates are to be included in all advertisements for the sale or rental of buildings	EPBD	From http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings	Member States shall ensure that an energy performance certificate is issued for: (a) buildings or building units which are constructed, sold or rented out to a new tenant; and (b) buildings where a total useful floor area over 500 m^2 is occupied by a public authority and frequently visited by the public. On 9 July 2015, this threshold of 500 m^2 shall be lowered to 250 m^2 .	Art. 12, par. 1
BP_02	EU countries must establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect	EPBD	From http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings	Member States shall lay down the necessary measures to establish a regular inspection of the accessible parts of systems used for heating buildings, such as the heat generator, control system and circulation pump(s), with boilers of an effective rated output for space heating purposes of more than 20 kW. Member States shall lay down the necessary measures to establish a regular inspection of the accessible parts of air-conditioning systems of an effective rated output of more than 12 kW. 4. As an alternative to paragraphs Member States may opt to take measures to ensure the provision of advice to users concerning the replacement of boilers or air-conditioning	Art. 14, 15

				systems, other modifications to the heating or air conditioning system and alternative solutions to assess the efficiency and appropriate size of the boiler. The overall impact of this approach shall be equivalent to that arising from the provisions set out in paragraphs 1, 2 and 3.	
BP_03	All new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018)	EPBD	From http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings	Member States shall ensure that: (a) by 31 December 2020, all new buildings are nearly zero- energy buildings; and (b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.	Art.9, par. 1
BP_04		EPBD		Member States shall draw up national plans for increasing the number of nearly zero-energy buildings. These national plans may include targets differentiated according to the category of building.	Art.9, par. 1

BP-ID	Informal text from which to formalize the BP description	Reference policy document	URL of the informal text	Excerpt from policy document text, from which to formalize the BP description	Part of the reference policy document
BP_05		EPBD		The Commission shall by 31 December 2012 and every three years thereafter publish a report on the progress of Member States in increasing the number of nearly zero-energy buildings. On the basis of that report the Commission shall develop an action plan and, if necessary, propose measures to increase the number of those buildings and encourage best practices as regards the cost-effective transformation of existing buildings into nearly zero-energy buildings.	Art.9, par. 5
BP_06	EU countries must set cost-optimal minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.)	EPBD	From http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings	(b) the application of minimum requirements to the energy performance of new buildings and new building units; (c) the application of minimum requirements to the energy performance of: (i) existing buildings, building units and building elements that are subject to major renovation; (ii) building elements that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are retrofitted or replaced; and (iii) technical building systems whenever they are installed, replaced or upgraded;	Art. 1, 4, 6, 7

BP-ID	Informal text from which to formalize the BP description	Reference policy document	URL of the informal text	Excerpt from policy document text, from which to formalize the BP description	Part of the reference policy document
BP_07	EU countries have to draw up lists of national financial measures to improve the energy efficiency of buildings	EPBD	From http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings	Member States shall draw up, by 30 June 2011, a list of existing and, if appropriate, proposed measures and instruments including those of a financial nature, other than those required by this Directive, which promote the objectives of this Directive.	Art. 10
BP_08	EU countries make energy efficient renovations to at least 3% of buildings owned and occupied by central government	EED	From http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings	Each Member State shall ensure that, as from 1 January 2014, 3 % of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year to meet at least the minimum energy performance requirements that it has set in application of Article 4 of Directive 2010/31/EU. The 3 % rate shall be calculated on the total floor area of buildings with a total useful floor area over 500 m2 owned and occupied by the central government of the Member State concerned that, on 1 January of each year, do not meet the national minimum energy performance requirements set in application of Article 4 of Directive 2010/31/EU. That threshold shall be lowered to 250 m2 as of 9 July 2015.	Art. 5, par. 1

BP-ID	Informal text from which to formalize the BP description	Reference policy document	URL of the informal text	Excerpt from policy document text, from which to formalize the BP description	Part of the reference policy document
BP_09		EED		For the purposes of paragraph 1, by 31 December 2013, Member States shall establish and make publicly available an inventory of heated and/or cooled central government buildings with a total useful floor area over 500 m^2 and, as of 9 July 2015, over 250 m^2 , excluding buildings exempted on the basis of paragraph 2. The inventory shall contain the following data: (a) the floor area in m^2; and (b) the energy performance of each building or relevant energy data.	Art. 5, par. 5
BP_10		EED		Once a year, Member States shall publish the energy savings achieved by each obligated party, or each sub-category of obligated party, and in total under the scheme.Member States shall ensure that obligated parties provide on request:(a) aggregated statistical information on their final customers (identifying significant changes to previously submitted information); and(b) current information on final customers' consumption, including, where applicable, load profiles, customer segmentation and geographical location of customers, while preserving the integrity and confidentiality of private or commercially sensitive information in compliance with applicable Union law.Such a request shall be made not more than once a year.	Art. 7, par. 8

BP-ID	Informal text from which to formalize the BP description	Reference policy document	URL of the informal text	Excerpt from policy document text, from which to formalize the BP description	Part of the reference policy document
BP_11	EU governments should only purchase buildings which are highly energy efficient	EED	From http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings		
BP_12	EU countries must draw-up long-term national building renovation strategies which can be included in their National Energy Efficiency Action Plans	EED	From http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings		
BP_13	Each Member State to submit National Energy Efficiency Action Plans by 30 April 2014 and every three years thereafter.	EED	From COMMISSION IMPLEMENTING DECISION of 22 May 2013 (2013/242/EU)		
BP_14	CoM signatories have to prepare within the year following their official adhesion a Baseline Emission Inventory (BEI)	CoM	From "How to develop a Sustainable Energy Action Plan" - http://www.covenantofmayors.eu/IMG/pdf/seap_guidelines_en-2.pdf		

BP-ID	Informal text from which to formalize the BP description	Reference policy document	URL of the informal text	Excerpt from policy document text, from which to formalize the BP description	Part of the reference policy document
BP_15	CoM signatories have to prepare within the year following their official adhesion a Sustainable Energy Action Plan (SEAP)	CoM	From "How to develop a Sustainable Energy Action Plan" - http://www.covenantofmayors.eu/IMG/pdf/seap_guidelines_en-2.pdf		
BP_16	CoM signatories have to submit an 'Implementation Report' every second year following the submission of the SEAP	CoM	From "How to develop a Sustainable Energy Action Plan" - http://www.covenantofmayors.eu/IMG/pdf/seap_guidelines_en-2.pdf		

2.2 Survey on Buildings related datasets available in the INSPIRE geoportal

A survey on the datasets available in the INSPIRE geoportal and related to the INSPIRE theme Buildings[8] was performed during the phase-1 of the Energy Pilot.

The aim of the survey was to investigate the availability and usability of building-related datasets relevant to the Energy Pilot in particular and to the needs of the EU energy efficiency policies in general. DG ENER was also interested in evaluating the results of the survey, in order to see at what extent these results can contribute to the EU Building Stock Observatory activities undertaken by DG ENER. Extending the survey to other data portals different from the INSPIRE geoportal was considered out of scope of the survey.

A methodology applied to discover in the INSPIRE geoportal building-related datasets was described and the results achieved documented in the technical report "Buildings related datasets accessible through the INSPIRE geoportal" [6], focusing primarily on datasets usability in a GIS environment. A screenshot of the cover page of the report is shown in ***Figure 4***

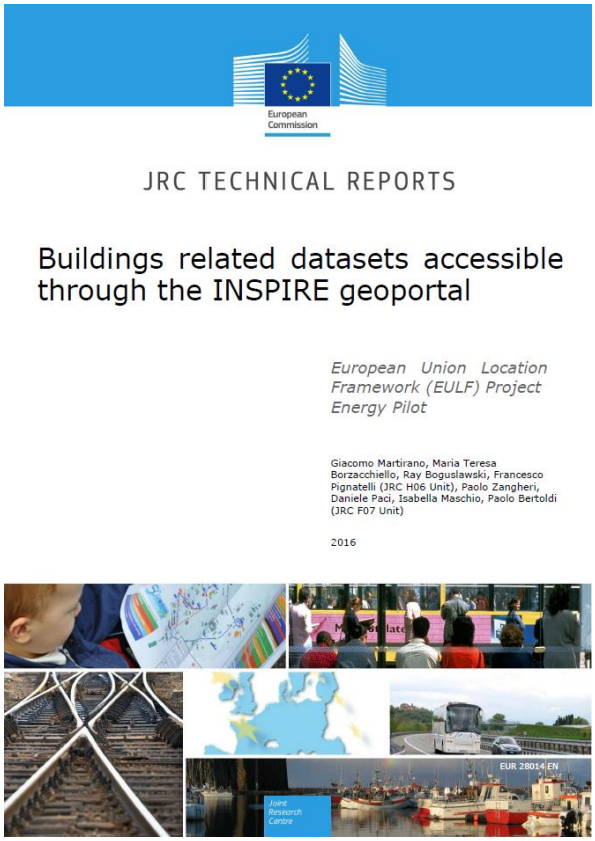

Figure 4 *– Cover page of the report "Buildings related datasets accessible through the INSPIRE geoportal"*

The findings presented in the report showed the usefulness of the INSPIRE geoportal to discover building-related datasets which fit the EULF Energy Pilot and the DG Energy's EU Building Stock Observatory purposes.

It is worth to highlight that, coherently with the INSPIRE roadmap, in the INSPIRE geoportal it is possible to find BU related datasets that are not yet conformant to INSPIRE data models. The INSPIRE roadmap deadline of 2020 (related to Buildings and

[8] http://inspire.ec.europa.eu/Themes/126/2892

to other Annex III INSPIRE data themes) requires that Member States will have to make their Buildings datasets conformant to one of the two INSPIRE core profiles (Buildings2D or Buildings3D), which contain only few attributes relevant to energy policies. Therefore, also INSPIRE compliant Buildings-related datasets which will be made available in the future by MS may have a limited usability in the energy sector, because of their limited semantic content related to energy aspects. Nevertheless, these datasets will constitute a useful basis for further energy-related semantic enrichment.

Regarding the report mentioned in this section, a sampling mechanism was adopted to select a small number of datasets to be further inspected (among the several hundreds of datasets discovered in the INSPIRE geoportal).

Even though the datasets inspected cannot be considered fully representative of all the building related datasets present in the INSPIRE geoportal, they showed a still poor level of harmonization across Europe, coherently with the INSPIRE roadmap. However the analyses performed in a GIS environment evidenced that INSPIRE mechanisms to harmonise Buildings related datasets according to semantically rich data models shared by all MS and to make this harmonised datasets accessible through WFS download services, can strongly support energy policies.

This support will be effective especially if the INSPIRE datasets (at building level) will be elaborated in order to obtain aggregated indicators at local, regional or national level. In its first version, the EU Building Stock Observatory will collect national data only. However, this tool could evolve to include sub-national data, and then INSPIRE could be an important source of information.

