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Big data for buildings

Building Information aGGregation, harmonization and analytics platform

Project Nº 957047

D7.2- Update of contributions to standardization actions and preliminary Market2Go strategy including BIGG impact

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Executive Summary

The BIGG project aims at demonstrating the application of big data technologies and data analytic techniques for the complete buildings' life cycle of more than 4000 buildings in 6 large-scale pilot test beds. The proposed solutions will be deployed and tested cross pilot and country validation of at least two business scenarios in Spain and Greece.

The BIGG project will achieved its targets by: 1) The Open Source BIGG Data Reference Architecture 4 Buildings for collection/funnelling, processing and exchanging data from different sources (smart meters, sensors, BMS, existing data sets); 2) An interoperable buildings data specification, BIGG Standard Data Model 4 Buildings, based on the combination of elements from existing frameworks and EC directives, such as SAREF, INSPIRE, BIM, EPCHub that will be enhanced to reach full interoperability of building dates; 3) An extensible, open, cloud-compatible BIGG Data Analytics Toolbox of service modules for batch and real-time analytics that supports a wide range of services, new business models and support reliable and effective policy-making.

WP7 aims at setting the foundation for effective exploitation and deployment of results into the market. Its main goal is to support the developments by providing: 1) a clear picture of already existing standards, and 2) all the tools and support for ensuring great market impacts of the exploitable results developed in WP3, WP4 and WP5 and demonstrated in WP6.

This second iteration of WP7's deliverable provides an update version of contribution to standardization actions and a preliminary Market2Go strategy including BIGG impact.

During the first year of the project, Task 7.1 has been focusing on studying the use cases, technical requirements and specifications done in WP2 (general framework) and WP4 (central data model), in order to identify all existing standards, standardization committees and international initiatives that could be of interest for the project. This document gives a technical and organizational descriptions of them. During the second year of the project, technical work packages have started using existing standards or developing new ideas concepts. So, this document now also describes all contribution to standardization actions that have been initiated from what is produced by BIGG project:

- Collaboration with identified committees and international initiatives
- Technically implement the standards in the project and produce "standardizable" results.
- Actively contribute to standardization by promoting BIGG experiments and results.

From the exploitation point of view, Task 7.2 has been focusing on defining and implementing an exploitation strategy to facilitate the successful exploitation and adoption of results and benefits within stakeholders. Deliverable D7.2 documents this effort by offering a Market Analysis for each of the Business Cases or Use Cases (in case of multiple Use Cases within a Business Case) and listing the Exploitable Results and their connection with the Use Cases. In addition, Exploitable Results which relate to the whole project and facilitate the Use Cases have been identified and described. Tasks 7.2 and 7.3 further analysis focuses on the business models that emerge from the Exploitable Results based on the methodology already described in D7.1.

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Table of Acronyms and Definitions

Acronym	Definition
BIM	Building Information [Model | Modeling | Management]
IFC	Industry Foundation Classes
bSI	buildingSMART International
SAREF	Smart Applications REFerence (*SAREF*) *ontology*
SOSA	SOSA (Sensor, Observation, Sample, and Actuator) is a lightweight but self-contained core ontology part of the SSN ontology (Semantic Sensor Network ontology)
DEEP	The EEFIG De-risking Energy Efficiency Platform (DEEP) is an open-source database for energy efficiency investments performance monitoring and benchmarking to up-scale energy efficiency investments in Europe.
INSPIRE	Infrastructure for Spatial Information in Europe
AIOTI	Alliance for Internet Of Things Innovation
W3C	World Wide Web Consortium
OGC	Open Geospatial Consortium

ISO	International Organization for Standardization
CEN	European Committee for Standardization (CEN, French: Comité Européen de Normalisation
ESCO	Energy Services Company
UC/BC	Use Case / Business Case
EPC	Energy Performance Certification
EPCo	Energy Performance Contract
TRL	Technology Readiness Level
IPR	Intellectual Property Rights
ECMs	Energy Conservation Measures
RES	Renewably Energy Sources
DSO	Distribution System Operator
DR	Demand Response
BMS	Building Management System
CMMS	Computerized maintenance management system
EuBSO	European Building Stock Observatory
ER	Exploitable Result
ICT	Information and Communications Technology

I. INTRODUCTION

I.1. Purpose and organization of the document

The purpose of this document is to present the work done and the results achieved in work package 7 during the first two years of the project.

The main objective of WP7 is to provide the project with an effective exploitation and deployment strategy. It will support the developments by providing a clear picture of needs, requirements and standardization framework. WP7 has the following specific objectives:

- Create a long-term collaboration framework with standardization bodies to which BIGG can technically contribute,
- Characterize the markets, the stakeholders and their needs,
- Assess the outstanding features of our exploitable results providing us with a market advantage,
- Manage, protect and find agreements on the exploitable results,
- Assess, discern and propose business models capable of empowering the commercial and technical offerings,
- Set forward dedicated plans for commercialization and market uptake for each exploitable result contemplating the appropriate business models.

The document is divided into 2 main parts:

- First part presents the updated version of contributions to standardization actions.
- Second part focuses on the Market Analysis of BIGG Use Cases and on the description of BIGG Exploitable Results, implementing the first and second steps of the BIGG exploitation strategy.

I.2. Scope and audience

This second version of WP7's deliverable covers the work done during the first two years, on the concrete approach of the project's relation to standardization, and preliminary Market2Go strategy. To achieve this, WP7 collaborate closely with WP2 (general framework), WP4 (central data model), WP6 (use cases) and WP8 (exploitation & dissemination).

This document is dedicated to all person willing to understand how the project articulates with standardization and what could be the economic impact of the project outcomes.

II. CONTRIBUTIONS TO STANDARDIZATION

In this first part of the document, we detail the work done and the results achieved concerning the contribution of BiGG project to standardization.

It is divided into five sections. Section 1 introduces the bases and motivations of the relation between a European project and standardization committees. Section 2 gives an overview of the economic impact of standardization. Section 3 presents the methodology and organization of task 7.1. The core of this part, section 4, presents the different phases of the collaboration with standardization. In section 5, we introduce a set of recommendations concerning standardization in EU project. Finally, section 6 gives a more detailed description of interaction between task 7.1 and task 8.3, which focuses on “Liaisons, stakeholders' engagement and other synergies”.

II.1. Introduction to standardization

‘The Infrastructure for Spatial Information in the European Community (INSPIRE)’ in the construction of the EU Digital Single Market (DSM) is an initiative by the European Commission to build a territorially unified digital market spanning the entire European Union, aimed at developing unified standards for geospatial data [1]. To overcome the challenges associated with utilising many types of interoperability to implement sociotechnical systems across borders, the Commission focused on two mechanisms ‘legal and technical interoperability’.

The former ‘legal interoperability’ requires coordination between geographic agencies across the EU, its member states, and subnational administrations. While the latter ‘technical interoperability’ is crucial in setting standards for spatial production and distribution. In reference to the INSPIRE project the Digital Single Market premise is based on the capacity for changes in legal and technical interoperability focusing on reducing barriers that constrain the supply of cross-border digital trade. In fact, the European Commission has incorporated spatial data infrastructure into a legally binding regulation. The process included a variety of stakeholders known as Spatial Data Interest Communities (SDICs), collaborating with the Legally Mandated Organizations (LMOs) of each member state in the EU (such as national geographic agencies). The assumptions are that all “Member States of the European Union develop their own infrastructures and make them interoperable through agreed technical specifications”. In this context, European projects, due to the public funding they receive, must ensure that the research done, and the results produced can be shared and are easily exploitable or reusable. Relying on standards is a very good solution for that.

When it comes to BIM, the importance of standardization is even more obvious. BIM is all about interoperability, and the straight way to guaranty best interoperability possible between tools, processes, and people, is to use, test, improve and push standards.

Figure 1 shows the most common interactions between a research project and the standardization world:

- Phase 1: During the specification phase of the research project, each requirement or use case identified shall be mapped with existing standard solution. Project partners will consult standards and attend some standardization committees’ meetings, looking for information.
- Phase 2: During the conception phase of the research project, each identified standard solution will be analysed, and challenged with the objective of the project. Project partners will need more technical support from the standardization committees in order to ensure the standard solution meets the project needs and is adequately used.
- Phase 3: During the development phase of the research project, each selected standard solution will be implemented and tested. When limitations or problems are identified, project teams will adapt by suggesting correction or additions. When it is

possible, project partners will demonstrate their on-going implementation of the standards to the corresponding committees.

- Phase 4: Finally, during the dissemination phase of the research project, most interesting project outcomes will be push toward standardization committees. Depending on the outcome type, these "contribution to standardization" can be:
    - Demonstrating the standard implementation in the project through different use-cases.
    - Suggesting some correction / addition to the standard.
    - Suggestion a new (or a new version of a) standard.

Of course, modern research projects don't always follow this kind of "linear" development process. But the presented organization can easily be adapted to "agile" methods, where several "iterations" are performed.

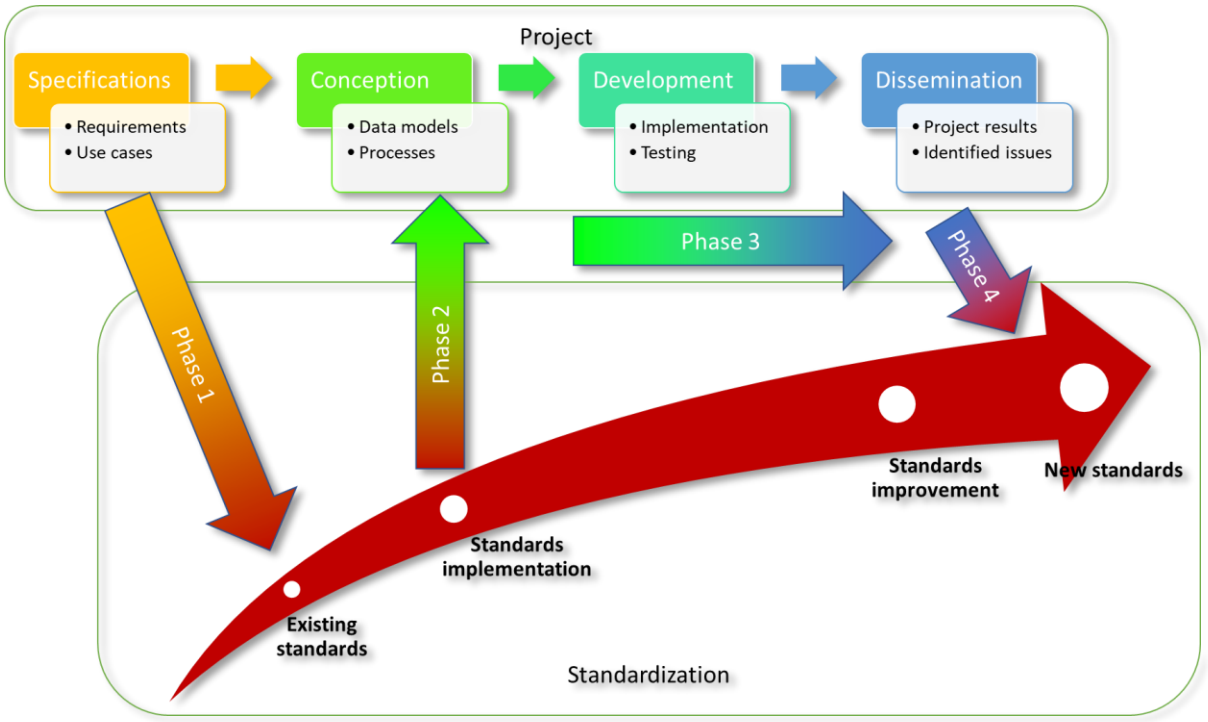

Figure 1 – Link between project and standards

II.2. Economic Impact of standardization

In economies where technological improvement constitutes the main source of growth, standardization contributes directly to pushing back technological frontiers, thereby benefitting the greatest number of people. Standards are a way of

- codifying knowledge
- disseminating innovation and
- developing good market practices.

Furthermore, standards ensure greater safety and security in many areas, which helps lower the cost of safety/ security measures and obtaining the necessary insurance.

There have been many studies confirming that the benefits of standardization acknowledged by companies include product interoperability, increased productivity, market share gains, and

ease of cooperation with public R&D institutions. These benefits can be summarized in the following 5 areas:

1. Company value enhancement: The knowledge capital contributed by corporate involvement in standardization work represents true value.
2. Innovation: Standardization promotes the dissemination of innovation. It emphasizes a product's advantages and constitutes a product selection tool.
3. Transparency and ethics: Standards contribute to better compliance with the rules of competition. By establishing the rules of the game, standards make it easier to eliminate players who fail to comply.
4. International: By promoting the development of international exchanges, standardization provides companies with a genuine passport for exporting their products.
5. Product and service quality: Standardization gives companies a great degree of control over safety-related problems and provides a genuine guarantee of quality.

Microeconomic analyses carried out in several studies aiming to access the relationship between standards and growth in the long term, have shown that there is a direct contribution of standardization to the growth in a country's economy. In France for example, standards have a stabilizing effect on growth corresponding to about 0.81% of the gross domestic product, whereas in Germany to about 0.7% to 0.8% of the GDP [2], [3]

Due to the increasing number of specializations, industry will have to recognize eventually that it will operate in an environment where interoperability is challenged, especially as long as there is a lack of universally accepted standards. Specifically for Build Information Modelling (BIM) the challenges are noted as lack of rules, agreements, and solutions about legal and IPR consequences of BIM information exchanges. Furthermore, the lack of organizational interoperability (positioning organizational issues such as social resistance to change, traditional methods of contracting) are now considered as a major barrier to BIM adoption.

To overcome aforementioned barriers, it is critical to clarify ownership and contractual relationship of the parties creating and using BIM, and to address design liability, reliance on data and sharing of copyrighted data issues that may arise. This requires the alignment of business processes, responsibilities, and expectations towards common goals, by setting up inter-organizational relationships between service providers and service users, can bring significant economic benefits.

In this direction, the standardized ISO 19650 series has pronounced the legal and technical agreements that are now appearing in collaborative BIM environments with examples including BIM execution plans and coordination programs, master/task information delivery plans, asset information models and requirements, organizational information requirements, and data exchange definitions. An example of successful adaptations that can build trust and a positive environment for collaboration is the case of Singapore supply chain systems whereby contractual arrangements had to be complemented by a well-defined BIM scope, in addition to communications across multiple tiers [4].

Economics of Software Interoperability in Construction

Integration is a major challenge for software development in buildings and construction, in particular Global Software Development (GSD), as integration failure remains hidden during the development phase and surfaces during system integration. The causes of such failures are attributed to incompatibilities and integration complexities that lead to delays, extra costs and affects the overall quality [II-5]. The National Institute of Standards and Technology 2004 report 'Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry' identified that interoperability issues occur creating a fragmented business process and

organizational structure. *It is estimated that the cost of inadequate interoperability in the U.S capital facilities industry is $15.8 billion per year*. In 2002, the value of capital facilities in the U.S. was $374 billion. Of these costs, two-thirds are borne by owners and operators, most of them occurring during the facility operation and maintenance phase (O&M) [II-6]. The magnitude of this figure suggests that even small improvements in efficiency potentially represent significant economic benefits. The McGraw Hill Construction SmartMarket report defined interoperability, as the ability to manage and communicate electronic product and project data among collaborating firms [II-7]. Beyond the technological aspect, it is the ability to implement and manage collaborative relationships among members of cross disciplinary teams that enables integrated project execution. The report highlights that the traditional method generally focuses its greatest amount of effort during the construction documentation phase, in contrast to the integrated approach, where the team members work closely together during the design phase, resulting in a greater ability to save costs before the construction process. BIGG consortium is built on similar principles, transferring the experience of its partners across multiple disciplines into the development of the multi-layered software architecture under BIGG toolkit.

Economic Impact of interoperability for Smart Homes and Grids

The energy sector is facing an unprecedented transformation towards utilisation, challenging existing practices, development procedures and business models. ICT solutions are critical in supporting connectivity between elements of the smart grid, such as building blocks and houses and their integration, with the grid services and the energy providers. Energy providers however can have contradicting interests operating in an unbundled energy sector, either due to their regulatory role (for System and Distribution Operators), or simply due to increased competition in often low margin markets (Utilities). Interoperability is crucial to allow the integration of the various energy system stakeholders with ICT the focus of EC directorate general groups such as DG-CONNECT and DG-ENER. EC by issuing mandates M/490, M/441 and M/468 has set recommendations for providing connectivity between electricity networks and consumers requiring information to be exchanged in a normalized way through authorized entities. Such integration can lead to the successful materialisation of DR products which are also a focus of the BIGG project, ultimately bringing significant economic benefits by reducing energy consumption.

BIGG Project departs from the confined IoT domain, bringing together innovation from the construction sector, building efficiency and IoT infrastructure to empower the consumer as they seek to optimise their consumption according to their environment and needs. Within literature such needs have been identified not only in electricity, but also in water management, making the solutions they propose universal and applicable for any resource with similar consumption characteristics (data-driven, smart sensor applications) [II-8]. The delivering of advanced demand strategies requires the integration of building a network scale data which could only be achieved through semantic alignment of concepts across demand and supply sides, such as coherent data schemas for demand side appliances, socio-technical concepts, and smart metering data, as well as supply side GIS and telemetry. Having the designed ontologies validated amongst a wide range of stakeholders provided a near real-time decision support system and contributed significantly to the international standards identified by ICT4Water as critical towards the penetration of ICT within the water domain.

In this context, standardization in systems with heterogeneous internal data structures and domain perspectives (such as both water and electricity systems) can achieve interoperability through semantic alignment. Smart systems will improve the efficiency and longevity of existing networks as well as reducing energy consumption, losses and costs whilst improving consumption profiles through demand-side management strategies. BIMs properties of utilizing design and construction data alongside operational data, IoT solutions and sensor descriptions are the key potential to unlock vast cost, resource, and CO_2 emission savings through intelligent management.

II.3. Methodology

To be efficient, the contribution to standardization action must involve as many partners as possible. Therefore, there are several very important dependencies between WP7 and other work packages and actions (see Figure 2):

- First, the WP7 relies on technical work pages, where the requirements, conception and implementations are done, especially:
  - WP2 for the use cases analysis, technical requirements, and architectural design.
  - WP4 for central data model definition.
  - WP5 for specific Artificial Intelligence and Machine Learning developments.
- A specific relation with Task 8.3 has been defined and is detailed later in the document.
- All these inputs will allow us to build deliverables D7.1 (M12) and its update D7.2 (M24).
- During the 3rd year of the project, a specific task in WP4, Task 4.4, will be dedicated to technical contribution to EU standards and ontologies, which corresponds to a specific part of the "Phase 4" of the process explain in previous part, focused on contribution to data model standards and ontologies.
- In addition to the specific work done on task 4.4, WP7 activities will lead to a last version of the deliverable, D7.3 (M36).
- All WP7 outcomes will produce inputs for the WP8 dissemination & communication activities.

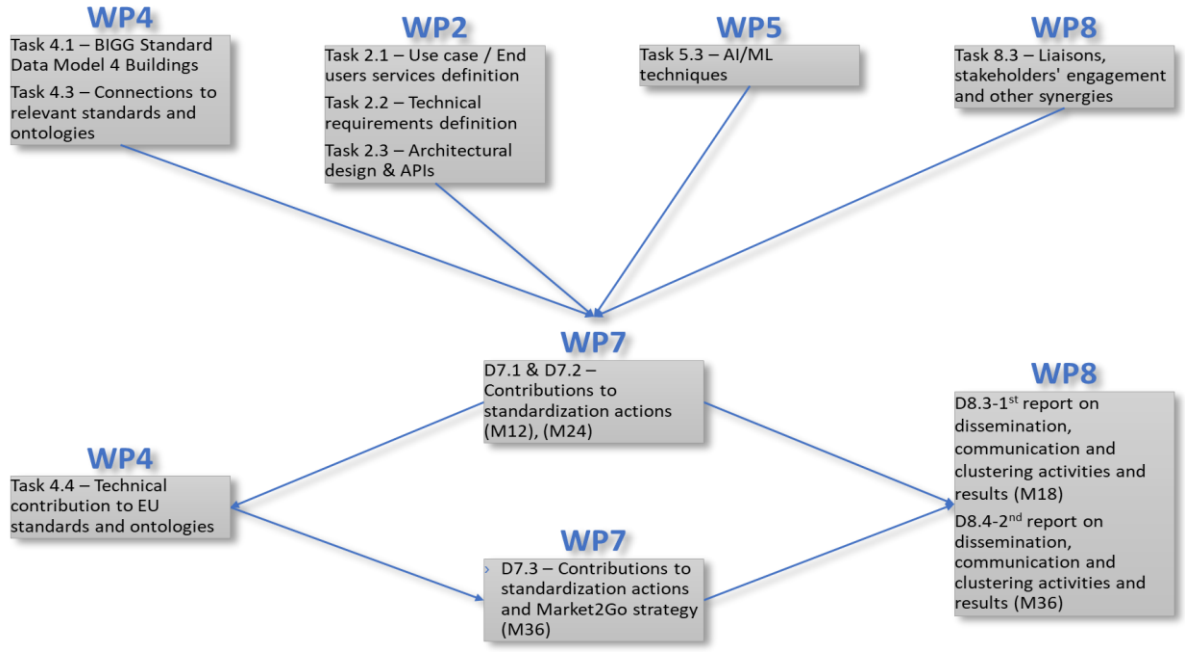

Figure 2 – Connection of D7.1 with other tasks and deliverables

II.3.1. Organization of Task 7.1

Task 7.1 production is organized around three main activities:

- Origination of Standardization Workshops.
- Cooperation with other WP/Tasks

- Specific standard meeting (with selected partners).

Standardization Workshops aim at:

- Defining the role of the different partners in the task (roles can evolve during the project).
- Identifying the standards & standardization committees of interest for the project
- Identifying the partners best suited for the collaboration with the different committees.
- Identifying the potentially standardizable outcomes
- Defining the potential contribution strategies

The first standardization workshop was held on the 2nd of August 2021, 10-12 am, with partners from ECTP, CIMNE, HERON, and CSTB. The main outcomes of this workshop are:

- The definition if the role of the different partners with respect to standardization:
    - CSTB focus is on BIM standardization, especially connected to buildingSMART International standards and Building Linked Data community.
    - CIMNE also involved in BIM standardization, but more oriented towards Energy Simulation aspects.
    - ECTP itself is not directly involved in standardization activities but can rely on their members for connection to specific standardization committees, and also for dissemination and communication of the project's outcomes.
- The preliminary identification of interesting standards and committees (see next chapter).
- The definition of relations with other partners, work packages (see previous chapter).

A second standardization workshop was held on the 8th of November 2022, 10:30 to 12 am. This workshop was organized by ECTP partner in collaboration with WP8 and was dedicated to creation and first round the table discussion of a "sister projects standardization community". Identified sister projects are presented in section II.4.1.d. and a description of the workshop itself is given in section

II.4. Standardization phases

In this part of the document, we will detail each Phase of the process presented in section II.1. above, and present the effective outcomes of our work. Naturally, for this "Initial contribution to standardization", most of the work was related to the first phases, the other will be addressed later in the project.

II.4.1. Phase 1 – Requirements lead to standards

The main objective of this first phase is to Identify the "standardization needs" of the project. By analyzing the requirements and the use cases, partners identify their needs, and try to map them with existing standards. This work has been done simultaneously in different Work packages.

In WP4, Task 4.1 focuses on the definition of a central data model for BiGG. To meet the requirements and the use cases, this data model should aggregate information about

buildings, buildings usage, building energy performance, measurement equipment installed in the buildings, geolocation and weather conditions. WP4 partners have developed a dedicated model, which is the aggregation of parts of existing standards, in particular:

- IFC
- SSN/SOSA
- geoSPARKL
- SAREF / SAREF4CITY
- UNIFORMAT2

In WP3, for the harmonization layer, we need to transform incoming JSON data in order to map them with the BiGG data model.

- RML

These international standards are developed and managed by different specializes pre-standardization or standardization committees:

- buildingSMART International
- CEN/T442
- ISO/TC 59/SC 13
- W3C
- OGC

In WP5, a very interesting standard measurement and verification protocol has been identified and will be used as a reference in the analyses of buildings performances:

- IPMVP

The study of the use cases in WP6 shows that several international initiatives are closely related to BiGG project, in terms of unified methodology and recommendations or shared data base:

- DEEP
- INSPIRE
- AIOTI
- bSI Use Case Management platform

Some other have been identified during brainstorming session of T7.1, but not yet studied:

- EU Building Stock Observatory
- ETSI SmartM2M Technical Committee
- CEN-CENELEC Focus Group on AI
- EU Build stock observatory
- bSF group on exploitation

II.4.1.a. Identified standards

For each identified standard, a template table has been filled in, and will be updated along the project, in particular the following fields:

- Use for BIGG: How this standard can be used in BiGG project?
- Limitations: Have we identified some limitations for our use?
- Potential improvements: Which improvements / modifications could we provide?