Moreover, some recommendations were 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 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.

In conclusion, the activities described in the report were useful to better understand the role of the INSPIRE buildings datasets in support of energy efficiency policies, and in particular as a source of data for the EU Building Stock Observatory. Next steps would include monitoring the availability of such datasets at the level of each Member State and the analysis of their usability, in the course of INSPIRE implementation.

2.3 Methodological approaches to assess building energy performance

Several approaches can be applied to assess the energy performance of a building, each of them having different requirements on input data and different methodological complexity, determining different levels of accuracy of the results obtained.

Six different approaches have been identified and classified into three categories named "holistic", "measured data" and "calculation", according to their main characteristics. A definition of the six approaches is provided below:

- Holistic
  - Approach 1: Simplified method based on administrative data
  - Approach 2: Approach 1 + climate data and user behavior information
- Measured data
  - Approach 3: Energy consumption and energy performance data, including metering data
  - Approach 4: Energy performance assessment based on measured data
- Calculation
  - Approach 5: Simplified calculation method
  - Approach 6: Detailed calculation method, according to standardized calculations.

A brief introduction to each of these approaches is given below.

Approach 1: Simplified method based on administrative data

It consists in a holistic assessment, based on building administrative data, such as year of construction and/or renovation, type of building, size (surface area or floor area), geo-location. Some of these data can be retrieved by authoritative data sources such as the cadaster. The building energy performance is often assessed by means of a comparison with reference buildings for which a performance assessment is available. No climate or energy data is considered.

Approach 2: Climate and user behavior information included

It is an extension of approach 1, including additional data coming from climate and end-user feedback. This may give further insight into and a more accurate assessment of the energy needs of the building, as well as of the energy systems and resources in the building. End-user information may be linked to annual energy billing for a correlation indicator of indoor and outdoor climate. Geo-location data may be used for selection of energy resources, in particular from environmental sources (renewables) or energy infrastructure and providers.

Approach 3: Energy consumption and performance data, including metering data

It represents a further extension of approach 2, which is possible when metering data is available at daily or even hourly interval. A combined statistical and analytical method might be applied to distinguish building energy needs (related to real climate and building fabric) from end-user energy consumption (behavioural aspect). The assessment techniques are more dynamic than static and offer the possibility to optimise the energy demand to climate as well as to user behavior. Integration of renewable energy related technologies could be considered as well.

Approach 4: Building performance assessment based on in-situ measured data

It is based on in-situ measurements of the energy performance. The main energy flows, e.g. thermal transfer through envelop and by an air tightness measurement, are measured by so-called co-heating experiments. These measurements are often accompanied by infrared camera observations or other specific measurements. The

information obtained is correlated to site and local weather conditions and requires proper conversion to a generalised energy performance value.

Approach 5: Simplified calculation

It consists in a simplified calculation, for which two versions can be identified: the first one is based on annual climate data, the physical building structure is simplified and represented by its volume and by the envelop area exposed to climate. Climate data can be simplified and represented by HDD (Heating Degree Days). In the second one, a more detailed assessment can be made based on monthly climate data and details of the envelope, such as window area, orientation to include impact of solar radiation and ventilation for air quality requirements. The impact of thermal mass may be also taken into account.

Approach 6: Detailed calculation based on standards

It is based on detailed calculation rules and requires hourly or monthly data for the assessment. These calculation rules are described in standards, such as those provided by CEN, ISO or by national standards related to energy in buildings, e.g. the overarching standard EN 15603 and the corresponding technical report EN 15615 of CEN. The dynamic calculation assessment takes into account variable climate data as well as thermal mass of the building.

An example of the different level of accuracy of the assessments made using different approaches can be made comparing approach 5 and 6, focusing on the limitations implied by the use of HDD. HDD is used in approach 5 to take into account the relation between indoor and outdoor climate, for an annual assessment, not providing information for shorter calculation intervals. Moreover, HDD do not consider impact of solar radiation nor wind. Another consideration to be made when using simplified calculations is that HDD do not consider the building insulation characteristics, which are becoming more important for new constructions. Indeed, newer buildings (as from 2010) are built with more severe requirements for insulation levels and energy system technologies. Member States review the national building codes and define more strict requirements in relation to energy performance and sometimes also include energy consumption and quality of the indoor environment. This may lead to nearly zero-energy buildings (NZEB), as requested by the EPBD. As a result, the importance of the energy needs for exchanging the air volume contributes more significantly to the total energy needs of the building. A simplified method based on only annual data (based on HDD) does not take sufficiently into account this aspect. It should be also noted that passive solar buildings and nearly zero-energy buildings should be treated as high performance buildings in which specific building energy system techniques are applied to optimise the energy balance. These and other methodological limitations can be removed using the detailed approach based on standards.

Another important aspect to be considered is related to the terminology used in the energy related methodologies. In particular, the three main expressions widely used, and illustrated in ***Figure 5***, are energy performance, energy efficiency and energy consumption, which have different definitions, meanings and units of measurement:

- Energy performance "*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*", as defined by EPBD [3]; Unit of measurement: CO_2/m^3 or kWh/m^2.
- Energy efficiency is the ratio between output and input energy from/to a building energy system and it is a unit-less expression: %, 0 … 1, COP (Coefficient of Performance).
- Energy consumption is the amount of energy actually used and depends also on factors such as user behaviour, gains, appliances, in additions to factors

determining energy performance (e.g. building fabric and climate conditions) and energy efficiency (e.g. building energy systems); Unit of measurement: MWh.

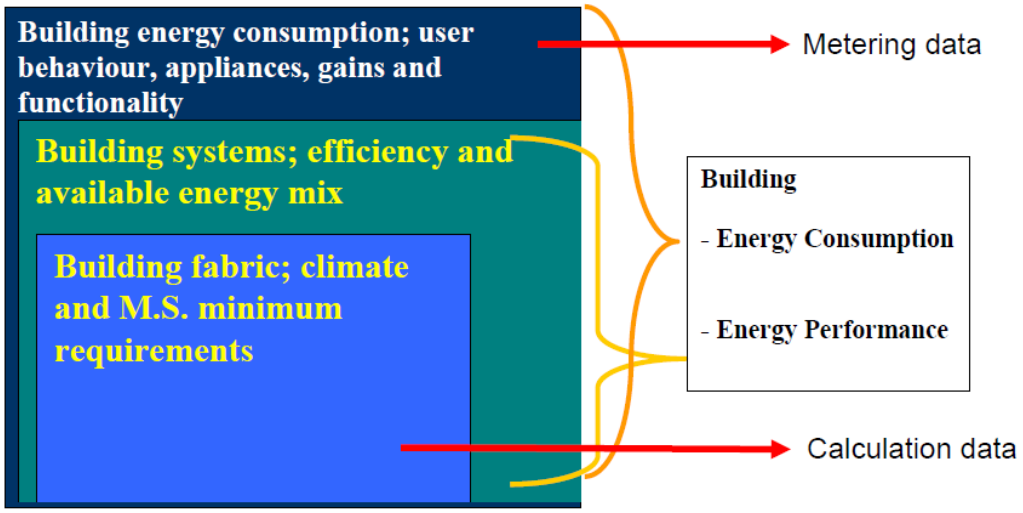

Figure 5 *– The relation between energy performance and end-user energy consumption*

A clear distinction has to be made between building energy needs, building energy systems that are needed to fulfill the requirements of the building energy needs and energy consumption, corresponding to the end-user demand for working and living in the building in order to maintain the envisaged conditions. Note that the EPBD defines energy usage for: Heating, Cooling, Ventilation, Hot Water and Light and therefore the user energy consumption part that covers energy use of appliances and user behavior (user-profile) is excluded from the Energy Performance Value or Certificate. Energy consumed for appliances, communication (TV, computer, internet) is not considered under the EPBD.

Moreover, it is worth also to recall the Trias Energetica model[9] developed by the Delft University of Technology (NL), that supports the reduction of energy consumption in building sector, presenting three priority steps in relation to "minimise", "maximise" and "optimize" concepts:

1. Minimise energy needs of a building, improving insulation of the building envelop and therefore energy saving related to indoor (comfort level of temperature, air quality and light) and outdoor environment conditions (temperature, solar radiation and wind) for comfortable working and living in buildings.
2. Maximise energy efficiency of building energy installations and systems, combining efficiency of the installations for heating, cooling, ventilation, hot water and electricity in relation to available energy mix, which are the relevant factors in the end-use energy consumption.
3. Optimise the use of renewable energy resources (solar energy, bio-energy, etc.), as well as the energy consumption due to behaviour of the occupants, including control and gains.

All approaches can be also considered as consisting of four components, input requirements, method, tools (software) and output, as schematised in the tables below.

Holistic - Approach 1: Simplified method based on administrative data

[9] http://www.eurima.org/energy-efficiency-in-buildings/trias-energetica

Input requirements	Minimum information is building 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.

Holistic - Approach 2: Climate and user behavior information included	
Input requirements	Minimum information is building 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 each dwelling.

Measured data - Approach 3: Energy consumption and performance data, including metering data	
Input requirements	Regular readings from gas, electricity, water, heat and other resources. Time frequency can be hourly, daily or other frequent meter readings. Climate data.
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.

Measured data - Approach 4: Building performance assessment based on in-situ 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 infrared 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.

Calculation - Approach 5: Simplified calculation	
Input requirements	Minimum information is volume, floor area, exposed envelope area, air change per hour (ACH) and reference climate for the location. Approach 5a could be based on annual climate data (HDD) whereas approach 5b could be dealing with monthly climate data and incorporate a seasonal calculation method.
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/m^2

Calculation - Approach 6: Detailed calculation based on standards	
Input requirements	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. Reference climate data is required for the calculation.
Tools	
Output	

A final consideration about methodologies is related to the different implications that different energy policies have on buildings.

The assessment of the energy performance of a building, as required by the EPBD, is related to a single building (or building unit) expressed in primary energy (that requests for a controversial conversion). EPBD links directly to standards for calculation as well as measurements when it concerns performance assessment. EPBD does not cover energy consumed by appliances, but restricts to Heating, Cooling, Ventilation, DHW (Domestic Hot Water) and Light energy consumption. EPBD addresses new as well as majorly renovated buildings. Energy providers and industry products consuming energy are not directly affected by EPBD. Energy providers, such as producers of electricity, gas and district heat, as well as energy distributors, use in fact physical networks that serve many buildings (end-users).