Table 1 – IFC description

Standard name	IFC
Full name	Industry Foundation Classes
Version	4.0.2.1 (Version 4.0 - Addendum 2 - Technical Corrigendum 1)
Status	ISO 16739-1:2018
Documentation	https://standards.buildingsmart.org/IFC/RELEASE/IFC4/ADD2_TC1/HTML
Ontology	https://standards.buildingsmart.org/IFC/DEV/IFC4/ADD2/OWL/index.html
Formats	Express, XSD, RDF, TTL
Description	The Industry Foundation Classes, IFC, are an open international standard for Building Information Model (BIM) data that are exchanged and shared among software applications used by the various participants in the construction or facility management industry sector. The standard includes definitions that cover data required for buildings over their life cycle. This release, and upcoming releases, extend the scope to include data definitions for infrastructure assets over their life cycle as well.
Maturity	• Widely used for building design and construction phases • Starting to be used in building exploitation phase
Competitors	• Standards • Non standards: Revit file format
Use for BIGG	• IFC model will be used as input for the BIGG data model. • A part of IFC ontology is used to describe the building structure in the BIGG data model.
Limitations	• All equipment are not described with the same level of details
Potential improvements	• Define a more homogeneous description of all building equipment.
Committees	buildingSMART International (Table 9), CEN/TC 442, ISO/TC 59/SC 13

Table 2 – SOSA description

Standard name	IFC
Full name	Semantic Sensor Network Ontology / Sensor, Observation, Sample and Actuator (SSN/SOSA)
Version	OGC 16-079 / W3C Recommendation 19 October 2017
Status	W3C recommendation
Documentation	https://www.w3.org/TR/vocab-ssn/

Ontology	https://github.com/w3c/sdw/blob/gh-pages/ssn/rdf/sosa.ttl
Formats	RDF, TTL
Description	The Semantic Sensor Network (SSN) ontology is an ontology for describing sensors and their observations, the involved procedures, the studied features of interest, the samples used to do so, and the observed properties, as well as actuators. SSN follows a horizontal and vertical modularization architecture by including a lightweight but self-contained core ontology called SOSA (Sensor, Observation, Sample, and Actuator) for its elementary classes and properties. With their different scope and different degrees of axiomatization, SSN and SOSA are able to support a wide range of applications and use cases, including satellite imagery, large-scale scientific monitoring, industrial and household infrastructures, social sensing, citizen science, observation-driven ontology engineering, and the Web of Things. Both ontologies are described below, and examples of their usage are given.
Maturity	• *[TO BE EVALUATED]*
Competitors	• Standards: • Non standards:
Use for BIGG	• SOSA model will be used as input for the BiGG data model. • A part of SOSA ontology is compatible with BiGG data model to describe the sensor network and measurements context in the
Limitations	• BiGG has its own measurement model but is it aligned with SOSA
Potential improvements	• Stable
Committees	W3C, OGC

Table 3 - IPMVP description

Standard name	**IPMVP**
Full name	International Performance Measurement and Verification Protocol
Version	Published in three volumes until 2012 Since 2015, published as the IPMVP Core Concepts. Several sections • Renewables: EVO 10200-1:2016 • Uncertainty Assessment for IPMVP: EVO 10100-1:2018 • M&V Issues and Examples: EVO 10300-1:2019 • M&V for Energy Performance contracting (in preparation)

	• Program Evaluation M&V (in preparation) • Non routine Events and Non-Routine Adjustments in M&V (in preparation) • Water Application (in Preparation)
Status	Additional concepts in preparation
Documentation	https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp
Ontology	*[NOT APPLICABLE]*
Formats	*[NOT APPLICABLE]*
Description	The **International Performance Measurement and Verification Protocol** (IPMVP®) defines standard terms and suggests best practice for quantifying the results of energy efficiency investments and increase investment in energy and water efficiency, demand management and renewable energy projects. The Protocol has become the national measurement and verification standard in the United States and many other countries, and has been translated into 10 languages. IPMVP is published in three volumes, most widely downloaded and translated is IPMVP Volume 1 Concepts and Options for Determining Energy and Water Savings. A major driving force was the need for a common protocol to verify savings claimed by Energy Service Companies (ESCOs) implementing Energy Conservation Measures (ECM). The protocol is a framework to determine water and energy savings associated with ECMs.
Maturity	• *[TO BE EVALUATED]*
Competitors	• Standards: • Non standards:
Use for BIGG	• The BIGG service will leverage the methodology proposed by the IPMVP when quantifying the savings generated by the implementation of an Energy Conservation Measure. Particularly in Business Case 4 and 5.
Limitations	• *[TO BE EVALUATED]*
Potential improvements	• *[TO BE EVALUATED]*
Committees	ONG Efficiency Valuation Organization (EVO)

Table 4 - geoSPARQL description

Standard name	**geoSPARQL**
Full name	Geographic Vocabulary and Query Language for RDF Data
Version	1.0 Approved 1.1 Draft

Status	Approved OGC Implementation Standard
Documentation	https://www.ogc.org/standards/geosparql (v1.0) https://opengeospatial.github.io/ogc-geosparql/geosparql11/spec.html#_normative_references (v 1.1)
Ontology	geo: http://www.opengis.net/#geosparql geof: http://www.opengis.net/def/function/geosparql/ w3cGeo: http://www.w3.org/2003/01/geo/wgs84_pos# geor: http://www.opengis.net/def/rule/geosparql/ sf: http://www.opengis.net/ont/sf#
Formats	RDF, geoJSON-LD. Compatible with geoJSON, KML, GML, WKT
Description	This ontology is related to other complementary OGC standards and ontologies : WKT, GML, WGS84
Maturity	• *[TO BE EVALUATED]*
Competitors	• Standards: • Non standards:
Use for BIGG	GeoSpatial data, geospatial context, geolocation (Buildings), geometry description (Buildings footprints parcels).
Limitations	Concerning geoSPARQL 1.0, various serializations of geometry data (e.g. KML, GeoJSON, GML) are still expected. Work remains in expanding GeoSPARQL vocabularies with axioms for logical spatial reasoning. Standard processes for converting GML file to RDF would be beneficial.
Potential improvements	The GeoSPARQL 1.1 release incorporates many additions requested of the GeoSPARQL 1.0 Standard, including the use of new serializations. Where GeoSPARQL 1.0 supported GML & WKT, GeoSPARQL 1.1 also supports GeoJSON, KML and a generic DGGS literal. GeoSPARQL 1.1 also supports spatial scalar measurements. Plans for future GeoSPARQL will be discussed and decided by the OGC GeoSPARQL Standards Working Group and related groups.
Committees	ISO, OGC (GeoSPARQL Standards Working Group), W3C

Table 5 - SAREF description

Standard name	**SAREF**
Full name	Smart Applications REFerence Ontology, and extensions
Version	V3.1.1
Status	Published

Documentation	https://saref.etsi.org/core/v3.1.1/
Ontology	https://saref.etsi.org/core/v3.1.1/saref.ttl
Formats	JSON-LD, N3, N-Triples, RDF/XML, Turtle
Description	The Smart Applications REFerence (SAREF) ontology is a shared model of consensus that facilitates the matching of existing assets in the smart applications domain.SAREF explicitly specifies recurring core concepts in the smart applications domain, the main relationships between these concepts, and axioms to constrain the usage of these concepts and relationships. SAREF has been created based on the following fundamental principles: • Reuse and alignment of concepts and relationships that are defined in existing assets • Modularity to allow separation and recombination of different parts of the ontology depending on specific needs • Extensibility to allow further growth of the ontology • Maintainability to facilitate the process of identifying and correcting defects, accommodate new requirements, and cope with changes in (parts of) SAREF
Maturity	Recommanded by ETSI
Competitors	SSN/SOSA (W3C and OGC standard)
Use for BIGG	Base for SAREF4BLD
Limitations	Less integrated to other W3C ontologies than SSN/SOSA. Overlaps with IFC and BOT.
Potential improvements	NA
Committees	ETSI

Table 6 - SAREF4CITY description

Standard name	**SAREF4CITY**
Full name	SAREF extension for Smart City
Version	V1.1.2
Status	Published (2020-06-05)
Documentation	https://saref.etsi.org/saref4city/ https://www.etsi.org/deliver/etsi_ts/103400_103499/10341004/01.01.02_60/ts_10341004v010102p.pdf
Ontology	https://labs.etsi.org/rep/saref/saref4city/-/blob/develop-v1.1.2/ontology/saref4city.ttl

Formats	JSON-LD, N3, N-Triples, RDF/XML, Turtle
Description	The present document is a technical specification of SAREF4CITY, an extension of SAREF [1] for the Smart Cities domain. This extension has been created by investigating resources from potential stakeholders of the ontology, such as standardization bodies (e.g. Open Geospatial Consortium), associations (e.g. Spanish Federation of Municipalities and Provinces), IoT platforms (e.g. FIWARE) and European projects and initiatives (e.g. ISA2 programme) as reported in ETSI TR 103 506 [i.1]. In addition, the use cases defined in [i.1] were also taken into account, namely: • Use case 1: eHealth and Smart Parking. • Use case 2: Air Quality Monitoring and Mobility. • Use case 3: Street Lighting, Air Quality Monitoring and Mobility. Taking into account ontologies, data models, standards and datasets provided by the identified stakeholders, a set of requirements were identified and grouped in the following categories: Topology, Administrative Area, City Object, Event, Measurement, Key Performance Indicator, and Public Service.
Maturity	Recommanded by ETSI
Competitors	SSN/SOSA (W3C and OGC standard)
Use for BIGG	Store results coming out the AI ToolBox
Limitations	Less integrated to other W3C ontologies than SSN/SOSA
Potential improvements	NA
Committees	ETSI

Table 7 - RML description

Standard name	**RML**
Full name	RDF Mapping Language
Version	V1.1.1
Status	Unofficial Draft 16 November 2022
Documentation	https://rml.io/specs/rml/
Ontology	NA
Formats	NA
Description	RML is a generic mapping language, based on and extending [R2RML]. The RDF Mapping language (RML) is a mapping language defined to express customized mapping rules from heterogeneous data structures and serializations to the RDF [RDF-CONCEPTS] data model. RML is defined as a superset of the W3C-standardized mapping language

	[R2RML], aiming to extend its applicability and broaden its scope, adding support for data in other structured formats. [R2RML] is the W3C standard to express customized mappings from relational databases to RDF. RML follows exactly the same syntax as R2RML; therefore, RML mappings are themselves RDF graphs.
Maturity	W3C standard
Competitors	SPARQL-Generate
Use for BIGG	Used in the Harmonizer components, allowing to map JSON input data to BIGG ontology concepts.
Limitations	Mapping on a per-source basis. Mapping on a per-format basis. Manual alignment.
Potential improvements	Complex operations (aggregating) can be handled by developing RML extensions
Committees	W3C

Table 8 – UNIFORMAT II description

Standard name	UNIFORMAT II
Full name	UNIFORMAT II The ASTM E1557 Building Standard
Version	E1557-09R20E01
Status	Active – Published in May 2020
Documentation	https://www.astm.org/e1557-09r20e01.html
Ontology	NA
Formats	PDF
Description	The UNIFORMAT II ASTM E1557 Standard provides a common structure linking the building program, specifications, and estimates through its classification for building elements and related sitework. Its integration in the design process results in improved communications and coordination among all project participants, an accelerated design, and significantly increased productivity.
Maturity	Considered to be quite high, as it has been in use for many years and is widely accepted in the construction industry.
Competitors	• MasterFormat and OmniClass
Use for BIGG	Classification for identification of specific elements in BIGG ontology.

Limitations	• It can be somewhat difficult to use for projects that are outside the scope of traditional construction, such as building renovations or repairs. • Additionally, because it is a hierarchical system, it can be challenging to accurately classify certain types of projects that do not fit neatly into the established categories
Potential improvements	NA
Committees	ASTM

II.4.1.b. Identified committees

For each committee responsible of an identified standard, a template table has been filled in, and will be updated along the project, in particular the following fields:

- Membership: How can we become member of this committee?
- Contribution strategy: How would we contribute to this committee
- Contributing partners: Which partners are already involved or plan to get involved, and what are their (actual or future) contributions

Table 9 – bSI description

Standardization committee	buildingSMART International
Type	BIM Pre-standardization
Standards	IFC, IDM, MVD, BCF, bSDD.
Web site	https://www.buildingsmart.org/
Description	buildingSMART is the worldwide industry body driving the digital transformation of the built asset industry. buildingSMART is committed to delivering improvement by the creation and adoption of open, international standards and solutions for infrastructure and buildings. buildingSMART is the community for visionaries working to transform the design, construction, operation and maintenance of built assets. buildingSMART is an open, neutral and international not-for-profit organization.
Membership	• Membership in buildingSMART International is open to companies, government bodies and institutions from around the world. buildingSMART International offers three levels of membership. Membership is required for those parties wishing to take an active role in the development of solutions to user or technical requirements. bSI members have voting rights in the standards committee. • Some partners of BIGG project are buildingSMART members: CSTB, …
Dynamism / activity	• Very active on standard evolution

	• 2 international Summits per year, plus tens of specific meetings • Serval new emerging project every year

Contribution strategy	• Become a member of bSI or local chapter.
	• Attend BIGG-related Working groups or Rooms meetings
	  ○ First to get information about the standards.
	  ○ Later to i) promote the use of standards in BIGG project, ii) suggest some modification/improvement of the standards, and iii) initiate de development of new standards.