The Energy Efficiency Directive [4] calls for energy savings requirements including on buildings Member State level. This includes making central government buildings more energy efficient and requiring EU countries to establish national energy efficiency action plans. EU countries are also asked to draw up national long-term building renovation strategies, to show how they plan to foster investments into the renovation of residential and commercial buildings. These strategies are part of their National Energy Efficiency Action Plans, and provide an overview of the national building stock, identify key policies that the country intends to use to stimulate renovations, provide an estimate of the expected energy savings that will result from renovations. EED links to energy savings, e.g. reduction of energy consuming appliances and other products, refers to EPBD for renovation and role of public bodies' buildings and requires annual reports of the progress towards 2020 targets.

2.4 Energy Pilot use cases definition

The energy pilot is being implemented and tested through a series of use cases, which aim at covering as much comprehensively as possible the wide spectrum of the energy policies related business processes that can be enabled and supported by location information.

This section provides a detailed description of an initial set of use cases. Because some of the use cases, as currently described, have not yet reached a sufficient level of maturity, and the finalisation of their description is still on-going, updated description of existing use cases, as well as the description of new use cases, will be provided during the phase 2 of the pilot started in 2017.

Starting from the draft outline of the five use cases contained in the Feasibility Study Report [2] and benefitting from the discussions had during the workshop held in JRC Ispra from 24th to 26th of November 2015 [5], a more detailed description of the following six use cases has been provided.

It is to be highlighted that the numbering of the use cases is not related to any priority, but rather to a temporal sequence of execution, determined by internal organisational reasons. The use cases are related to investigate the possible benefits that the INSPIRE Directive can bring to the existing policy framework of the EPBD and the EED.

- Use case 1 - Transformation of Energy Performance Certificates datasets.
- Use case 2 - Comparative analysis of different methodologies and datasets for 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.

The use case description has been provided re-using the INSPIRE use case template (used during the drafting of the Data Specifications to provide practical examples addressing needs of different user communities). One additional field has been included in the template, namely the "Status" field, in order to provide information about the current status of the use case.

The final number of use cases may change, according to new emerging needs, e.g. new topics to address and/or new project management requirements to be accomplished.

Table 3 *– Use case description template*

Use Case Description	
Name	*A short name for the use case, usually describing an activity*
Status	*Status of the Use Case*
Primary user	*The main person or system or organization interested in the use case output*
Data provider	*The provider of input data which will be elaborated in the use case*
Goal	*The goal of the primary user*
Description	*A short narrative description of the use case*
Documentation	*Include pointers to any additional documentation*
Pre-condition	*What are the pre-requisites? What input is required?*
Post-condition	*What is the output from the use case? What are the anticipated next steps?*
Flow of Events – Basic Path *Describe the basic steps needed for executing the use case from the perspective of the primary actor.*	
Step 1.	
…	
Step n-1.	
…	

2.4.1 Use Case 1 – Transformation of Energy Performance Certificates (EPCs) datasets

Table 4 *– Use case 1 description*

Name	Use case 1 – INSPIRE data transformation of existing Energy Performance Certificate datasets and creation of a web application for accessing them.
Status	A first sequence of the nine steps described below has been completed and documented [7]. A set of next steps to be performed to improve the results already achieved, as well as to re-use the results in different geographical/organizational contexts has been identified.

Primary user	• Government:
	  ○ Energy Policy makers at regional level
	  ○ Energy Policy makers at local level
	
	• Businesses:
	  ○ Energy auditors and certifiers
	  ○ Companies working in the sector of energy renovation of buildings
	  ○ ESCO
	  ○ Utilities
	
	• Consumers:
	  ○ Citizens (building/building unit owners/tenants)
	  ○ Citizens (willing to buy/rent a building/building unit)
	  ○ Real estate companies
	  ○ Notaries

Data provider	• Government:
	  ○ Public Authorities managing an EPC register/database
	• Consumers:
	  ○ Citizens (building/building unit owners)

Goal	To establish an accessible and interoperable common knowledge base for EPC datasets to support local government and private sector involved in energy efficiency policies.
Description	To harmonize existing EPC datasets according to INSPIRE and to create a user friendly web application to make them accessible and re-usable.
Documentation	• Energy Performance Certificates (EPC) databases across the EU. A mapping of national approaches 2014[10] • Report on existing monitoring initiatives and database systems. From Databases to Retrofit Action: How European Countries are using Energy Performance Certificate (EPC) Database Systems[11] • Report on best practice meeting in Brussels. Using Energy Performance Certificate databases - turning data into action.[12]
Pre-condition	• Availability of EPC georeferenced datasets to be harmonized according to INSPIRE. • Availability of datasets needed to georeference those EPC datasets eventually not georeferenced.
Post-condition	• INSPIRE harmonized EPC datasets will be made accessible by means of INSPIRE Network Services (WMS + WFS), in order to be reused by any interested party for its own purposes. • INSPIRE harmonized EPC datasets will be made accessible to the interested users through a web application, which will enable easy visualization/query of (part of) the datasets

[10] http://bpie.eu/publication/energy-performance-certificates-across-the-eu/
[11] http://building-request.eu/sites/building-request.eu/files/d2.1_wp2_report_on_existing_monitoring_initiatives_and_databases_150901_aea.pdf
[12] http://building-request.eu/sites/building-request.eu/files/d2.2_wp2_report_on_european_best_practice_meeting_150227_public_aea.pdf

	attributes.
Flow of Events – Basic Path (to georeference and harmonize the EPC dataset of Provincia Autonoma di Trento, IT) **See also *Figure 6***	
Step 1	To access/obtain from Autonomous Province of Trento (PAT) the EPC dataset to be georeferenced using cadastral open datasets
Step 2	To access the cadastral open datasets
Step 3	To define a methodology to georeference the EPC dataset using cadastral data
Step 4	To implement the methodology, obtaining a georeferenced EPC dataset.
Step 5	To create the target data model extending the INSPIRE core data model for Buildings
Step 6	To transform the georeferenced EPC dataset into the INSPIRE extended target data model
Step 7	To publish the transformed dataset by means of INSPIRE Network Services (WMS + WFS)
Step 8	To use the harmonised dataset into a GIS client desktop application
Step 9	To assess the possibility to apply the methodology (or enhance it) to other EPC datasets, managed by other organizations in other countries/regions

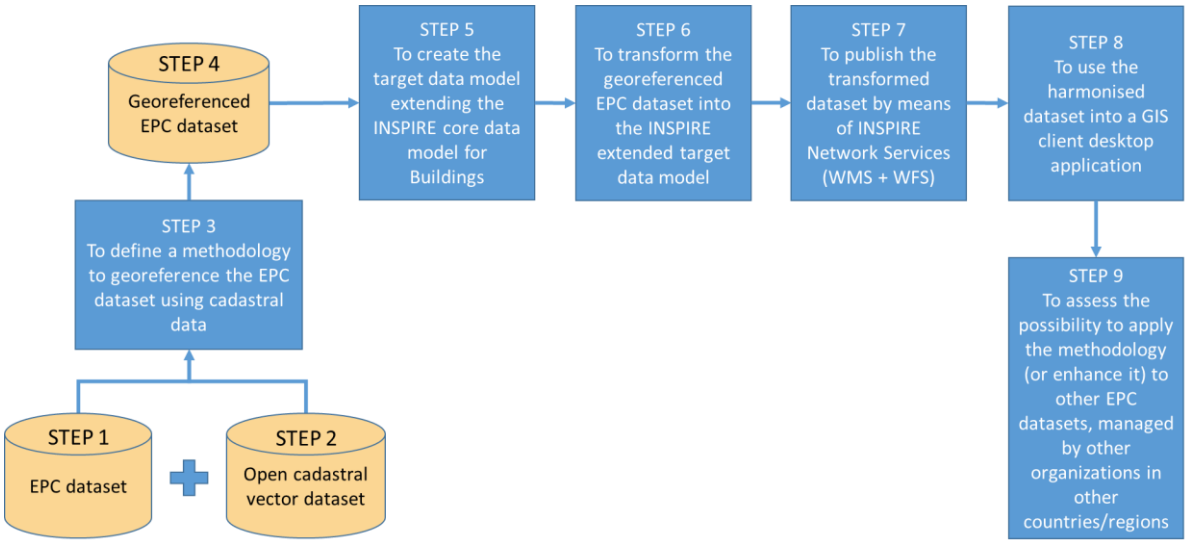

Figure 6 *– Steps of use case 1*

Expected benefits:

Easier accessibility to INSPIRE harmonized EPC datasets will improve:

- the competitiveness of the private players working in the sector of buildings renovation to improve their energy performance;
- the effectiveness of the decisions taken by policy makers involved in energy efficiency policies lifecycle at urban/local level.

EPC registers/databases that practically almost all Member States are developing and managing could support obtaining high quality data on the building stock. The Evaluation of the EPBD concluded that EPC registers/databases can be a key instrument for reinforced compliance, improve the knowledge on the building stock and better inform policy makers and support the decisions of market players to design building renovation programmes, target investments, identify priority interventions areas and map risk areas for energy poverty.

Few examples:

1. A certifier wants to perform a market analysis to identify potential customers in a specific geographical area, interested in renewing their certificate and/or having a new certificate.
2. A city council, independently if it is a CoM signatory or not, wants to apply for regional/national funds to renovate its building stock.[13]

2.4.2 Use Case 2 – Comparative analysis of different methodologies and datasets for Energy Performance Labelling of buildings

Table 5 *– Use case 2 description*

Use Case Description	
Name	Use Case 2 – Comparative analysis of different methodologies and datasets for Energy Performance Labelling of buildings
Status	The initial draft description of the use case started in December 2015. Then, starting from May 2016, a deep analysis about the methodologies to be applied and the potential partners to be selected is ongoing. Use case description finalized, use case not started.

Primary user	• Government:
	  ○ Energy Policy makers at regional level
	  ○ Energy Policy makers at local level
	  ○ Local authorities signatories of the CoM
	• Businesses:
	  ○ Companies working in the sector of energy renovation of buildings
	  ○ ESCO
	  ○ Utilities

[13] http://www.cened.it/bando_piccoli_comuni

	• Consumers:
	  ○ Citizens (building/building unit owners/tenants)
	  ○ Citizens (willing to buy/rent a building/building unit)

Data provider	• Government:
	  ○ National Authorities (Cadastre, Mapping Agencies, etc.)
	  ○ Local Authorities
	• Consumers:
	  ○ Citizens (building/building unit owners)

Goal	To perform a comparative analysis ((including costs and benefits assessment) of different methodologies used to produce EP label datasets from different data sources with different level of accuracy, in order to better meet the EPBD needs and to facilitate the planning and implementation of energy (renovation) strategies.
Description	To produce different EP labelling datasets at building level or building unit level for the same determined areas, starting from the simplified method (e.g. "default dataset" or "level 0 dataset" similar to "1 star dataset" of http://www.energielabelatlas.nl/) and then improving its accuracy using more sophisticated methodologies which require more accurate data, and then make a Cost Benefits Assessment.
Documentation	• http://www.energielabelatlas.nl/ • Link 2 (Utilities)[14]
Pre-condition	• Availability of the required input data (possibly including crowd sourced data) and methodologies for each dataset to be produced.
Post-condition	• Input and output datasets to/from the methodologies will be harmonized according to a common target data model and made accessible by means of INSPIRE Network Services (WMS + WFS), in order to be reused by any interested party for its own purposes. • The harmonized datasets will be made accessible to the interested users through a web application, which will enable easy visualization/query/editing of (part of) the datasets' attributes.
Flow of Events – Basic Path (to produce "level 0 dataset")	
Step 1	To identify areas of interest and partners to be involved
Step 2	To select the labelling methodologies and their requirements (data, knowledge, etc.)
Step 3	To create the common data model to be used to harmonize the datasets, consisting of an extension of INSPIRE BU core data model.

[14] http://www.comune.fe.it/attach/superuser/docs/idea_progettuale_ing_ferraresi_hera.pdf

Step 4	To get input source data from data provider(s) (possibly including crowd sourced data)
Step 5	To transform input source data into the common target data model
Step 6	To apply the methodologies to derive EP labels
Step 7	To transform output data into the common target data model
Step 8	To publish transformed datasets by means of INSPIRE Network Services (WMS + WFS)
Step 9	To publish transformed datasets by means of a web application, which will enable easy visualization/query/editing of (part of) the datasets attributes by authorized users.

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

***Table 6** – Use case 3 description*

Use Case Description	
Name	Use Case 3 – Assessing the Energy Performance of buildings with dynamic measured data
Status	A detailed description is not yet available and has to be finalized. Contacts with international research projects have been established. Further input have been provided during the second international workshop held on September 2016 [8].

Primary user	• Government:
	  ○ Energy Policy makers at regional level
	  ○ Energy Policy makers at local level
	  ○ Local authorities signatories of the CoM
	• Businesses:
	  ○ Companies working in the sector of energy renovation of buildings
	  ○ ESCO
	  ○ Utilities
	• Consumers:
	  Citizens (building/building unit owners/tenants)

Data provider	• Government:
	  ○ Member States (according to obligations set by Art. 7, par. 8 of EED)
	  ○ Local Authorities (e.g. CoM signatories should have access to energy consumption data by utilities)
	• Businesses:
	  ○ Utilities
	  ○ ESCO

	• Consumers: ○ Citizens (building/building unit owners), who agree to share dynamic measured data
Goal	• To derive EP labelling of buildings/building units from actual consumption data. • To optimize energy consumption in buildings at city or district level. • To harmonize the management of measured energy consumption data at buildings/building units level.
Description	To be finalized
Documentation	C.I.T.I.E.S. project
Pre-condition	• Availability of measured energy consumption data. • Availability of the methodologies to process measured energy consumption data (for the scope of the use case).
Post-condition	To be finalized
Flow of Events – Basic Path	
Step 1	Identify areas of interest and partners to be involved (CITIES; DTU)
Step 2	To be finalized
Step n-1	To be finalized
Step …	To be finalized

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

***Table 7** – Use case 4 description*

Use Case Description	
Name	Use Case 4 – Supporting Energy Efficiency driven renovation planning of the building stock at local level.
Status	Use case description finalized. Identified PoliTo (Politecnico di Torino, IT) as potential partner. Use Case not started.

Primary user	• Government:
	  ○ Energy Policy makers at regional level
	  ○ Energy Policy makers at local level
	• Businesses:
	  ○ Companies working in the sector of energy renovation of buildings
	  ○ ESCO

	○ Banks ○ Utilities • Consumers: ○ Citizens (building/building unit owners/tenants) ○ Citizens (willing to buy/rent a building/building unit)
Data provider	• Government: ○ Local Authorities ○ Statistical Offices • Businesses: ○ Utilities ○ Projects • Consumers: ○ Citizens (building/building unit owners/tenants), e.g. by means of crowdsourcing platforms
Goal	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 (e.g. in areas having energy distribution networks or in historical centres); • 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.
Documentation	Buildings' energy efficiency and RES potential in urban contexts – G.Mutani, Proceedings of the workshop: Spatial data for modelling building stock energy needs: Ispra, 24-25-26 November 2015[15]
Pre-condition	• Availability of input data. • Availability of methodologies to produce the desired output.
Post-condition	Energy renovation planning scenarios
Flow of Events – Basic Path	
Step 1	To identify geographical areas of interest and partners to be involved
Step 2	To identify the methodology for the definition of energy renovation planning scenarios, starting from measured energy use and actual building stock information, and using bottom-up, top-down as well as hybrid models, including cost-optimal assessment.

[15] http://publications.jrc.ec.europa.eu/repository/handle/JRC99902

Step 3	To identify both the minimum set of necessary input data (i) and the set of complementary data which can enhance the accuracy of the results (ii).
Step 4	To harmonize the input data according to INSPIRE (design the target model extending the actual INSPIRE core data models, transform the source data according to the target data model, publish the transformed data).
Step 5	To define and implement a simplified model to scale-up the energy consumption model identified in Step 2 for its application to the whole building stock, including the identification of calibration coefficients dependent on the building stock and on the local conditions.
Step 6	To process the output of step 5 in combination with spatial information of energy dependent variables (land use, population distribution, socio-economic variables, energy distribution networks), in order to define energy renovation planning scenarios.
Step 7	To identify the most appropriate scenarios to contribute to reach 2020 targets. Different scenarios can address different targets, e.g. CO2 emission reduction, energy consumption reduction, increase of RES (Renewable Energy Sources) share, with a different level of priority.

Expected benefits:

To make available to Local Public Authorities a methodology enabling to assess the energy saving potential of a specific area. The methodology can be reusable in different geographical areas, because it takes into account the local conditions, which are different for different areas.

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

***Table 8** – Use case 5 description*

Use Case Description	
Name	Use Case 5 – Supporting integrated energy planning and monitoring at urban/local level (SEAP BEI/MEI)
Status	Use case description finalized, use case not started. The relationship with Covenant of Mayors has to be clarified.

Primary user	• Government:
	  ○ Policy makers at local level
	  ○ Local authorities signatories of the CoM
	• Businesses:
	  ○ Utilities

	○ ESCO
Data provider	• Government: ○ Local authorities signatories of the CoM • Businesses: ○ Utilities • Consumers: ○ Citizens (building/building unit owners/tenants)
Goal	To facilitate the production of SEAP BEI/MEI, using energy consumption data at building/building unit level and accurate data about energy production at local level.
Description	To produce and update the different datasets, related to final energy consumption in buildings and to local energy production, required to fill-in the relevant tables of BEI/MEI[16].
Documentation	
Pre-condition	• Availability of datasets containing final energy consumption in buildings, at building/building unit level (it could be an output of Use Cases 2 and/or 3). • Availability of source datasets containing energy local production. • Availability of a common target data model to be used to harmonize the source datasets containing energy local production.
Post-condition	• The relevant cells of the tables A, B2, B3 and B4 of My Emission Inventories are filled in. • The harmonized datasets related to local energy production will be made accessible by means of INSPIRE Network Services (WMS + WFS), in order to be reused by any interested party for its own purposes. • The harmonized datasets related to local energy production will be made accessible to the interested users through a web application, which will enable easy visualization/query of (part of) the datasets attributes.
Flow of Events – Basic Path	
Step 1	To identify areas of interest and partners to be involved
Step 2	To get input data containing final energy consumption in buildings, at building/building unit level from data provider(s) (it could be an output of Use Cases 2 and/or 3 if the same partner/area are involved).
Step 3	To get source datasets containing energy local production from data provider(s)

[16] http://www.covenantofmayors.eu/IMG/pdf/New_Monitoring_Template.pdf

Step 4	To transform source data into the common target data model(s)
Step 5	To publish transformed datasets by means of INSPIRE Network Services (WMS + WFS)
Step 6	To publish transformed datasets by means of a web application, which will enable easy visualization/query of (part of) the datasets attributes by authorized users.
Step 7	To fill-in the relevant cells of the tables A, B2, B3 and B4 of My Emission Inventories of SEAP.

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

***Table 9** – Use case 6 description*

Use Case Description	
Name	Use Case 6 – Supporting the design and implementation of a regional energy strategy
Status	Use case description to be finalized. Contacts with international research projects have been established.

Primary user	• Government:
	  ○ Policy makers at regional level
	• Businesses:
	  ○ Companies working in the sector of energy renovation of buildings
	  ○ ESCO
	  ○ Utilities
	• Consumers:
	  ○ Citizens (building/building unit owners/tenants)
	  ○ Citizens (willing to buy/rent a building/building unit)

Data provider	• Government:
	  ○ Regional Authorities
	  ○ Local Authorities
	  ○ Statistical Offices
	• Businesses:
	  ○ Utilities
	  ○ ESCO

Goal	To support the design and implementation of a regional energy strategy
Description	To be finalized
Documentation	Energy and Location: CIMNE point of view, Proceedings of the workshop: Spatial data for modelling building stock energy needs:

	Ispra, 24-25-26 November 2015 [5]
Pre-condition	• Availability of input data. • Availability of methodologies to produce the desired output.
Post-condition	To be finalized
Flow of Events – Basic Path	
Step 1	To identify areas of interest and partners to be involved
Step …	To be finalized
Step n-1	To be finalized
Step …	To be finalized

2.4.7 Primary users matrix

The following table summarises the categories and groups of primary users identified for each use case.

Table 10 *– Primary users matrix*

Category of primary users	Groups of primary users	use case 1	use case 2	use case 3	use case 4	use case 5	use case 6
Government	Energy Policy makers at regional level	✓	✓	✓	✓		✓
	Energy Policy makers at local level	✓	✓	✓	✓		
	Local authorities signatories of the CoM		✓	✓	✓	✓	
Businesses	Energy auditors and certifiers	✓					
	Companies working in the sector of energy renovation of buildings	✓	✓	✓	✓		✓
	ESCOs	✓	✓	✓	✓		✓
	Utilities	✓	✓	✓	✓	✓	✓
	Banks				✓		
Consumers	Citizens (building/building unit owners/tenants)	✓	✓	✓	✓		✓
	Citizens (willing to buy/rent a	✓	✓		✓		✓

Category of primary users	Groups of primary users	use case 1	use case 2	use case 3	use case 4	use case 5	use case 6
	building/building unit)						

2.5 Analysis of state of the art research in Europe about geoICT applied to the energy sector

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 focus was on the analysis of relevant initiatives dealing with energy in combination with the use of location data, starting from the list of examples mentioned in the feasibility study on "Location Data for buildings Related Energy Efficiency Policies" [2].

The initiatives analysed are relevant for the EULF Energy Pilot due to their objectives related to the geographical dimension of energy; some of them are focused on data collection, mainly at national level (key statistical data related to policies) based on building stock inventories and energy performance certificates.