Contributing partners	• CSTB:
	  ○ Member of buildingSMART France
	  ○ Participation in several working groups (to be detailed)
	  ○ Participation to biannual bSI Technical Summit
	• [Partner]:
	  ○ [Contribution actions]

Table 10 - CEN/TC 442 description

Standardization committee	**CEN/TC 442**
Type	BIM standardization
Standards	Idem ISO/TC 59/SC 13
Web site	https://standards.cencenelec.eu/dyn/www/f?p=205:7:0::::FSP_ORG_ID:1991542&cs=100E563A3950D53807585F6A443ACB202
Description	Standardization in the field of structured semantic life-cycle information for the built environment. The committee will develop a structured set of standards, specifications and reports which specify methodologies to define, describe, exchange, monitor, record and securely handle asset data, semantics and processes with links to geospatial and other external data.
Dynamism / activity	• *[TO BE EVALUATED]*
Membership	•
Contribution strategy	• *[TO BE DEFINED]*

Contributing partners	• CSTB
	  ○ Member of CEN/TC 442 (through AFNOR PPBIN group)
	• [Partner]:
	  ○ [Contribution actions]

Table 11 - ISO/TC 59/SC 13 description

Standardization committee	ISO/TC 59/SC 13
Type	BIM Standardization
Standards	ISO/DIS 7817 (LOIN), ISO 12006, ISO/CD 12911, ISO 16739 (IFC), ISO 16757, ISO 19650, ISO 21597, ISO 22263, ISO/TR 23262 (GIS / BIM interoperability), ISO 23386, ISO 23387, ISO 29481 (IDM).
Web site	https://www.iso.org/committee/49180.html
Description	ISO/TC59 is responsible for standardization in the field of buildings and civil engineering works. SC 13 is charged by TC 59 to focus on international standardization of information through the whole life cycle of buildings and infrastructure across the built environment: • to enable interoperability of information; • to deliver a structured set of standards, specifications and reports to define, describe, exchange, monitor, record and securely handle information, semantics and processes, with links to geospatial and other related built environment information; • to enable object-related digital information exchange.
Dynamism / activity	• *[TO BE EVALUATED]*
Membership	•
Contribution strategy	• *[TO BE DEFINED]*
Contributing partners	• CSTB ○ Member of ISO/TC 59/SC 13 (through AFNOR PPBIN group) • [Partner]: ○ [Contribution actions]

Table 12 - W3C description

Standardization committee	W3C
Type	Ontology standardization
Standards	RDF, OWL, FOAF, SKOS, DC, PROV, SOSA, QUDT, geoSPARQL
Web site	https://www.w3.org/standards/semanticweb/ontology
Description	The World Wide Web Consortium (W3C) is an international community where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C develops these technical specifications and guidelines through a process designed to maximize consensus about the content of a technical report, to ensure high technical and editorial quality, and to earn endorsement by W3C and the broader community. In addition to the classic “Web of documents” W3C is helping to build a technology stack : the Semantic Web. The Semantic

	Web is a Web of Data — of dates, titles, properties and any other data one might conceive of. The collection of Semantic Web technologies (RDF, OWL, SKOS, SPARQL, etc.) provides an environment where application can query that data, draw inferences using vocabularies
Dynamism / activity	• *[TO BE EVALUATED]*
Membership	Organizations join W3C to drive the direction of core Web technology and exchange ideas with industry and research leaders. Members can find additional information on the Member site (Member-only). W3C Standards are royalty-free to implement and do not require W3C Membership to use. If an organization has specific requirements, it would like to see addressed by Web Standards, then joining W3C and being active in the work is the best way to achieve that. https://www.w3.org/Consortium/join
Contribution strategy	The Member Submission process allows Members to propose technology or other ideas for consideration by the Team. After review, the Team may make the material available at the W3C Web site. The formal process affords Members a record of their contribution and gives them a mechanism for disclosing the details of the transaction with the Team (including IPR claims). The Team also makes review comments on the Submitted materials available for W3C Members, the public, and the media.
Contributing partners	• CSTB: ○ Member of the Linked Building Data Community Group

Table 13 - OGC description

Standardization committee	**OGC**
Type	Geospatial pre-standardization
Standards	CityGML
Web site	https://www.ogc.org/
Description	The Open Geospatial Consortium (OGC), an international voluntary consensus standards organization, originated in 1994. In the OGC, more than 500 commercial, governmental, nonprofit and research organizations collaborate in a consensus process encouraging development and implementation of open standards for geospatial content and services, sensor web and Internet of Things, GIS data processing and data sharing.
Dynamism / activity	• *[TO BE EVALUATED]*
Membership	•
Contribution strategy	• *[TO BE DEFINED]*
Contributing partners	• [Partner]: ○ [Contribution actions]

II.4.1.c. Identified initiatives

For each identified initiative, a template table has been filled in, and will be updated along the project, in particular the following fields:

- Membership
- Contribution strategy
- Contributing partners

Table 14 - DEEP description

Initiative	DEEP
Type	Europe's largest database of Energy Efficiency investment projects
Web site	https://deep.eefig.eu/ and https://eefig.ec.europa.eu/
Description	EEFIG comprises over 200 organizations working on energy efficiency investments throughout the European Union. These include financial institutions, investors, bank associations, energy efficiency practitioners, academia and other experts across the finance market. EFFIG works on defining the issue of energy efficiency investments in the context of the EU Energy Union strategy. For this, in 2017, EFFIG launched Europe's largest database of energy efficiency investment projects (DEEP). DEEP, De-risking Energy Efficiency Platform, is an open-source initiative to increase investments in energy efficiency in Europe through improved sharing and transparent analysis of existing projects in buildings and industry. Thus DEEP-Effig is a key initiative in the standardization of processes related to investments in energy efficiency projects in buildings at European level.
Dynamism / activity	• *[TO BE EVALUATED]*
Interest for BiGG	• Standardization of taxonomies of energy efficiency actions and/or projects. • Exchange data between BIGG and DEEP Platform (enriching both initiatives)
Membership	Membership in EFFIG is informal and open to financial institutions, investors, bank associations, energy efficiency practitioners, academia and other experts. But with expectations that members demonstrate their contribution to furthering the objectives of EEFIG, add value to the workings of EEFIG and have a commitment to strengthening the efforts for the European Union to meet its long-term climate and energy objectives through greater investments in energy efficiency. EFFIG Membership form: https://ec.europa.eu/eefig/join-us_en
Contribution strategy	• Becoming a member of EFFIG • Becoming a DEEP-EFFIG data provider
Contributing partners	• CIMNE: ○ DEEP data provider.

Table 15 - INSPIRE description

Initiative	INSPIRE
Type	Spatial data infrastructure policies and activities Directive
Web site	https://inspire.ec.europa.eu
Description	The INSPIRE Directive aims to create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure will enable the sharing of environmental spatial information among public sector organizations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries. To ensure that the spatial data infrastructures of the Member States are compatible and usable in a community and transboundary context, the INSPIRE Directive required that common Implementing Rules (IR) were adopted in a number of specific areas Metadata , Data Specifications , Network Services, Data and Service Sharing, Monitoring and Reporting. The INSPIRE coordination team consists of staff of the European Commission from DG Environment (as an overall legislative and policy coordinator) and the Joint Research Centre (JRC) (as the *overall technical coordinator*) and staff of the European Environmental Agency (EEA) (as EU level coordination)
Dynamism / activity	• *[TO BE EVALUATED]*
Interest for BIGG	• Adoption of spatial environmental and buildings data standards of INSPIRE Directive
Membership	• **Register as an expert** The MIG is complemented by a pool of experts drawn from the stakeholder community. The experts in this pool are called upon when MIG sub-groups are formed to address specific implementation or maintenance issues, but will also provide the opportunity to reach out to experts involved or interested in particular aspects of INSPIRE implementation or maintenance. The call is open to all individuals with a high level of expertise in one or several of the aspects relevant for INSPIRE implementation and maintenance.
Contribution strategy	• Becoming INSPIRE EXPERT • Participating in INSPIRE annual conferences • Contacting with national INSPIRE contact points https://inspire.ec.europa.eu/INSPIRE-in-your-Country
Contributing partners	• CIMNE: ○ Non-Monetary Agreement collaboration with JRC, involved in different projects and initiatives related with INSPIRE

Table 16 - AIOTI description

Initiative	AIOTI
Type	European Internet of Things ecosystem
Web site	https://aioti.eu/

Description	The Alliance for Internet of Things Innovation (AIOTI) was initiated by the European Commission in order to develop and support the dialogue and interaction among the Internet of Things (IoT) various players in Europe. The overall goal of the AIOTI is the creation of a dynamic European IoT ecosystem to unleash the potentials of the IoT. This ecosystem is going to build on the work of the IoT Research Cluster (IERC) and spill over innovation across industries and business sectors of IoT transforming ideas into solutions and business models. The Alliance will also assist the European Commission in the preparation of future IoT research as well as innovation and standardization policies. AIOTI leads, promotes, bridges and collaborates in IoT & Edge Computing and other converging technologies research and innovation, standardization and ecosystem building providing IoT deployment for European businesses creating benefits for European society. AIOTI co-operates with other global regions to ensure removal of barriers to development of the IoT & Edge Computing market, while preserving the European values, including privacy and consumer protection.
Dynamism / activity	• *[TO BE EVALUATED]*
Interest for BiGG	The project BIGG implies the use of big data technologies, as well as IoT, for the complete buildings life-cycle. Thus, it seems necessary to be aligned with recommendations and standards on IOT. AIOTI collaborates on different levels with a range of organizations at European and international level, as well as with standardization activities (CEN/CENELEC, OGC, ETSI SmartM2M, …). Furthermore, being member of the AIOTI will offer the opportunity to influence the requirements development, technology adoption, and future direction of the IoT by joining with leaders in technology, R&D and academia in AIOTI Groups. The Working Group 13 **Smart building & Architecture** seems to be aligned with the topics tackled by the project. It covers IoT technologies and solutions deployed in buildings and districts of buildings to improve life of the occupants by addressing and optimising elements such as comfort, light, temperature, air quality, water, nourishment, fitness and energy usage. • Identified Horizontal Groups that could be of interest for BIGG: ○ **Digital for Green** (aioti.eu/dfg/). The scope of this group is to define the value of using IoT and edge computing in supporting Green Deal policies. ○ **Policy and Strategies** (aioti.eu/wg_ps/). To further contribute to a stable, predictable, reliable and enabling IoT Policy Framework across Europe which will stimulate innovation, build trust and dynamic assurance while mitigating risk, accelerate human-centric IoT uptake and thus strengthen European society, economy, resilience and competitiveness. ○ **Standardization** (aioti.eu/wg_standardization/). This group aims at being recognized as a major contributor to the worldwide interoperability, security, privacy and safety of IoT systems and applications, and particularly for the development of the market in Europe. More specifically, two activities could be aligned with *BIGG: WP2 High Level Architecture and WP5 Security (in cooperation with WG Policy & Strategies*). • Identified Vertical Groups that could be of interest for BIGG: ○ **Buildings** (aioti.eu/wg_buildings/) (covering all types of buildings, residential and non-residential, as well as existing buildings and newly

	constructed buildings). The purpose is to work on the application of IoT solutions and understand how they can benefit the various stakeholders, the occupants being top priority.
Membership	AIOTI has two membership types: • **Full member.** Any legal entity can become Full member, enjoying tall membership rights, including voting rights at the General Assembly as well as the right to be elected in the Management Board. Two of the criteria required to become a Full member are to be involved in Europe based research and development, innovation, demonstration, industrialization, deployment or standardization of technologies and services related to or relevant for the IoT; or to Contribute as a partner in projects of a European Framework Program for Research and Innovation. • **Associate member.** Any legal entity (including any public entity and/or public administration) can become an Associate member. However, Associate members cannot vote at the General Assembly or be elected in the Management Board.
Contribution strategy	Being part of the AIOTI community will be a dissemination tool for the project. A member has the opportunity to participate in AIOTI events and receive special discounts on third-party IoT conferences, reports and subscriptions, where to promote BIGG. AIOTI members will benefit from: access to reports, white papers, industry scenarios and other deliverables produced by the AIOTI; network with other members and industry experts to create collaborations and improve your business; create and lead new testbeds or join existing AIOTI-member testbeds.
Contributing partners	• [ECTP: ○ ECTP is already member of AIOTI. Thus, an ECTP member (to be named at a larger state) could take advantage of it in order to communicate about BIGG and establish a link with AIOTI ecosystem.

Table 17 - UCM description

Initiative	UCM
Full name	Use Case Management
Type	buildingSMART International project
Web site	https://ucm.buildingsmart.org/use-case-management
Description	The Use Case Management of buildingSMART has the goal to exchange experiences from already implemented or ongoing BIM/VDC projects among experts. Thus, a best practice is generated from individual practical experiences. Use cases are not related to individual project phases but consider the entire value chain (planning / construction / operation / deconstruction). Each Use Case follows a clear objective and focuses on a specific outcome or benefit. The information requirements for the various actors are determined for each project phase. It is defined who needs what information at which point of time in which format and in which level of detail in order to achieve a specific result.

Dynamism / activity	• *[TO BE EVALUATED]*
Interest for BiGG	• Develop a standard description of the of the project's Use Cases • Exchange experiences around Use Cases development
Membership	• For members of bSI or active members in a bSI Room: to start a project with the UCM, just contact bSI and get full access to the UCM Co-Creation Space for free. • Companies, associations, and institutions can purchase access to the UCM and develop your own brand inside the platform • Chapter leader or part of a buildingSMART Chapter: help develop the UCM for your region and better help support your end-users.
Contribution strategy	• To be defined
Contributing partners	• [Partner]: ○ [Contribution actions]

II.4.1.d. Identified "Sister projects"

Table 18 – BUILTHUB description

Sister project	BUILTHUB
Full name	Dynamic EU building stock knowledge hub - BuiltHub
Type	4-year European Project funded under the Horizon 2020 programme
Web site	https://builthub.eu/
Description	The EU-funded BuiltHub project will define a roadmap and vision for a durable data flow to characterize the EU building stock and support its decarbonization. For this purpose, the project will develop an organized and inclusive data collection method in a easy-to-access-and-use datahub platform. The web-based BuiltHub platform will ensure and support a long-lasting data flow through a benefits-based engagement strategy of potential beneficiaries and users such as data and metadata providers and simple users. The strategy will be applied through the development of value information services around data transformation and interpretation tailored to platform users.
Contact partners	• Filippi Oberegger Ulrich, Senior Researcher in the Energy Efficient Buildings group of Eurac Research (ulrich.filippi@eurac.edu) • Abel Muñoz Alcaraz, Solution Specific Knowledge Leader at NTT Data (abel.munoz.alcaraz@nttdata.com)

Common research topics	• Platform to feed in and extract data for designing more effective building • Building performance data collections • Standardised data management approach for a reliable building stcok status • EPBD, European performance of buildings directive • EU Building Stock Observatory
Standardization collaboration opportunities	• [TO BE DEFINED IN D7.3 – M36]
Contribution strategy	• [TO BE DEFINED IN D7.3 – M36]

Table 19: MATRYCS description

Sister project	MATRYCS
Full name	Modular Big Data Applications for Holistic Energy Services in Buildings
Type	3-year European Project funded under the Horizon 2020 programme
Web site	https://matrycs.eu/
Description	The EU project MATRYCS aims to capitalise and combine existing modern technological breakthroughs in the areas of ML / DL and big data, in order to develop a new decision-making and data analytics solution for energy-efficient buildings. MATRYCS will realise a holistic, state-of-the-art AI-empowered framework for decision-support models, data analytics and visualisations for Digital Building Twins and real-life applications. The overall vision of MATRYCS is to define and deploy a Reference Architecture for Buildings Data exchange, management and real-time processing, and to translate this reference architecture into an Open, Cloud-based Data Analytics Toolbox (MATRYCS Modular Toolbox). It will enable AI-based cross-sector analytics for smart energy-efficient buildings through three layers, MATRYCS-GOVERNANCE, MATRYCS-PROCESSING and MATRYCS-ANALYTICS.
Contact partners	• Francesco Saverio Nucci, Application Research Director at Engineering R&D Labs (Francesco.Nucci@eng.it) • Vaggelis Marinakis, Assistant Professor at NTUA (vmarinakis@epu.ntua.gr)
Common research topics	• Open Data analytics Toolbox • Interoperability framework • Data-driven Reference Architecture for AI-based big data management and analytics • Validation of big data platform through large-scale pilots • EU Building Stock Observatory

	• Exploitation and business cases development
Standardization collaboration opportunities	• [TO BE DEFINED IN D7.3 – M36]
Contribution strategy	• [TO BE DEFINED IN D7.3 – M36]

Table 20: BEYOND description

Sister project	**BEYOND**
Full name	A reference big data platform implementation and AI analytics toolkit toward innovative data sharing-driven energy service ecosystems for the building sector and beyond
Type	3-year European Project funded under the Horizon 2020 programme
Web site	https://beyond-h2020.eu/
Description	BEYOND H2020 project develops and offers a big data platform and a set of technologies that allow a data consumer to search, find and utilize data generated by buildings (data owners). Based on these, the data consumers can run analytics and simulations that are actually needed to design a project and exploit them during the real-time operation of the buildings to optimize their operation and energy performance. Beyond that, the whole process is concluded between the data providers and data consumers under a data smart contract that allows a data provider to get remunerated. On the other hand, the data consumer can satisfy its business functions while at the same time can run analytics on this data and gradually, turn into a data provider itself by making available these insights to other stakeholders in the energy market.
Contact partners	• Tasos Tsitsanis, Business Development Director at Suite5 (tasos@suite5.eu)
Common research topics	• Big data reference architecture and platform to allow consumers to find and utilize date generated by buildings • AI Analytics Toolkit • Validation of big data platform through large-scale pilots • Interoperability framework • Business models driven by big data • Standardization
Standardization collaboration opportunities	• [TO BE DEFINED IN D7.3 – M36]
Contribution strategy	• [TO BE DEFINED IN D7.3 – M36]

II.4.2. Phase 2 – Adopting the standards

The main objective of this second phase is to adopt the identified standard by participating to standardization events, committees' meetings, domain conferences, etc.

By attending these events, partners can provide interesting inputs about standards, use cases, future evolution to the whole consortium.

When no partner is already involved into certain committees, ECTP partner can rely on its many members to try to find the right entry point and ensure an easy access to the committee events or contents. A specific procedure will be defined and initiated during the second year of the project.

The following table will be updated all along the project in order to map the active participation of project partners to standards related events.

Table 21 - Partner participation to standardization committees

Standardization event	Partner	Standards	Interest for the project
buildingSMART International Technical Summit Spring 21	CSTB	IFC	Better understanding of the very last and future developments of IFC standard
LDAC2021 / CIB W78	CSTB	IFC and related ontologies	Awareness of the very last "state of the art" use case and standards developments
Webinar - Leveraging on standardisation for building data aggregation and analytics, Tuesday 8th November	CSTB, Heron, ECTP, Inetum	Building ontologies	Initiation of collaboration with sister project on contribution to standardisation.
buildingSMART International Virtual Summit Spring 2022	CSTB	IFC	Better understanding of the very last and future developments of IFC standard

II.4.3. Phase 3 – Using standards & Building standardizable outcomes

The main objectives avec the third phase is to use the standards in the technical developments of the project and identify the potentially "standardizable" outcomes.

During the technical developments done in the project, the following components have used some standards:

- BIGG Data Model: the objective of Task 4.1 is to develop a central data model organizing data coming from all use case. For that, a dedicated ontology has been produced, based on several concepts found in existing standards:

    - Building spatial structure and building / system components, as well as group / zone concept are taken from ISO 16739 (IFC).
    - Sensors, measurements and observers' concepts are taken from SSN/SOSA Ontology.
    - AI toolbox results will be stored in the model using SAREF4City concepts.

- Harmonizer: Due to the large number of use cases, one of the main challenges of this project was to be able to map data coming from the use cases into the BiGG Data Model. For that purpose, WP3 developed an “Harmonizer” which transforms data JSON data from the use cases to RDF model corresponding to BiGG ontolology. This was achieved by developing a two stages component:
    - JSON2RDF: developed using RML standard.
    - RDF2RDF: developed using SPARQL standard.

During the last PMB meeting in October 2022, a session was dedicated to the development of a list of project outcomes. From that list, we have initiated a table that will be used and completed during the last year of the project, to select the more interesting outcomes that should be pushed towards standardization (see figure just below).

Table 22 : List of standardizable project outcomes

BiGG Asset	Action Type	Description	Standard / Committee / Entity	Project Component (WP)	Related Use Cases	Involved partners	What we are using	What we need	Who can help	What is our contribution	What is our strategy
BiGG Data Model	Use Standard	BiGG Ontology uses IFCOWL concepts	buildingSMART International	WP4		CIMNE, CSTB	Spatial structure elements, groups and zones	Attend bSI Technical Summits			
BiGG Data Model	Use Standard	BiGG Ontology uses SOSA concepts		WP4							
BiGG Data Model	Contribute - Publication	Publish BiGG ontology		WP4							With sister projets?
BiGG Data Model	Use Standard	Develop a mapping between BiGG ontology and existing concepts		WP4							
BiGG Data Model	Build standardization Group	Compare BiGG ontology with other projects		WP4 / WP8		CIMNE, CSTB, ECTP					
AI Toolbox	Use Standard	AI Toolbox uses IPMPV method									
Harmonizer	Use Standard	Harmonizer uses RML		WP3 / WP4		CSTB	JSON to RDF conversion				
Harmonizer	Use Standard	Harmonizer uses SPARQL		WP3 / WP4		CSTB	RDF to RDF conversion				
Harmonizer	Contribute - Demo	Demonstrate Harmonizer principle & capacities		WP3 / WP4		CSTB	RDF to RDF conversion				
	Use Standard	??? Uses UNIFORMAT2 classification									
	Contribute - Publication	Publish some BiGG Uses Cases	bSI Use Case Management								
Use Cases											
KPIs											

II.4.4. Phase 4 – Contribution to standardization

The fourth and last phase aims at actively contributing to the standardization world. All important achievement of the project relative to standardization should be made public, presented, and demonstrated to standardization community.

We've identified three main types of active contribution, which are detailed in the sections below.

All along the project, when the standardizable outcomes of the project is available, the following sections will be filled to describe how BiGG project have been contributing to standardization.

As standardization actions can sometimes be difficult to run on our own, we have initiated the creation of a standardization community with sister projects and run a first common standardization workshop presented in the next section.

II.4.4.a. Creation of a "Standardization sister projects community"

Here is the description of the first even organised with our new standardization community.

TITLE OF THE WORKSHOP: "Leveraging on standardisation for building data aggregation and analytics"

DATE: November 8, 10:30 – 12:00 CET

HOST&MODERATOR: BuildUp (more than 10K subscribers and ~700 Youtube subscribers)

AGENDA: 1h 30

1) Welcome and BuildUp presentation (5 min)
2) Introduction of the agenda
3) Pitch of 4 EU projects (4 x 7min): introduction of the project+what has been done/overall plan in terms of standardisation
    - BIGG
    - BEYOND
    - BuiltHub
    - MATRYCS
4) Roundtable (40 min) -> 3-4 questions
5) Questions of the audience (5-10 min)
6) Wrap-up and potential next actions around the community of standardisation (5 min)

Figure 3 - First standardization workshop with sister projects

FOCUS OF THE WORKSHOP

The aim of the discussion will be to:

- share each project's vision of contribution to standardisation,
- identify the common subjects and ideas that could be pushed to standardisation,
- identify similar structures among the projects that could help to influence the standards,
- co-define together the founding principles and operational mechanisms of the Community of Standardisation.

The workshop will set the basis of the "sister projects community" and will expose:

- the intention of taking part together in actions organised by standardisation bodies and regulators
- and how the projects can approach, participate in them and actively contribute to standardisation.

QUESTIONS FOR THE ROUNDTABLE

- How to identify the outcomes of a project that should be pushed to standardisation?
- What's the best way for an EU project to approach and contribute to standardisation committees?
- How could a "sister project community" improve our standardisation impact?
- How can we collaborate among the projects to co-develop a common ontology?

Attendance

- Attendees: 32
- Registrants: 51
- Attendance rate: 63%

Presentation & recoding of the workshop

Slides: https://www.buildup.eu/en/news/webinar-leveraging-standardisation-building-data-aggregation-and-analytics

Recording: https://www.youtube.com/watch?v=j9ShPrx6lLE (69 viewers on 22/11/22)

II.4.4.b. Demonstrating standard use

Whenever it is possible, standards implementation and use by BiGG project should be demonstrated to experts and public. This could be done by:

- Participating to a technical standardization meeting, with the opportunity to present the specific standard implementation done in the context of BiGG project.
- Submitting a scientific paper to specialized journal.
- Submitting an article to a domain conference.

II.4.4.c. Suggesting standards modification / extension / linking

During the implementation of a standard for BiGG project, some limitations may be identified, and some modification / extension proposed. In this case, it would be very important to share these elements with responsible standards committees.

II.4.4.d. Submitting new standards

Finally, if the need for a new standard arises from the project, it would be very interesting ta, at least, initiate the submission process for these standards, and see how it can be handled after the end of the project (standardization process can be quite long).

SAREF Extension: During the development of BiGG data model, we used some concepts coming from SAREF ontology, but we've also added some concepts that we needed for our Use Cases. These additions could be submitted to SAREF community as an extension. This option will be analysed and discussed during the last year of the project.

II.5. Recommendations about standardisation

As a conclusion to this report, we found it useful to give some recommendations. First about the general management of standardization actions during a European project, and then more specifically about the standards that, from our point of view, should be considered to implement an efficient BIM-based building life-cycle analysis project.

II.5.1. Efficient standardization during European Projects

Performing an efficient and well-structured contribution to standardization during a European Project can be quite challenging, and often make it difficult to find a common direction to follow. The main difficulties come from:

- The very large number of subjects, technologies, and areas covered by the project
- The very slow standardization development process can be incompatible with project timing
- The large number of different types of actors involved in the project.

- But standardization is essential to the collaboration between construction stakeholders, and we believe that some quite simple actions can make it more efficient:
- Do not try to address all standardization aspects covered by the project at the same time. It is way more efficient to prioritise subjects, starting with the ones that should bring the most valuable standardization contribution.
- The duration of a European project being between 3 and 4 years, it would be very difficult to develop entirely a new standard and push him to standardization (unless the standardization process can be carried on by some partners after the project, or by another project). This is why we should focus on the identification and use of existing standards, and also the dissemination of the use of the standard that was made during the project.
- Try to involve as many partners as possible
    - Diversity of standardization approaches is often very constructive
    - SME participation in standardization should be ensured for these standards to be adapted to SME needs and widely used
- Organize dedicated workshops, really focused on standardization. It is often much more efficient than a standardization timeslot in a general project meeting.
- Try to create / animate standardization communities
    - With sister projects sharing some common standardization needs or goals.
    - By organizing joint workshops (dedicated sessions) in domain conferences.
    - Try to periodically reconsider some under-development standards. Some of them may have evolved and be of interest for the project.

II.5.2. Important standards for building life-cycle analysis project.

Finally, from what we've learned during this project, here is a list of what we think are the most important standards for BIM-based building life-cycle analysis project [this in a first version of this list, it will be finalized in the last version of this deliverable, due at the end of the project]:

- To ensure the best overall Interoperability between software and platforms, IFC format should be used whenever it is possible for the description of building structure (IFC ontology version).
- SSN/SOSA and SAREF (with extension) seems to be very well adapted to the modeling of sensor devices, exploitation data and analysis results.
- Finally, it appears very useful to consider buildingSMART Use Cases Management (UCM) platform for all projects related to BIM. First to see if the use cases we consider using in our project had not been already standardized (huge time saving), and then to publish new use cases specifically developed for our project.