The analysis focused on H2020 funded projects related to geo-ICT and energy at urban scale, therefore dealing with spatial and/or semantic aspects close to the objectives of the EULF Energy Pilot.

The analysis was based on both CORDIS web portal[17] and open datasets available in the European Union Open Data Portal related to "CORDIS - EU research projects under Horizon 2020 (2014-2020)"[18].

Two different datasets were considered, containing detailed data about organizations and projects funded by the European Union.

The analysis identified existing projects and initiatives related to energy in combination with the use of location data, providing solutions that can be re-used to support the goals of the Energy Pilot.

From the methodological point of view, the selection of H2020 projects from the full detailed dataset available on the EU open data portal offers a unique opportunity to identify projects that might be interesting for the EULF Energy Pilot. Indeed, this selection is based on an authoritative source, consisting of datasets of H2020 funded projects and partner organisations, thus representing an actual and neutral view about new initiatives, without any bias derived from subjective knowledge.

Thanks to the availability of these datasets, it has been possible to highlight projects funded in different programmes of H2020 framework and falling into its different topics; the selection was performed considering all 7574 projects funded in H2020 with starting dates ranging from January 2014 until September 2016.

[17] http://cordis.europa.eu/projects/home_en.html
[18] https://data.europa.eu/euodp/en/data/dataset/cordisH2020projects

From the full list of 7574 project, 91 have been identified and have been mapped against the use cases described in section 2.4 and the methodological approaches described in section 2.3.

The detailed list of the 91 projects is available in the public Google spreadsheet at the following URL: https://goo.gl/eOiJo5, which can be downloaded as local XLS file (or other formats), to filter the list with one or more criteria (e.g. H2020 topic, starting date, EULF Use Case, EULF Approach), in order to perform deeper analyses.

As an example, after having applied some filters and identified 18 projects most relevant for use case 2, after a further analysis of the projects' resources (e.g. deliverables) available on their websites, a final list of six projects was compiled. Establishing direct contacts with the project coordinators, in order to explore possible synergies for the implementation of use case 2, is recommended.

A detailed description of the results of this task is provided in the Final Report "Expert Contract Number - C392524. Supporting the EULF in the mobilization of the Energy Pilot" and its "Annex 1 - Existing projects and initiatives related to energy efficiency and the use of location", edited by the expert Piergiorgio Cipriano.

2.6 Partnering approach

An approach to establish formal relationships with partners to be involved in the definition and execution of the use cases, at different levels and with different roles, was identified and it is presented in this section.

The approach can also facilitate the selection of the most appropriate template of collaboration instrument, among the different templates used by JRC to formalise the cooperation with external partners[19], taking into account the following main aspects:

- the different typology of partners (e.g. Public Authorities, private commercial organizations, not for profit organizations, project consortia),
- the different roles they play in the use case(s) (e.g. data provider, domain expert),
- the different typology of resources they provide (e.g. data, methodologies, tools, expertise).

The process leading to the formalisation of the relationships with the partners is schematized in ***Figure 7***.

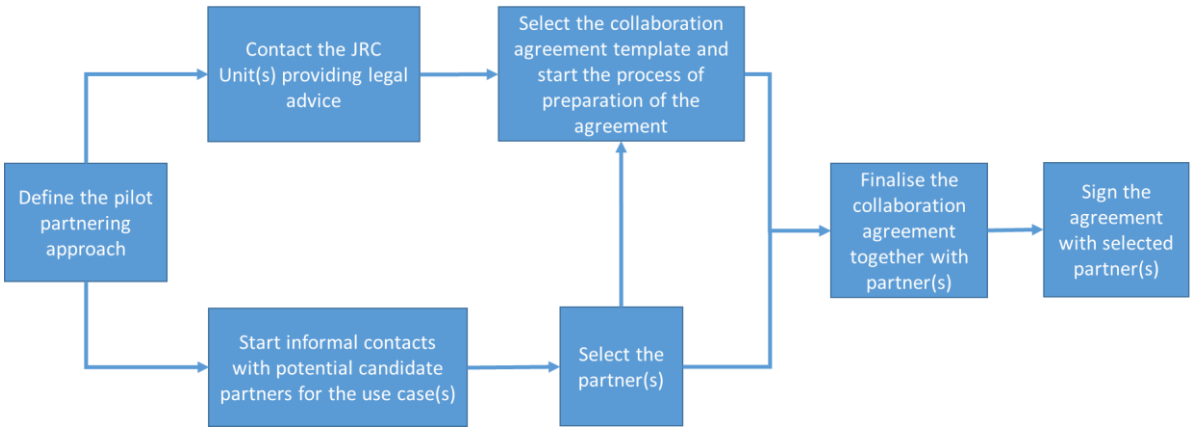

Figure 7 – *The partnering process*

[19] https://connected.cnect.cec.eu.int/community/jrc/partners/ca

The main requirements underlying the definition of this approach were:

- to provide a common framework the different templates of collaboration instruments fit with;
- to ensure timeliness of the entry into force of the collaboration instruments with the selected partners;
- to ensure transparency of the process to select candidate and final partners.

In the following ***Table 11*** are shown the different typologies of resources required by each of the six use cases currently defined and supposed to be provided by external partners to be identified, selected and involved.

Table 11 *–Resources required from external partners for the execution of the use cases*

Use Case	Data	Methodo-logies	Tools	Energy policies expertise
Use Case 1 – Transformation of EPC (Energy Performance Certificate) datasets	✓	JRC internal pilot team	JRC internal pilot team	Not needed
Use Case 2 – Benchmark of different Energy Performance Labelling of buildings	✓	✓	✓	Not needed
Use Case 3 – Assessing Energy Performance of buildings with dynamic metering data	✓	✓	✓	Not needed
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)	✓	JRC internal pilot team	JRC internal pilot team	Not needed
Use Case 6 – Supporting the design and implementation of a regional energy strategy	✓	✓	✓	✓

With reference to ***Table 11***, external partners with the following roles should be identified, selected and involved in the use cases:

- data providers are required in all six use cases;
- domain experts providing the required methodologies should be involved in use cases 2, 3, 4 and 6;
- domain experts providing the required tools should be involved in use cases 2, 3, 4 and 6;
- domain experts providing their competences in regional/local strategies related to energy efficiency should be involved in use cases 4 and 6.

During the workshops held at JRC on 24-26 November 2015 [5] and on 12-14 September 2016 [8], some of the invited experts expressed their willingness to be involved in the use cases, as summarised in ***Table 12***.

Moreover, investigations based on desk researches and/or on pre-existing contacts with other projects in the field, and/or on new contacts made during dissemination events (e.g. Geospatial World Forum 2016 and INSPIRE Conference 2016), led to identify the following additional potential partners:

- Regione Lombardia (IT), which publishes as open data a dataset containing about 1.000.000 of energy performance certificates, and as restricted access data the vector cadastral data of the whole Region, and therefore it is a potential data provider for use case 1;
- Sunshine and GeoSmartCity EU projects, which should act as data providers and/or domain expertise provider (in terms of methodologies and/or tools) for use cases 2 and 3 and/or as data providers for use case 5;
- Geonovum (NL), a public foundation working on GI standards, currently involved in activities related to GI standards applied in the energy fields; they could be involved in use cases 2 and 3 providing support in the methodological aspects;
- Flanders Information Agency (BE), currently working on setting-up a federal registry of buildings containing energy related information; they could be involved in use cases 1 and 2;
- Saxion University (NL), recently involved in a research activity aiming at collecting dynamic metering data from 20 smart dwellings; they could be involved as data providers in use case 3.

It is to be highlighted that the following list of potential partners is provisional and may change in the future, due to contacts that can be established with new potential partners and/or to the unavailability of partners who expressed so far their willingness to be involved.

In addition, it is worth to mention that further candidate partners could be found within the informal group Energy & Location[20] set-up in the E3P (European Energy Efficiency Platform)[21] of JRC (further details about E3P are provided in the section [2.8]).

Table 12 *– Provisional list of potential partners to be involved in the use cases*

Use case	Data provider	Domain expert (methodologies)	Domain expert (tools)	Domain expert (regional/local strategies)
Use case 1 – Transformation of EPC (Energy Performance Certificate) datasets	• Regione Lombardia, IT • Provincia Autonoma di Trento, IT • Boverket, SE • Flanders Information Agency (BE)			
Use case 2 – Benchmark of	• HFT, DE (linked to German data	• HFT, DE • Dutch Kadastre (NL)	• HFT, DE • Sunshine EU project	

[20] http://e3p-beta.jrc.nl/communities/energy-and-location
[21] http://e3p-beta.jrc.nl/

different Energy Performance Labelling of buildings	providers) • Dutch Kadaster (NL) • Sunshine EU project • GeoSmartCity EU project	• Sunshine EU project • GeoSmartCity EU project • Geonovum (NL) • Flanders Information Agency (BE)	• GeoSmartCity EU project	
Use case 3 – Assessing Energy Performance of buildings with dynamic metering data	• Sonderborg city, DK • CIMNE, ES • Saxion University (NL)	• ProjectZero, DK • DTU, DK • Geonovum (NL)	• ProjectZero, DK • DTU, DK	
Use case 4 – Supporting Energy Efficiency driven renovation planning of the building stock at local level	• Polito, IT	• Polito, IT	• Polito, IT	• Polito, IT
Use case 5 – Supporting integrated energy planning and monitoring (SEAP BEI/MEI)	• Sonderborg city, DK			
Use case 6 – Support the design and implementation of a regional energy strategy	• BPIE, BE • CIMNE, ES	• BPIE, BE • CIMNE, ES	• CIMNE, ES	• BPIE, BE • CIMNE, ES

In order to satisfy the three requirements underlying the definition of the partnering approach mentioned above, a hybrid partnering approach is recommended, based on the following assumptions:

- for use cases where the following conditions simultaneously apply:
  - the use case definition is already finalized,
  - only few partners are required,
  - their role is limited to data provider,
  - potential partners have been already identified,
  - the re-use of existing resources is particularly beneficial for the pilot, avoiding duplication of efforts,
  - data are the only missing component for an immediate start of the use case activities,

direct bilateral agreements could be established with the identified partners, using the appropriate template(s). Use case 1 is an example of this scenario.

- Complementarily, for use cases where at least one of the following conditions apply:
    - the involvement of a stakeholder community in order to identify potential partners can be particularly beneficial for the pilot dissemination and exploitation,
    - potential partners, primarily data providers, have not been yet identified,

  the launch of an open call for expression of interest to select the partners is encouraged. Use case 5 could be an example of this scenario, with Covenant of Mayors acting as big thematic community to be involved.
- For use cases not fitting with the two above mentions scenarios, a combination of the two approaches could be put in place, based on use case specific requirements.