II.6. Alignment between T7.1 and T8.3

From the submission of this deliverable onwards, synergies will be created between T7.1 and T8.3 *Liaisons, stakeholders' engagement and other synergies*. The two main objectives of T8.3 are:

- to make sure that BIGG tools are aligned with the existing standards and regulations. Even though a 1st listing of potential standards and regulations has already been identified in the early stages of T8.3, they will mostly be identified during the work carried out in the technical WPs of the project and in particular within T7.1.

- to influence policymakers, regulation bodies, standardization bodies and experts (energy sector companies CTOs/CIOs, ICT-providers, …) in the building sector, so that they take into account the findings or recommendations made by BIGG within future standards and regulations. This shall favor the market opportunities for big data and AI solutions.

Table 23 - Standardization bodies and regulators identified in T8.3

Standard	Some key elements
INSPIRE	Create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment.
CEN/TC 442	BIM, Structured semantic life-cycle information for the built environment. A structured set of standards, specifications and reports which specify methodologies to define, describe, exchange, monitor, record and securely handle asset data, semantics and processes with links to geospatial and other external data.
CEN/TC 442 / prEN 17632	CEN Semantic Modelling and Linking Standard (SMLS) for data integration in the built environment
EN ISO 23386	Development of properties using dictionaries
EN ISO 23387	Data Templates for Construction Objects
SAREF	Smart Appliances REFerence ontology. A shared model of consensus that facilitates the matching of existing asset (standards/protocols/data models/etc.) in the smart appliance domain
Industry Foundation Classes (IFCs)	Standardized, digital description of the built asset industry (open, international standard: ISO 16739-1:2018)
ISO/TC 59/SC 13	Organization and digitization of information about buildings and civil engineering works, including BIM
ETSI SmartM2M Technical Committee	Developing standards to enable “Machine-to-machine” services and applications and certain aspects of the IoT
CEN-CENELEC Focus Group on AI	European Committee for Standardization (CEN); European Committee for Electrotechnical Standardization (CENELEC)

Therefore, T8.3 will organize different actions in order to reach out the organizations identified in WP7 (and more broadly by the whole project). The goal will be to showcase the BIGG tools, their usability for different business cases as well as their market potential.

This will be based on a stakeholder’s analysis and mapping, done together with WP7. In this framework, surveys and interviews will be conducted.

As part of the Communication and Dissemination work package (WP8), T8.3 aims at communicating about events and ensuring the participation of Consortium Partners to other initiatives, working groups, etc. such as:

- initiatives suggested by the European Commission (e.g. BRIDGE),

- projects funded under the same call
- standardization bodies meetings
- information meetings
- training
- other dissemination events (e.g. contractors' workshops, briefing days, etc. related to H2020)
- …

As a first step, it is planned to organize an internal workshop (i.e. within the Consortium) during the first quarter of 2022, that will focus on the target policies, regulations and directives identified so far. The Partner will discuss their relevance, how BIGG is related, how BIGG could influence them for their potential improvement, etc. In addition, the Partners will agree on an action plan to approach and collaborate with the groups/persons in charge of those policies. It is expected that for each policy, regulation or directive, a BIGG Partner will be designated as main contact point.

Table 2. Influence policies and directives identified in T8.3

Topic	Policies / legislations / directives	Some key elements
Energy consumption of buildings	Energy Performance of Buildings Directive (EPBD, 2010 - revised 2018)	Decarbonize the national building stocks by 2050 Support massive buildings renovation & modernization (promote smart technologies + installation of building automation & control systems + health/well-being) Common EU scheme for rating the smart readiness of buildings -> SRI
	Energy Efficiency Directive (2012)	Promotes: Zero-emission building stock target by 2050; SRI; E-mobility infrastructure; Tackle energy poverty Protect consumers' right to receive easy & free access to data on real-time and historical energy consumption Rules on metering & billing of thermal energy (simpler & clearer for consumers)
	Renewable Energy Directive	Make households and energy communities become clean energy producers
	Regulation & Directive on the Internal Market for Electricity	More flexibility to integrate an increasing share of RenE in the electricity grid Smart meter and a dynamic price contract (clearer & cheaper for consumers)
	Fit for 55 Package?	
Waste management and the circular economy	Waste Framework Directive (2008/98/EC)	Framework towards a European recycling society (high resource efficiency, increase construction & demolition waste re-use/recycling/recovery
	EC's Circular Economy Action Plan 2.0 (2015)	Includes measures to stimulate Europe's transition towards a circular economy Identification of Construction as key sector

		Incorporation of circular economy & life cycle principles in the design/construction of new/renovated buildings
EU Strategic Energy Technology Plan	Strategic Energy Technology Plan (SET-Plan)	Accelerate the development & deployment of low-carbon technologies
	EC's Communication for an Integrated Strategic Energy Technology Plan (2015)	Identify 10 priority actions to accelerate the energy system transformation
Policy framework for climate neutral cities	Pathway towards Positive Energy Districts (defined in SET Plan Action 3.2)	Targets at least 100 Positive Energy Districts (PED) deployed in Europe and synergistically connected to the energy system by 2025
	EC Mission for Climate Neutral & Smart Cities	By 2030, 100 cities should reach a net zero greenhouse-gas-emission balance
	Urban Agenda for the EU	City led partnerships and initiatives in the areas of Circular Economy, digital and energy transition. Many of the pilots could be improved through R&I and scale up.
Policy framework for decarbonized transport & related infrastructures	Roadmap to a Single EU Transport Area ("Towards a competitive and resource efficient transport system"), 2011	10 goals to reduce by min. 60% by 2050 transport sector's GHGs (compared to 1990) Relies on cleaner urban transports and modal shifts, and the required adaptation of the related infrastructures
Directive for industry	EU Energy-Intensive Industries' 2050 Masterplan	Sets out how EU industry can become climate-neutral while staying competitive.
Directive for finance	Sustainable Finance Action Plan and EU Green Taxonomy	Tool to reorient capital flows towards sustainable investment Buildings are identified in the Taxonomy as "a critical cross-cutting issue" with "relevance to the emissions performance of almost all economic activities"
Other	Paris Agreement on Climate (COP21)	Common legally binding agreement Integrated with frameworks for action on resilience and adaptation
	EU Green Deal	Renovation wave' and circular economy are among the key focus
	Clean Planet for all	Spatial planning supporting reduced pollutant concentrations

III. EXPLOITATION FRAMEWORK: MARKET ANALYSIS AND PROPOSED BUSINESS MODEL APPROACH

The purpose of this section of the deliverable is to lead the market analysis of each Use Case developed in BIGG and extract the appropriate Exploitable Results that will be further elaborated as business models in D7.3.

III.1. Activities included in the BIGG Exploitation Strategy

The activities are represented in the diagram below:

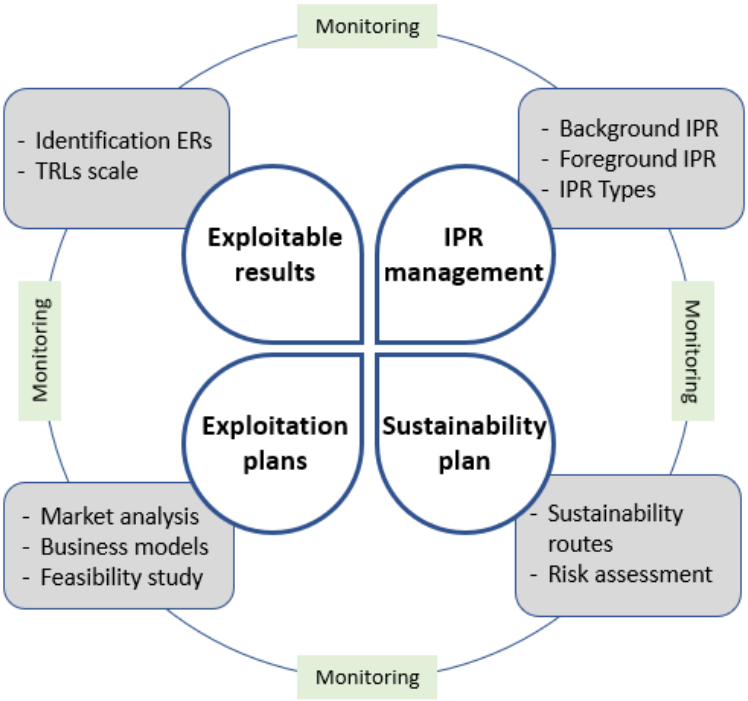

Figure 4 – BIGG project exploitation activities

III.1.1. Identification of exploitable results

Having described each step of the process shown in Figure 4 in D7.1, D7.2 carries the first and second steps of the process which aim to identify the exploitable results and proceed with their market analysis before evaluating the business models using the Business Model Canvas and SWOT methods already introduced in D7.1.

As part of D7.2, this process has been reversed, with the first step now supporting the partners in drafting the Market Analysis of each Use Case they lead or are the main contributors, which in turn is used to identify the exploitable results of the project.

Leading to a workshop conduced in parallel to the BIGG PMB meeting held in Lyon from 22/10/2022 to 24/10/2022 virtual meetings were organised to collect feedback from each consortium partner on the UC Market Analysis. It should be noted that the Market Analysis focuses on Use Cases that can lead to specific Exploitable Results and not on Use Cases which aim to support Use Case without concrete and marketable Exploitable Results.

III.1.2. Market Analysis

BIGG project is conceived with the objective to enable the collection, exchange, and to increase the ability to process valuable building data of highly heterogeneous sets of data sources (local energy production, energy consumption, physical infrastructure, weather, materials, etc.) through a universal data science toolkit for enhancing data-driven approaches in business. It develops an open-source software solution for overcoming several of the key barriers for development of innovative data-driven models and services such as: interoperability between databases and tools; operational storage of heterogeneous static and dynamic building data; configurable and modular service solutions over open analytic toolbox; security and advanced data access management allowing the configuration of different 3rd party services.

A key part of any business plan is Market Analysis. Market Analysis is a quantitative and qualitative assessment of a market. It looks into the size of the market both in volume and in value, the various customer segments and buying patterns, the competition, and the economic environment in terms of barriers to entry and regulation. In D7.2 we use the Market Analysis as the starting point from which relevant Exploitable Results are extracted in relation to each Use Case, or Business Case if applicable.

A thorough Market Analysis should address the following areas:

1. Stakeholder analysis

Stakeholder analysis covers a range of techniques used to initially identify the major actors that will benefit by the adoption of data-driven solutions in energy and then analyse the attributes, interrelationships and interfaces between stakeholders, leading to the mapping of a potential customer base. Specially in the context of BIGG, which brings together multiple sources of data and analytics services to create an AI & analytics toolbox and not a singular self-contained product, this can be a complex task: stakeholders may undertake different and possibly contradicting roles, depending on which instruments of the BIGG toolbox they are interested in.

The major actors that impact and are impacted by data-driven energy solutions and are considered as prospective stakeholders of BIGG UCs are presented below:

Users	Technical providers, software developers/ architects developing data-driven energy focused highly specialised solutions. ESCO/ Facility Management / Utility professionals: mainly building managers and operators and other technical experts involved in the whole building life-cycle such as designers, builders, energy services and maintenance companies.
Enablers	Those who impact the regulatory and standardization conditions. Policy makers at all levels: - Local and regional authorities organizations (CPMR, Energy Cities) and public buildings management agencies; - National ministries; - European Associations (AEEBC, EBC, EuroACE, etc), Standard Development Organizations and regulators (TNO, ETSI, CEN-CENELEC, etc) and Building data stock managers (EU BSO), project networks (MEDNICE).
Suppliers	Those who bring the technical context to integrate BIGG in the market e.g. Utilities - energy retailers, IoT devices manufacturers, cloud providers, systems integrators, ESCOs etc.
Researchers	Big data processing and AI related expertise including AI experts and data scientists both from academic and industry.

Beneficiaries	Building occupants, energy retailer/ESCO customers that will profit of the advantages of applied-ICT in the building sector to improve its life-cycle and to provide a more optimal use of building resources.

2. Target Market

Target Market is the most important section of a Market Analysis as this is where the ideal customer is described. This data should include the following elements:

Market size	How many potential customers are there for the BIGG Exploitable Result.
Demographics	Target group's typical age, gender, education, income level, and lifestyle preferences.
Location	Which countries, regions, states, cities, will be our target groups base.
Psychographics	Which are the user needs, and how they'll react. What are their likes and dislikes? How do they live? What's their personality and behavior?

The analysis of the above can lead to the identification of market segmentation. This is where similar types of customers are grouped into segments and the attributes of each segment are described.

3. Competition

A Market Analysis is thought to be incomplete without a good competitive analysis that should point out competitors' weaknesses. In order to do so the following areas have to be taken into consideration:

Direct competition	These are companies that are offering very similar products and services. The potential customers are probably currently buying from these companies.
Indirect competitors	It refers to alternative approaches and solutions that competitors may have to the same problem.

4. Legislation / Regulations

The relative legislation and the subsequent regulations that rule the targeted market must be "thoroughly" described and analyzed in order to intensify at an early stage the constraints and barriers they may impose. The legislation that must be studies includes both the EU' s frame as well as the relative frame of member – state that will be included in the target market.