The following recommendations should be applied when drafting the agreements, based on existing template(s):

- to distinguish between partners providing resources at no costs (e.g. data) from partners whose involvement can born reasonable costs (e.g. domain experts or data which may be available at a fee);
- when aiming to re-use the results of EU co-funded projects, to carefully consider any possible licensing agreement, generally formalized in the consortium agreements annexed to the contracts signed by the project coordinators with EC;
- to pay attention to the IPR clause(s), which will have to explicitly prevent any possible IPR issue with the partner.

Regarding the references for the collaboration instruments, a good reference for the Call for expression of interest to be possibly launched to select partners is represented by the "Call for expression of interest for individual experts and organizations to participate in the INSPIRE marine pilot". The Call text is available at the following url: http://inspire.ec.europa.eu/documents/INSPIRE /Call INSPIRE Marine Pilot 20141003.pdf. The referred call mechanism/text could be a good starting point, even though further refinements are required.

Another source to be taken into account is the JRC webpage regarding collaboration instruments and related guidelines and templates accessible at https://connected.cnect.cec.eu.int/community/jrc/partners/ca.

Regarding IPR issues, another source of knowledge and useful examples is https://connected.cnect.cec.eu.int/groups/ipr-trainings.

The partnering approach described in this section was applied to select the first partner involved in the execution of use case 1, i.e. APRIE – Agency for the Water Resources and for the Energy, of the Autonomous Province of Trento, IT. The collaboration instrument selected was the Collaboration Agreement and the related legal process consisted into two main steps:

- a JRC internal step consisting in the preparation and signature of a pre-approval form, signed by the pilot responsible, the Head of Unit and the Director of the two JRC Units/Directorates collaborating for the use case (Unit B.6 and Unit C.2) and lastly by the JRC Director General;
- the preparation of the Collaboration Agreement, signed by the JRC Director General and by the Legal Representative of the partner.

During the preparation of the Collaboration Agreement, it was also initiated a mandatory JRC internal procedure related to the assessment of possible data protection issues. Several meetings were held with the DPO (Data Protection Office) staff, during which

possible privacy issues related to specific data processing activities of the use case were analysed. In particular, it was analysed the possible sensitive nature of the processed data, e.g. energy performance label of a private building, in relation to the possibility to make this data accessible to the public, e.g. by means of a map allowing to identify a building with a specific label, and indirectly its owner. In order to speed-up the process, it was decided, together with the partner, to perform the data processing only on public buildings, for which the EPBD imposes to make the related energy data accessible to the public. Further details are provided in [7].

2.7 GeoICT Requirements

This section provides a set of generic requirements of technological and organisational nature that can support the partners who participated in the implementation and test of the use cases to operationalise the use cases' workflows within their organisations.

The following requirements were derived from the experience made during the execution of the use case 1 and they can be generalised to all use cases:

- analysis of the current business processes addressed by the use case and executed by the partner concerned, identifying the actors and their roles, focusing on duties and interfaces of multiple departments and/or external organisations eventually involved in different steps of the processes;
- analysis of the geoICT infrastructure of the partner concerned, e.g. in terms of:
    - the characteristics of its SDI, if existent;
    - the characteristics of its IT systems;
    - the geoICT skills of its human resources;
- analysis of the applicable data policies implemented by the partner concerned that can be relevant for the operationalisation of the use case results, e.g. related to open data, data and service sharing, data protection;
- collection and analysis of the geoICT requirements that the partner concerned may have to operationalize the use case results, e.g. related to:
    - the hosting of the server components (e.g. cloud-based vs. on premise, deegree vs. GeoServer, Oracle vs. Postgis);
    - possible changes in the procedures currently in use to execute the business processes addressed by the use case.

Specific geoICT requirements related to each use case will be identified during the execution of the use case and documented in the related reports.

A preliminary example of specific geoICT requirements was given by the expert Piergiorgio Cipriano in the Final Report "Expert Contract Number - C392524. Supporting the EULF in the mobilization of the Energy Pilot". In the report he outlined the technical specifications of possible specialised services for use cases 2 and 3. Specialised services can be defined as "geo-processing services able to implement an algorithm and to perform a calculation on spatial data using logical, mathematical and topological operators". In the context of the energy pilot, a set of specialised services is foreseen to implement algorithms and estimations related to the following use cases:

- use case 2: Comparative analysis of different methodologies and datasets for Energy Performance Labelling of buildings;
- use case 3: Assessing the Energy Performance of buildings with dynamic measured data.

Specialised services for use case 2

The use case is aiming at benchmarking different schemes and algorithms to calculate the "Energy Performance Labels". The use case can be implemented using two possible approaches [8] (refer also to section [2.3]):

- Approach 1. Holistic assessment. Based on building administrative data like year of construction and/or renovation, type of building, size (surface area or floor area), geo-location. Important are data sources like the cadaster. Often the building is assessed by comparison to reference buildings for which a performance assessment is available. Note that no climate or energy data is needed.
- Approach 2. An extension of approach 1 but for which additional data is coming from climate and end-user feedback. This may give further insight and a more accurate assessment for the energy needs of the building as well as the energy systems and resources in the building. 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, in particular from environmental sources (renewables) or energy infrastructure and providers.

The algorithm(s) implementing the required calculation can be easily designed as "specialised services" and implemented either as database procedures or as web processing services (on the fly, through the web).

In the first case (database) the calculation can be implemented as a stored procedure[22], thus having both spatial data and the operation capability stored in the same database server.

In the second case, the web processing service should be possibly based on the open OGC standard WPS[23], and it should be able to perform different kind of elaborations, including, for instance, complex topological operations and calculations such as polygons overlay, or the calculation of the surface of external walls of a building.

The WPS standard also defines how a client can request the execution of a process, and how the output of the process is handled. It defines an interface that facilitates the publishing of geospatial processes, their discovery and their binding to other processes.

A WPS module could perform a chain of operations on buildings' spatial data available also from remote servers (e.g. through WFS[24] services) and calculate the value of the estimated energy performance label.

In both cases, the input parameters of the calculation will be spatial data of buildings, containing the required attributes (described above) together with climatic parameters (e.g. climatic zone, heating degree days).

The output of the calculation will be a geographical layer containing the energy performance labelling of buildings (according to the labels and ranges defined at national or sub-national levels) to be made available through WMS[25] for viewing maps, and through WFS services for accessing the data.

The values calculated will represent the estimated energy performance label: this value will be only indicative of the overall energy required by the building, without considering the real level of occupancy nor the occupants' behaviour (that have a big direct influence on the real consumption).

More in detail, the estimation of the energy needed at building level could be performed using the standard WPS request operation.

The request takes as input the following information:

- **layer** (mandatory): it is the layer containing spatial data representing buildings (it can be a layer available as WFS *FeatureCollection*);

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[22] A stored procedure is a subroutine available to applications that access a relational database management system (RDMS). Depending on the database system, stored procedures can be implemented in a variety of programming languages, for example SQL, Java, C, or C++. Stored procedures written in non-SQL languages may or may not execute SQL statements themselves.
[23] http://www.opengeospatial.org/standards/wps
[24] http://www.opengeospatial.org/standards/wfs
[25] http://www.opengeospatial.org/standards/wms

- **climaticZone** (mandatory): it contains the codename of the climatic zone that is used to compute the energy performance of buildings; in this case, the algorithm should be able to extract properties of the climatic zone from a local database or repository (e.g. value of heating degree-days);
- **begin year** (optional): name of the attribute that contains the begin construction year of buildings;
- **end year** (mandatory): name of the attribute that contains the end construction year of buildings. If the begin field is used, the data considered by the computation can be the average of the 2 values;
- **building height** (conditional): name of the attribute that contains the value of the height of the building;
- **number of floors** (conditional): name of the attribute that contains the number of floors of the buildings (if "height" is not available);
- **average height of floor** (optional): name of the attribute that contains the information of the average floor height of the building (if "height" is not available)
- **refurbishment level** (optional): name of the attribute that contains the information about the refurbishment level. The values on the layer can be based on the ones defined by TABULA-EPISCOPE project[26]:
    - 0: no refurbishment;
    - 1: standard (measures for upgrading the thermal envelope and the heat supply system, typically reflecting national requirements for renovations);
    - 2: advanced (measures for upgrading the thermal envelope and the heat supply system which are usually only realised in ambitious renovation projects; e.g. passive houses);
- **uses of building** (mandatory): name of the attribute that indicates the use(s) of the building, according to a well-defined and public codelist containing a structured definition (e.g. INSPIRE Re3gistry "CurrentUse"[27]).

As a result of the computation, a new spatial layer (*FeatureCollection*) can be returned; for each building, the new layer can contain several properties related to the "Energy Labelling", e.g.:

- **energyLabel**: energy label (e.g. B)
- **classificationSystem**: labelling classification system used
- **energyLabelValue**: numeric value of the energy label (e.g. 1234,56)
- **energyLabelUoM**: unit of measure used (e.g. kWh/m^3/year)
- **uRoof**: roof heat transfer coefficients
- **uFloor**: floor heat transfer coefficients
- **uWall**: wall heat transfer coefficients
- **uWind**: window heat transfer coefficients
- **pWind**: percentage windowed of the building

It is noteworthy to consider the "temporal" aspect of the calculation to be performed: according to the input data used (attributes of buildings, climate) the estimated output data produced may vary during the time; possible options are:

- managing the storage of previous estimation (overwrite vs. duplication);
- managing the temporal evolution of the estimation (temporal dimension).

Specialised services for use case 3

The use case is aiming at estimating the energy performance of a building through the use of dynamic data provided by smart meters as well as energy consumption time series. With reference to the different approaches [8] (refer also to section [2.3]):

[26] http://episcope.eu/index.php?id=97
[27] http://inspire.ec.europa.eu/codelist/CurrentUseValue

- A further extension of approach 2 is possible when metering data is becoming available at daily or even hourly interval. A combined statistical and analytical method might be applied to distinguish building energy needs (real climate and building fabric related) from end-user energy consumption (behavioural aspect). The assessment techniques are more dynamic than static and offer the possibility to optimise the energy demand to climate as well as user behaviour.

In this case the "specialised services" should also consider the need to collect, store and process dynamic data coming from sensors (machines) or end-users (humans).

For the first case (sensors) two different open standards are suggested that can be alternatively implemented:

- Sensor Observation Service (SOS)[28], that is applicable to use cases in which sensor data needs to be managed in an interoperable way. This standard defines a Web service interface which allows querying observations, sensor metadata, as well as representations of observed features.
- GreenButtonData[29], that is an industry-led effort (USA) responding to a White House[30] call-to-action to provide customers with easy and secure access to their energy usage information in a consumer-friendly and computer-friendly format. With the implementation of the Green Button standard, users are able to securely download their own detailed energy usage in a simple and interoperable way, by using mobile apps or utilities' websites. In the context of the energy Pilot, in order to 'compare energy performance labels' it is necessary to collect data from sensors in a secure and interoperable way, avoiding proprietary software solutions; therefore, Green Button is a possible option for use case 3 to collect data (that will then be used to 'compare energy performance' using dynamic data).