III.1.3. Exploitable Results

Exploitable results are extracted following the market analysis of each Business Case and Use Case. As exploitable results we identify key BIGG outcomes that could find commercial applications after BIGG based on a common roadmap among the involved partners. Each ER is presented based on the following template:

ER ID	BC/UC in relation with	Short name
Description		

Partner	Technology or customer oriented
ER for specific BCs/UCs or part of project infrastructure	Component / Stand-alone (can it be launched as an independent product or is it a component)

Each ER is identified by an ID, the BC/UC from which it originates a short name and a description. In addition to the partners involved (**leader** and developers) we identify whether the ER is technology driven (i.e. software or methodology) aimed towards other developers or a customer oriented services aimed towards the wider public. Finally, we identify whether the ER is a component of a wider service or a stand alone product, both in terms of BIGG infrastructure and the wider technological ecosystem.

IV. MARKET ANALYSIS AND EXPLOITABLE RESULTS

IV.1. Business Case / Use Case Market Analysis

IV.1.1. Business Case 1: Benchmarking and energy efficiency tracking in public buildings

Under BC1 BIGG project offers considerable advances in building data gathering, management and services for energy efficiency in public buildings by developing and providing:

- An **open** big **data** infrastructure for storing all building data in one place and monitoring the performance of the whole building stock of the organisation through an easily accessible web application.
- Advanced energy benchmarking using BIGG's data storage and analysis capabilities to enable the subsequent production of customised reports for different stakeholders in organisations (policy makers, energy managers, maintenance staff, financial managers).
- **Continuous data gathering** from different sources (energy consumption, investments in energy efficiency measures, user provided information) for evaluation of applied energy efficiency measures (EEM) both in terms of energy and financial performance.

ICAEN is responsible for this BC, which breaks down in 2 Use Cases with Market Analysis performed for each of them based on the template introduced in Section III. The following two use cases descriptions are focused on the improvement of the energy efficiency on a major part of Catalonia's public buildings, by monitoring their consumptions and energy efficiency actions. The first challenge for BC1 was the selection of the information to be gathered and the set-up of the information gathering processes.

IV.1.1.a. Use Case 1: Benchmark and monitoring of Energy Consumption

Use case 1 focuses on developing tools and systems that enable advanced building benchmarking and monitoring both of building's performance and energy efficiency trends.

The main objective of this use case is to give public authorities and energy managers the necessary tools to improve control and manage the energy performance of a large park of buildings with automated methods. This is made possible by processing together large amounts of data (which were disperse in different databases before the project) and giving qualified and useful information to improve the decision making related to buildings energy management.

Stakeholder Analysis

Users	Building owner's and building user's, aimed a large building portfolios.
Enablers	Data protection legislation may apply.
Suppliers	Energy distribution companies provide smart meter data about building's energy consumption. Building's owners and operators provide the building information. Other external sources such as cadastre (cadastral data), climate data (from public to private sources).
Researchers	CIMNE

Beneficiaries	Building owners and occupants. They get access to facilitate building comparison (benchmarking) based on energy performance.

Target Market

Market size	Any building with smart meter
Demographics	Typically higher educated, building owners and operators.
Location	No limits
Psychographics	Users expect to manage their building's portfolios to detect the differences in energy performance of their buildings. They expect to have a picture of their building's energy performance and compare them to the rest (other owner's buildings) of the buildings with similar characteristics.

Competition

Direct competition	Other companies that offer benchmarking services such as Dexma.
Indirect competitors	Companies that offer energy accounting software with expanded functionalities that allow to add building surface data, such as Gemweb, Energy tools and SIE.

Legislation / Regulations

The main legislation affecting building benchmarking refers to data protection and the deployment of smart meters from regulatory perspective. Supporting legislation/regulation that will expedite the implementation of smart meters to facilitate the energy data collection is critical.

IV.1.1.b. Use Case 2: Energy Efficiency Measures: registration and evaluation

Use case 2 focuses on the follow up of energy efficiency measures (EEM), as a key point to evaluate the savings progress according to the achievement to sustainable EU targets. Use case 2 is developing an EEM repository starting by the identification and classification of EEMs based on their typology, characteristics, difficulty of implementation, required investment, etc., and evaluation on impact assessment of measures on achieved energy savings.

The main objective of this use case is to make a structured data base to store EEM and evaluate their impact on achieved energy savings from energy consumption data.

The expected improvements with BIGG are first linked to the quality of the data and second the capability to act on the data. It is expected to get more detailed information of the EEMs involving energy managers by registering the information in a more structured way, including some front end that allows to register and consult this information.

Stakeholder Analysis

Users	Building owner's and building user's, aimed a large building portfolios
Enablers	Energy efficiency facilitators teams within public institutions, such as ICAEN's own team. ESCO companies. Use of M&V protocol.

Suppliers	ESCO companies (or other similar companies) and software compagnies selling tools to building owners directly
Researchers	CIMNE, Dexma, and similar entities/companies.
Beneficiaries	Building owner's and building users.

Target Market

Market size	5-10% of current users of a M&V (Measure & Verification) protocol would decide to be in BIGG Platform.
Demographics	Typically, higher educated, building owners and operators.
Location	No limits
Psychographics	Users expect to be able to track the savings obtained after implementing energy efficiency measures.

Competition

Direct competition	M&V protocol provider companies, ESCO companies.
Indirect competitors	Maintenance companies and installer companies that may influence the ESCO market.

Legislation / Regulations

An M&V protocol such as IPMVP[1]. In addition, for each country in which such a solution will be deployed, there are local laws that promote savings in both public and private buildings which must be taken into account and closely monitored.

IV.1.2. Business Case 2: Energy certification in residential and tertiary buildings

The main focus of this business case is on the integration of Building Energy Performance Certification data and its combination with other external data such as INSPIRE cadastral data (UC3) and Levels data (UC4).

At this stage it is not clear that the results of this business case can be brought to the market, but rather that it is a first approximation to improve in the future the energy certification of building performance and to take advantage of this EPC data to extract conclusion of state of building park at regional, national or European level. Therefore, the UC description are presented however the Market Analysis and Exploitable Results will be further addressed as part of D7.3.

[1] The International Performance for Measure and Verification Protocol described in https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

IV.1.2.a. Use Case 3: Integration of INSPIRE spatial data with Energy Performance Certification (EPC)

The main target of UC3 is to adapt the current certificates to the INSPIRE standard, adapting all the certificates fields and defining the harmonisation where possible. The main task for UC3 will be defining the harmonisation of the BPC and ensuring that the end product complies with the INSPIRE standard.

The possible correlation of the data of the BPC with INSPIRE will improve the credibility of the results of the certifications and, on the other hand, it will facilitate the reuse of the data, either in future certificates on the same building or in the exploration of all together.

It is expected that the joint use of BPCs data and cadastral data will improve the quality and information of the BPCS viewer that currently the Catalan government makes available to the public.

IV.1.2.b. Use Case 4: Adoption of the sustainability indicators of common EU framework Level(s) in building certification

This use case seeks to expand the current indicators that ICAEN has for its buildings certification, according to the European Level(s) framework - Level(s). The main objective of this use case is to improve the exploration and indicators that could be extracted from the BCP registry. This will be achieved by aligning the current indicators extracted from the certifications of the buildings with the Level(s) standard.

IV.1.3. Business Case 3: Building Life-Cycle: From Planning to Renovation

The main objective of this Business Case is to demonstrate the data interoperability capabilities offered by the BIGG project. In contrast to Business Case 1 and 2, which mainly work with general building data, this Business Case works with the integration of disaggregated data within buildings (building areas, zones, equipment and sensors). Additionally, the data and results obtained with external systems such as DEEP or EuBSO are further integrated into BIGG data infrastructure. CIMNE is the leading BIGG partner in this BC which spans into 3 Use Cases: UCs 5, 6, 7.

IV.1.3.a. Use Case 5: Integration of data from BIM, Building Management Systems (BMS) and Computerised Maintenance Management Systems (CMMS)

This use case works mainly on the integration of data from the systems commonly used in buildings throughout their useful life. This integration is oriented to favour the processing of data for the improvement of energy efficiency in buildings, thanks to better control and data processing. From the BIM models used in their design, to the automated control systems (BMS) and maintenance control systems (CMMS) used in the continuous control and monitoring of buildings.

The main challenges associated with this use case are:

Heterogeneity of the BMS providers located in the buildings.

This has been solved with important work on the standardisation of the semantics of the variables that can be found in the systems, the prescription of a standard output format for the registers, currently in the use case done in Bacnet, together with the installation of common communication gateways in all the buildings to favour communication with the existing BSMs. These requirements will be integrated in the next tenders to be issued by the Catalan government.

Heterogeneity of the data that must be stored and processed. The buildings have multiple areas, zones, equipment and systems and, as is well known, their configuration is totally disparate from one building to another.

This has been solved by working on the characteristics and capabilities of the BIGG data model to be able to store and link these data in a robust way so that they can be retrieved later to be used in different services.

Stakeholder Analysis

Users	Building owner's and building user's, ESCO and Facility Management companies.
Enablers	Regulatory authorities and state legislature that can apply legal framworks to facilitate the access and integration of data. For example, force to diferents providers to standarase the data formats and communication chanels.
Suppliers	Building's owners and operators provide the building information. Building management systems integrators must know the prescriptions to favour the systems integrations. Building's owners and operators provide the building information and must prescript the BIGG recommendations in their contracts (Building management systems integrators, Computational maintenance systems providers, etc...)
Researchers	CIMNE
Beneficiaries	Building owners, ESCOS, Buildings and facilities managers (INFRA), even policy makers

Target Market

Market size	Any building with BMS, monitoring systems or CMM systems
Demographics	Typically, higher educated, building owners and operators.
Location	No limits
Psychographics	Users want to aggregate their buildings data in a common and standardized repository

Competition

Direct competition	Other data integration service providers.
Indirect competitors	ESCOS, Buildings and Facility Management companies

Legislation / Regulations

Typical GDPR issues with acquiring, processing and storing data that must be respected, in addition to the fact that regulatory developments have to be monitored.

IV.1.3.b. Use Cases 6: Interoperability of BIGG with EEFIG-DEEP

This use case works mainly on the integration of data from real energy efficiency measures applied in buildings with the European de-risking Energy Efficiency Platform (DEEP) of the EEFIG group. DEEP is the European reference platform for comparative analysis of energy efficiency measures applied in buildings and industry and is further described in Table 14 - DEEP description.

The main challenges of this use case are:

Semantic and structural interoperability of the data with DEEP.

To solve this interoperability, we have worked on the alignment of the BIGG data model with the structure and taxonomies of energy efficiency measures used internally by DEEP.

Contribution with new data for the DEEP platform.

Work has been done on the generation of results in formats that are directly compatible and importable by DEEP.

Stakeholder Analysis

Users	Building owner's and building user's, ESCO, Facility Management companies, financial institutions.
Enablers	Regulatory authorities and state legislature that can apply specific legal barriers.
Suppliers	Buildings owners and operators provide the building information.
Researchers	CIMNE
Beneficiaries	Building owners, ESCOS, Buildings and facilities managers (INFRA), even policy makers and financial institutions

Target Market

Market size	Any building or energy efficiency promoters that wants to apply renovation projects in their buildings and financial institutions
Demographics	Typically higher educated, building owners and operators.
Location	No limits
Psychographics	Users want to check with real data the impact that the energy efficiency measures they implement in their buildings will have. On the other hand, financial institutions need real data to check the real risk that the projects they finance may have.

Competition

Direct competition	Other data integration service providers.
Indirect competitors	ESCOS, Buildings and Facility Management companies with technological capacity

Legislation / Regulations

Typical GDPR issues with acquiring, processing and storing data that have to be respected, in addition to the fact that regulatory developments have to be monitored.

IV.1.3.c. Use Cases 7: Interoperability between EU Building Stock Observatory (EUBSO) and national/regional Energy Performance Certification hubs

This use case works mainly on the integration of data from Building Performance certificates national Hubs with European Building Stock Observatory [i]

The main challenges of this use case have been:

Semantic and structural interoperability of the data with EuBSO.

To solve this interoperability, we have worked on the alignment of the BIGG data model with the structure and taxonomies of EuBSO.

Contribution with new data for the EuBSO platform.

Work has been done on the generation of results in formats that are directly compatible and importable by EuBSO.

Stakeholder Analysis

Users	Building owner's and building user's, policy makers.
Enablers	Regulatory authorities and state legislature that can apply specific legal barriers.
Suppliers	Responsible for regional/national BPC repositories.
Researchers	CIMNE
Beneficiaries	Building owners and policy makers.

Target Market

Market size	Regions and Nationals European governments
Demographics	Typically, higher educated, building owners and operators.
Location	No limits
Psychographics	Users want to exchange open data form nationals and regionals BPC Hub

Competition

Direct competition	Other data integration service providers.
Indirect competitors	ESCOS, Buildings and Facility Management companies with technological capacity

Legislation / Regulations

Typical GDPR issues with acquiring, processing and storing data that have to be respected, in addition to the fact that regulatory developments have to be monitored.

IV.1.4. Business Case 4: Energy Performance Contract based savings in commercial buildings

The objective of BC4 is to create a solution able to manage EPC contracts from A to Z, from storing and organizing any EPC contract related assets, acquiring their related data (both static and dynamic), tracking the achieved savings, managing the contracts and milestones, and building any required report. The solution will have to enable smooth communication between the ESCO managing the EPC contract and the end customer who must be notified in case of any major savings deviation or when corrective actions are required.