In both cases, the implementation of a "sensor server" where to collect and store dynamic data from smart metering systems is needed; both SOS and Green Button offer an interoperable way to harvest dynamic data about energy consumption from remote (utilities) servers, using secure protocols.

In particular, in the case of Green Button, great attention was dedicated to the consumer's privacy: the Green Button standard requires that there is no Personally identifiable information (PII) contained within the data, rather only measured interval usage information. The US National Institute of Standards and Technology (NIST) cyber-security team reviewed the content of Green Button data to ensure it meets this requirement.

Moreover, Green Button data implements the North American Energy Standards Board's (NAESB) REQ 21 - Energy Service Provider Interface (ESPI) energy usage information exchange standard. This standard format ensures that energy information can be easily exchanged without requiring developers to invest time and money to support proprietary metered data conversion technologies. This enables application developers to create applications that provide services to consumers enabling them to analyse and plan their energy consumption, and ultimately to save money.

In the case of end-users (humans), many web and mobile apps already exist to involve different types of buildings' occupants to provide data.

The specialised services described in this section are examples of technical specifications that in turn will allow formulating detailed geoICT requirements during the design phase of the services.

[28] http://www.opengeospatial.org/standards/sos
[29] http://www.greenbuttondata.org/
[30] http://energy.gov/data/green-button

Other geoICT requirements are expected to be derived from further specialised services, as well as from other specific aspects, that will be identified during the implementation of the use cases.

2.8 Dissemination, Exploitation, Communication

Substantial dissemination activities have been done to share information about the pilot, increase its awareness and engage more stakeholders:

- two workshops were organised at JRC Ispra on November 2015 and September 2016, with the objective to collect from energy experts useful input about the pilot scope and to share with them views about the definition of the use cases; more information is provided in the two workshop reports [5] and [8] (see ***Figure 8***);
- one invited oral presentation about the pilot activities was given at the Geospatial World Forum 2016 in Rotterdam;
- a parallel session entitled "INSPIREd energy", with five presentations focusing on topics addressed by the pilot, was organised at the INSPIRE Conference 2016 in Barcelona (see ***Figure 9***).

Figure 8 *– Cover pages of the two workshop reports*

Figure 9 *– Agenda of the INSPIREd Energy parallel session at INSPIRE Conference 2016*

In addition, it is worth to mention the E3P (European Energy Efficiency Platform)[31], currently under finalisation by JRC Unit C.2 (see ***Figure 10***). In the Community section of the platform the informal group Energy & Location[32] was already set-up (see ***Figure 11***). The European Energy Efficiency Platform serves as the Commission online platform as described in the Energy Efficiency Directive Article 25. The E3P among other tasks facilitates the practical implementation of the Energy Efficiency Directive at national, regional and local levels, with data collection and analysis. The E3P also supports the exchange of experiences on practices, benchmarking, networking activities, as well as innovative practices.

[31] http://e3p-beta.jrc.nl/
[32] http://e3p-beta.jrc.nl/communities/energy-and-location

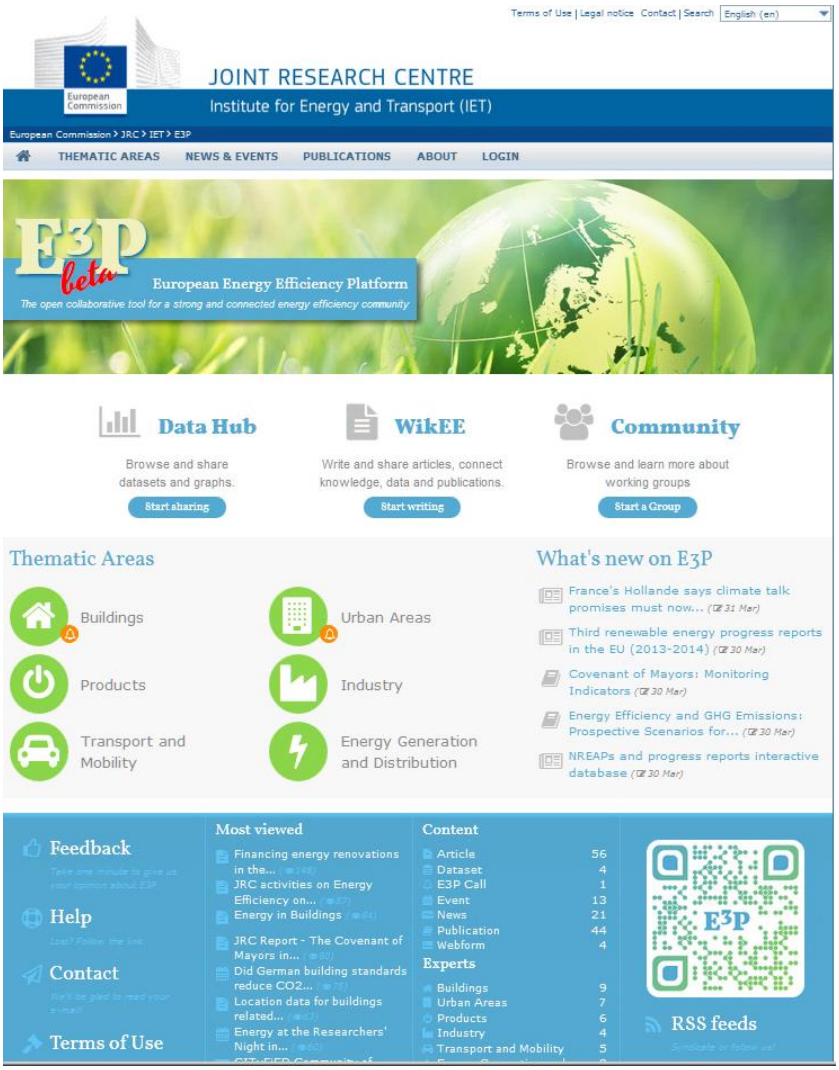

Figure 10 *– E3P Home page*

Figure 11 *– Home page of the Energy and Location informal group in E3P*

3 Expected benefits

The pilot is expected to produce benefits to the different actors participating in the different steps of the energy policies lifecycle, increasing the efficiency and the effectiveness of many business processes in which they are involved, thanks to the accessibility of high quality, reusable and interoperable location information.

Regarding how to measure those benefits, it will be difficult to make it in terms of increased effectiveness of the relevant business processes. Conversely, it should be easier to make a quantitative assessment of the efficiency gained, e.g. in terms of labour time saved, comparing alternative data processing scenarios.

The following ***Figure 12*** shows examples of data flows related to the energy directives and initiatives analysed within the pilot, that allow to identify different alternative data processing scenarios.

The first aspect to consider is related to the option to use or not use INSPIRE to execute some of the business processes contained in the energy directives and initiatives.

For instance, there are two alternative paths related with the EPBD: path A (consisting of A1+A2+A3), based on the INSPIRE data harmonization of the building related datasets and path B, allowing to fulfil the same obligations, but without applying INSPIRE.

Similar alternative paths can be identified related with the EED (path A1+A2+A3+G, using INSPIRE, alternative to path J, not using INSPIRE) and CoM (path A1+A2+A4, using INSPIRE, alternative to path D, not using INSPIRE).

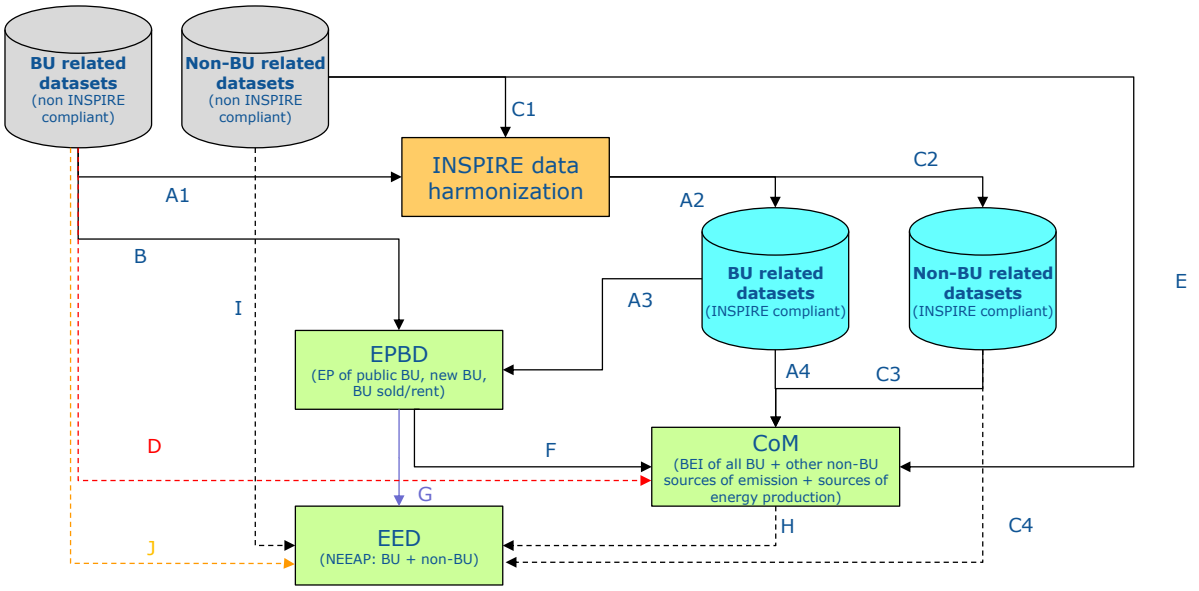

Figure 12 *– Examples of data flows related to energy policies*

The second aspect to consider is related to the option to re-use as input for a data flow some of the data obtained as output from another data flow. For instance, regarding EED, the path B+G (with re-use) can be seen as alternative to path J (without re-use) and, regarding CoM, the path B+F (with re-use) can be seen as alternative to path D (without re-use).

Further alternative data processing scenarios can be obtained combining INSPIRE/non-INSPIRE with re-use/non-re-use paths.

Finally, in ***Figure 12*** it is highlighted a distinction between the building/non-building related content of the data to be processed. This distinction is related to a possible lower level of standardisation of the datasets containing information not related to buildings (e.g. energy efficiency and/or consumption of transport systems and public lighting) required by EED and CoM, compared to building related datasets. This may have in turn different implications on the related data flows, constituting therefore another aspect to consider in terms of costs and benefits when comparing alternative data processing scenarios.

The partners participating in the execution of the pilot use cases will be asked to contribute to the quantitative assessment of the efficiency gained following the alternative data processing scenarios, as well as to identify and apply new metrics to measure the benefits expected to be produced by the use cases.

4 Issues identified

Several issues of different nature were identified during the phase-1 of the pilot.

Organisational issues

The partnering approach described in Section 2.6, providing, after deep consultation with the JRC Units providing legal advice, the mechanisms to engage the partners in the execution of the use cases, contains three main issues:

- it requires to follow a long and complex formal process leading to the signature of a collaboration agreement by the parties involved. As an example, there is a series of initial steps to be carried out internally to JRC to get approval of a preliminary collaboration form by several signatories: from the pilot responsible, to the Head of Unit, to the Director up to the Director General. Considering that

this pilot is jointly executed by two Units of two different Directorates, this preliminary phase may slow down the initiation of the use case activities.

- The non-monetary nature of the collaboration agreement makes difficult to secure the commitment of the partners, which decide to step in only if they identify tangible benefits coming from their participation that justify their return on investments. Most of the candidate partners are public organisations and they can not receive direct grants from the ISA Programme, which cannot fund the Member States directly. For some typologies of partners this obstacle can be partially overcome thanks to the possibility to sign small expert contracts with physical persons executing specific tasks in a limited number of person-days, but this possibility is unlikely to be applied to public organisations' employees. Moreover, if a use case requires to use data which are available only at a cost, the non-monetary nature of the collaboration agreement can make difficult to find the financial resources to cover the possible data acquisition costs or the data use licences fees.
- The process to formalise the collaboration agreement requires also the formal involvement of the JRC Data Protection Coordinator, who needs to assess if, during the execution of the data processing activities foreseen in the use case, JRC applies the law protecting individuals' personal data [9]. Unless there is a clear evidence that the data processing activities undertaken by JRC do not involve personal data, the Data Protection Coordinator requires to open a "Notification to the Data Protection Officer of the European Commission", which is a process leading to an official assessment of the proper management of possible personal data by JRC. The Notification remains open for a couple of months and available in a public register for consultation by possible affected parties, who may ask further clarifications about the management of personal data. After this consultation period, the Notification is archived and it remains available in the public register, together with the contact details of the JRC Data Controller (generally the Head of Unit), who may be asked at any time by any EU citizen or organisation to provide evidence that during the execution of the use case JRC applied the law protecting individuals' personal data. It is important to highlight that in the DPO Notification context data are classified as personal even though they are of non-sensitive nature but can directly or indirectly allow to identify characteristics of an individual (e.g. a map containing building footprints coloured according to their energy performance label is considered personal data in the DPO Notification context). Therefore, the process related to the DPO Notification prolongs the time span needed to sign the collaboration agreement.

Data privacy issues

Restrictions on access to and sharing of energy consumption dynamic measured data, required by some of the pilot use cases, emerged as an important issue related to data privacy.

Energy consumption data at building (sub) unit level, as it should be provided by smart meters, is locked because it contains commercially sensitive information about the energy use in a building unit. This information could lead to final customers profiling, costumer segmentation and geographical location of customers.

Therefore, energy distributors and/or retail energy sales companies, according to the provisions set by art. 7 of EED, provide on request to Member States aggregated statistical information on their final customers, preserving the integrity and confidentiality of private and commercially sensitive information in compliance with applicable Union laws.

Restricting access to disaggregated energy consumption dynamic measured data, either in time (time series at regular time intervals) and/or in space (at building sub-unit level)

makes difficult the application of several models and methodologies currently envisaged in some of the use cases.

Technical issues related to data

As already mentioned in Section [1.2], there is a lack of data available at building unit level, which represents the most detailed geographical scale for the purposes of the pilot.

This lack can be at geometric level (lack of 3D building data required by simulation software used to assess energy needs at building level) and/or at semantic level (lack of energy-related attributes, such as year of construction, year of renovation, building type, building use, building occupancy).

The lack of semantically-rich (from an energy policies related perspective) 3D data available on a coverage area sufficiently wide, at least at (sub)district level, prevents the application of several models and methodologies currently envisaged in some of the use cases.

Technical issues related to methodologies

Some of the use cases will apply upscaling or downscaling methodologies:

- upscaling methodologies, to scale-up at district, city or regional level (which is the reporting level most often required by the energy policies and initiatives) the few and scattered information that may be available at building or building unit level;
- downscaling methodologies, to disaggregate at the highest level of detail (ideally at building level) the energy consumption measured data, which is typically made available in the form of aggregated datasets to prevent the access to commercially sensitive data.

Even though in the first phase of the pilot it was not possible to conduct an exhaustive analysis on the available upscaling/downscaling methodologies potentially useful for the pilot purposes, the perceived lack of documented and re-usable algorithms represents a potential issue for the execution of some of the use cases, which need to be overcome in the second phase of the pilot.

Further specific issues can be identified and documented during the execution of the pilot use cases.

5 Conclusions and next steps

5.1 Achievements and lessons learned

The main achievements of the activities documented in this report, listed below, are related to the completion of a set of preparatory activities that enabled to define in more detail the pilot scope and its roadmap for the next years:

- extraction from EPBD, EED and CoM of a preliminary list of sixteen business processes location-related, whose execution can benefit from the availability of accurate, harmonised and interoperable spatial data;
- identification and description of six different methodological approaches that can be applied to assess the energy performance of a building, each of them having different requirements on input data and different methodological complexity, determining different levels of accuracy of the results obtained;
- definition of six use cases, that will support the pilot implementation, aiming at covering as much comprehensively as possible the wide spectrum of the energy policies related business processes that can be enabled by location information;

- definition of a partnering approach to establish formal relationships with partners to be involved in the definition and execution of the use cases, at different levels and with different roles.

Some of the activities completed during the first phase of the pilot in 2016 are documented in distinct deliverables:

- a survey on the datasets available in the INSPIRE geoportal and related to the INSPIRE theme Buildings, described in section [2.2] and reported in detail in [6]; it is important to highlight the positive feedback received by DG ENER in terms of potential usefulness of the outcomes contained in the report in relation to the activities of the EU Building Stock Observatory;
- an analysis of state of the art research in Europe about geoICT applied to the energy sector, described in section [2.5];
- dissemination activities, described in section [2.8] and reported in detail in [5] and in [8];
- results of the first phase of the use case 1 "INSPIRE transformation of existing Energy Performance Certificate datasets", reported in detail in [7].

In parallel to the above-mentioned achievements, the following main lessons were learned:

- the need to define in detail the use cases involving since the beginning the candidate partners, in order to clearly identify tasks, roles and responsibilities of each actor, as well as input data requirements and availability, methodologies and tools to be used;
- the need to overcome data privacy issues related to energy consumption measured data containing commercial sensitive information; accessibility only to spatially coarsely aggregated data can make difficult the application of several models and methodologies currently envisaged in some of the use cases.

5.2 Next steps

This section outlines a possible roadmap of the pilot, containing results to be achieved by the end of 2017 and other activities to be executed in the following years.

The timeline of some activity is indicative, depending on the resources that can be committed.

- To continue, in collaboration with the partner APRIE, the activities related to use case 1 "INSPIRE Transformation of existing Energy Performance Certificate datasets and creation of a web application for accessing them", executed during the phase 1 in 2016. The second phase in 2017 aims at completing the activities unfinished in 2016 (described in [7]) and to operationalise the use case results in the partner's organisation.
- To re-use the use case 1 results in other regions/countries.
- To finalise the description of use case 2 "Comparative analysis of different methodologies and datasets for Energy Performance Labelling of buildings" involving the candidate partners, to formalise the collaboration agreement, to start the activities and produce preliminary results by the end of 2017 (use case completion foreseen in 2018).
- To finalise the description of use case 3 "Assessing the Energy Performance of buildings with dynamic measured data" involving the candidate partners, to formalise the collaboration agreement, to start the activities in 2017 (use case completion foreseen in 2018).
- To formalise the collaboration with the candidate partner Politecnico di Torino and start in 2018 the activities related to use case 4 "Supporting Energy Efficiency driven renovation planning of the building stock at local level".

- To identify the partners and start in 2018 the activities related to use case 5 "Supporting integrated energy planning and monitoring at urban/local level (SEAP BEI/MEI)".
- To describe in detail the use case 6 "Supporting the design and implementation of a regional energy strategy", identify the partners and start the activities in 2018;
- To extend to other energy policy instruments (e.g. Renewables Energy Directive) the analysis to extract location-related business processes.
- To define possible new use cases addressing new data flows/business processes related to the analysed energy policy instruments.
- To continue the analysis of state of the art research in Europe about geoICT applied to the energy sector, whose results obtained in the first phase were reported in section [2.5].
- To continue the dissemination, communication and exploitation activities, in order to increase the awareness of the benefits that can be introduced in the energy policies lifecycle by the availability of accurate, harmonised and interoperable spatial data, to maintain the links already established during the first phase of the pilot with communities and experts and to engage new stakeholders.

The issues encountered in the first phase of the pilot and reported in the section [4] will be taken into consideration during the planning and the execution of the envisaged next steps and measures to mitigate their negative impact will be implemented.

For example:

- the slowness and complexity related to the preparation of several bilateral Collaboration Agreements, one for each use case, will be overcome working on a single multilateral agreement to be signed by all parties involved in different use cases;
- the reported technical issues related to data will drive the selection of the pilot area(s) of the use case 2 "Comparative analysis of different methodologies and datasets for Energy Performance Labelling of buildings";
- some of the technical issues related to the methodologies, in particular those to be applied in the use case 3 "Assessing the Energy Performance of buildings with dynamic measured data" will be solved conducting specific analyses and studies;
- some of the reported data privacy issues will be overcome attempting to focus initially on data related to public buildings, which are open by default, and then try to extend the relevant findings to all types of buildings; this strategy was already implemented in the context of the use case 1 "INSPIRE Transformation of existing Energy Performance Certificate datasets and creation of a web application for accessing them".

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List of abbreviations and definitions

Term/abbreviation	Description
ADE	Application Domain Extension
APRIE	Agenzia Provinciale per le Risorse Idriche e l'Energia della Provincia Autonoma di Trento (IT)
BEI	Baseline Emission Inventory
CoM	Covenant of Mayors
DPO	Data Protection Officer
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ESCO	energy service company or energy savings company
EULF	European Union Location Framework
GIS	Geographic Information System
GML	Geography Markup Language
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technologies
IPR	Intellectual Property Rights
IR	Implementing Rule
ISA	Interoperability Solutions for European Public Administrations
JRC	Joint Research Centre
MEI	Monitoring Emission Inventory
MS	Member State
OGC	Open Geospatial Consortium
SDI	Spatial Data Infrastructure
SEAP	Sustainable Energy Action Plan
SOS	Sensor Observation Service
WPS	Web Processing Service
WFS	Web Feature Service

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