HELEXIA and CORDIA are main contributors to this Business Case, which spans across UCs 8, 9 and 10. However UC 10 does not lead to specific Exploitable Results, as it mainly supports UCs 8 and 9; hence it is omitted from the Market Analysis.

IV.1.4.a. Use Case 8: Assets management to store, view, update all relevant assets such as buildings, contracts, invoices, meters, sub-meters, sensors, equipment.

Use Case 8 aims to enable the user to store, access, view and manage all relevant data regarding the management of an EPCo (Energy Performance Contract). The data includes the relevant information to describe the building, the contract, the invoices and consumption data, the monitoring hardware (meters, sensors) and the equipment.

The main objective of this use case is to structure the data collection process to enable the storage of all relevant information for the management of both an on-going EPC contract and a new EPC in the kick-off phase. Specifically, it is important to manage all the assets and data that intervene in the lifetime of EPC contracts, in a single digital platform.

Eventually, this data will be accessible from a single access point to ease the EPC management process and decision making.

For every site with an EPC contract, the process will be as follows:

1. Necessary research into the key areas for HVAC systems or Building envelop integration, in accordance with the desired ambient conditions in order to achieve energy savings;
2. Collection and analysis of ambient data parameters, for selected areas;
3. Collect the meta-data of all the physical assets, for which data must be stored and organized according to a tree structure;
4. Collect the EPC contract data;
5. Collect all the required dynamic data for EPC follow up, savings tracking, etc.
6. Take into consideration and assess relations that help to understand the use profiles and implications.

The expected improvements with BIGG for this Use Case are:

- Usage and validation of the data model from the BIGG platform (WP4)
- Centralize data collection using the collection layer from BIGG Platform (WP3)
- Easy Export & Import of assets from and to the BIGG platform (WP4)

- Transform of time-series data to align them with standard time grids to exploit them with the AI toolbox (WP4&5)
- It is desired from the ESCo part (CORDIA) that the tools currently used will be improved for the optimization of the energy management services and Energy Performance Contracts delivered (by the ESCo).
- Establishment of new innovative services regarding facilities management, esp. related to technical maintenance of energy efficiency of HVAC systems is also an expectation from BIGG.

Stakeholder Analysis

Users	ESCO and Facility Management companies, final users and owners of the facility and citizens, facility management and technical staff, Policy makers, researchers, and academia
Enablers	Regulatory authorities and state legislature that can apply specific legal barriers.
Suppliers	ESCO and Facility Management companies
Researchers	Technology providers developing innovative products in energy management sector.
Beneficiaries	Commercial buildings' owners getting access to greener and / or cheaper electricity and Utilities using innovative products to decrease their consumptions and their energy footprint as well as to improve occupants well being.

Target Market

Market size	5-10 % of commercial buildings
Demographics	Typically, higher educated, 30 years old.
Location	No limitation
Psychographics	Users expect to manage and monitor with a more efficient way their facilities and achieve energy costs and CO_2 emissions reductions.

Competition

Direct competition	Other ESCO and facility management companies offer similar technologies and platforms.
Indirect competitors	Technology companies that can offer independent products (monitoring).

Legislation / Regulations

Typical GDPR issues with acquiring, processing and storing data that have to be respected, in addition to the fact that regulatory developments have to be monitored.

IV.1.4.b. Use Case 9: Actual savings tracking realized by the Energy Conservation Measures undertaken by the ESCO and monitors on a daily/weekly/monthly basis

Use case 9 tries to ease the process of quantifying the impact of an Energy Conservation Measure on a given building through an accurate modelling of the building consumption. Additionally enables the user to track the implemented ECMs in time and their impact on the managed asset.

The main objective of this use case is to track the actual impact of ECMs and verify the associated savings.

The present Use Case –according to the pilot scenario taken into consideration- focuses on pre-existing buildings so measures are rather linked to different consumptions adjustment (e.g., electricity) and optimization of internal conditions (e.g., CO_2 concentrations lighting levels) rather than design plans (orientation of windows/openings).

The process that is being followed focuses on the next three steps:

1. From the energy consumption data prior to the EPC project and the data about factors impacting consumption, a regression model of the consumption is being identified to be used as baseline. The baseline takes into consideration the crucial parameters that contribute to energy consumption (e.g. outside temperature);
2. The precision of the model will be assessed according to the IPMVP protocol and must reach a good accuracy level in order to be used;
3. During the whole EPC lifetime, continuously compare the actual energy consumption with the baseline. The difference provides the estimated savings.

In this process there are the following general comments:

1. When identifying the baseline models, particular care must be taken to avoid overfitting.
2. A high model accuracy is a key requirement. Without it, in case the expected savings are not realized as expected, it is often impossible to determine if the cause lies within the ECM impact estimation, within a misuse of the building post renovation or within the poor accuracy of the savings estimation by the baseline model. This can lead to endless discussions between the customer and the ESCO and sometimes even to trial.
3. In order to achieve the highest accuracy to the baseline model, it may be needed to consider more than one parameter as independent variable (e.g., outside temperature and building occupancy) in creation.

Baseline models can be identified for a whole building, building parts or even a single equipment (and its respective energy use).

The expected improvements with BIGG for this Use Case are:

- To improve the regression models for more accurate savings estimation (WP5)
- To standardize ECM formalization (WP4)
- To build accurate savings estimations procedures for independent ECMs (WP5)
- To integrate non-routine adjustments to the IPMVP follow up (WP5)
- To define and create valuable savings tracking dashboards (WP3)
- To define and create the baseline models for new EPC contracts
- To establish new innovative services around facility management of the building.

Stakeholder Analysis

Users	ESCO companies, Policy makers, commercial buildings' owners' researchers, and academia
Enablers	Regulatory authorities and state legislature that can apply specific legal barriers.
Suppliers	ESCO companies
Researchers	Technology providers developing innovative products in energy management sector.
Beneficiaries	ESCO companies getting access to innovative products to decrease and simplify their "effort", to improve their services and their monitor methodology. Commercial buildings' owners to monitor their EPC contract.

Target Market

Market size	10-15 % of ESCO companies
Demographics	Typically, higher educated, 35 years old.
Location	No limitation
Psychographics	Users expect to manage and monitor their EPC contract with a more efficient way and achieve their financial savings.

Competition

Direct competition	Other ESCO companies offer similar technologies, methodologies, and platforms.
Indirect competitors	Partially, technology companies that can offer independent products (monitoring).

Legislation / Regulations

Typical GDPR issues with acquiring, processing and storing data that have to be respected, in addition to the fact that regulatory developments have to be monitored.

IV.1.5. Business Case 5: Buildings for occupants: Comfort Case

The main objective of this Business Case is to optimize energy consumption while keeping the same comfort level within large tertiary buildings. It will address different goals related to energy efficiency, renewable energy usage, comfort and cost of the building together and not in an isolated way, considering external forecasted conditions like weather, energy price and occupation. External conditions have a direct impact on the energy demand of buildings (e.g. necessity of heating/cooling), so that gathering those forecasted external conditions will allow to proactively match energy demand and supply to match the objectives of final users: improve comfort, reduce energy bill, reduce greenhouse gas emissions. This Business Case is being

led by CORDIA and HELEXIA and it spans across Use Cases 11, 12 and 13. UCs 11 and 12 lead to common Exploitable Results

IV.1.5.a. Use Cases 11 & 12: Forecast based optimization

Use cases 11 & 12 can be merged into one larger use-case, as both use-cases objectives are to optimize energy consumption while keeping the same level of comfort for occupant. The application will consider weather forecast 24 hours in advance while adding occupancy forecasts to the optimization logic. In optimum conditions, thermal conditions of a building should adapt to its occupancy. A forecasted occupancy will allow thermal conditions to be adjusted proactively.

Stakeholder Analysis

Users	ESCO & Facility Management companies, Large building owners & occupants (commercial, academia, health, public)
Enablers	Local & regulatory authorities, state legislature that can apply specific legal barriers, constraints or opportunities for better occupation comfort levels.
Suppliers	BMS (& light BMS) provider, IOT devices manufacturers, systems integrators, ESCOs, Facilities & utilities
Researchers	Technology providers developing Energy Management Systems, BMS & IOT devices
Beneficiaries	Building occupants & owners

Target Market

Market size	Very wide: Up to 50% of tertiary buildings & very low coverage of technology currently
Demographics	Almost no limitation: Large group of potential targeted demographics (Academia: up to 30 years old / Large commercial buildings: Typically higher educated, 30yo + / Health & public : no limitation
Location	No limitation
Psychographics	Users expect to reach energy consumption reduction with no change in comfort feeling (temperature & humidity). People might behave badly if comfort is reduced significantly, and energy consumption could be increased if local settings are available for short range personal comfort.

Competition

Direct competition	Other BMS providers, IOT devices manufacturers, systems integrators
Indirect competitors	Other ESCOs, Facilities & utilities companies offering similar technologies. Ultra-low consumption buildings with improved energy efficiency and insulation that doesn't requires that much energy for heating / cooling.

Legislation / Regulations

Comfort levels are strictly bordered by each local authority (eg. 19°C for tertiary, 5°C for logistics, 21°C for sensitive applications)

2002/91/CE EPBD directives enforce the use of BMS solutions making the technical solution easily spread in the market.

IV.1.5.b. Use Case 13: Optimization using price forecast

Optimization using price forecasts will add energy prices information on top of the weather and occupancy forecasts (uses cases 11 & 12) to always allow using the most sustainable and/or cheapest energy available.

Stakeholder Analysis

Users	ESCO & Facility Management companies, Large building owners (commercial, academia, health, public)
Enablers	Utilities, local & regulatory authorities, state legislature
Suppliers	BMS (& light BMS) provider, IOT devices manufacturers, systems integrators, ESCOs
Researchers	Technology providers developing Energy Management Systems, BMS & IOT devices
Beneficiaries	Building owners, energy purchasers

Target Market

Market size	Very wide: Up to 50% of tertiary buildings & very low coverage of technology currently
Demographics	Highly educated, + 35yo. (Energy purchasers, buildings owners)
Location	No limitation
Psychographics	Energy purchasers & final users have different expectations. Energy purchasers expect to reach energy bill reduction while final users want no change in comfort feeling. Final users might behave badly if comfort is reduced significantly, and energy billing could be increased if local settings are available for short range personal comfort.

Competition

Direct competition	Other BMS providers, IOT devices manufacturers, systems integrators
Indirect competitors	Other ESCOs & facilities Self-autonomous buildings without dependency on energy market prices

Legislation / Regulations

Purchasers needs to engage energy contract depending on spot market prices.

High dependency of CO2 carbon taxes, if it increases then this application may have significant impact in term of final energy prices of the buildings.

IV.1.6. Business Case 6: Flexibility potential of Residential consumers on electricity and natural gas

The main objective of this business case is to demonstrate and exploit the flexibility potential of residential and commercial buildings across the two main energy vectors of electricity and natural gas. The focus will be on characterizing the availability and the distribution of flexible loads within both residential and commercial setups, by analysing the plurality of data combined from various data sources, residing both at consumer premises (smart meters, controllers, sensors) and on the cloud (remote databases, services, etc.).

Through smartphone applications and dashboards, end users will monitor and manage the operation of their connected heavy consuming appliances (electric water heaters, gas boilers, etc.). Their preferences will be logged directly through the apps, while also providing the main communication interface for interacting with the demand-response (DR) management system and services which will allow indirect inference of their preferences based on smart metering data.

IV.1.6.a. Use Case 14: Demand Response for Electricity

In this UC, HERON demonstrates Demand Response management for residential electricity consumers. HERON provides access to real-time data on consumption of electricity through a platform accessible to pilot participants. Data is collected through smart meters, smart plugs and movement sensors installed in selected pilot participants.

In addition, HERON offers access to meteorological data and data regarding the Hellenic electricity grid (e.g., market conditions and generation mix).

Under the developed UC, consumers can manage home appliances associated with heavy but not always flexible loads such as ovens, and more flexible such as washing machines and dishwashers. For a subset of pilot participants there have been smart plugs installed, monitoring the appliances' consumption (kWh) and power (kW).

The supplier offers signals to the consumers, expecting their reaction in return. Given the regulatory and legal situation in Greece, focus is given in sustainability signals, promoting consumption during hours in which RES are the biggest contributors. In the absence of DSO deployed smart meters, any direct monetary reward based on consumption cannot be given, given that the data upon which it relies cannot be verified. Therefore, UC14 implements a green tariff scheme, akin to a market tariff, which aims to incentivise consumers to shift their electricity demand during "greener" hours.

A critical element of this UC is the supplier's ability to forecast the offered flexibility by using occupancy and home usage forecasts and optimize demand management through the DR platform based on the consumers preferences to increase probabilities that its recommendations are being followed.

Stakeholder Analysis

Users	Technology savvy and environmentally aware electricity consumers, early adopters.
Enablers	Regulatory authorities and state legislature that can remove specific legal barriers.

Suppliers	DSO as the deployer and operator of Smart Metering infrastructure. Utility companies supplying energy to their clientele, increasing efficiency in consumption.
Researchers	Technology providers developing innovative products in support of innovation driven services launched from Utility companies.
Beneficiaries	Electricity consumers getting access to greener and / or cheaper electricity and Utilities using innovative products to increase their market share.

Target Market

Market size	5-10% of a Utility's market share representing the most eager early adopters.
Demographics	Typically higher educated, 35 years old.
Location	Urban centres.
Psychographics	Users expect to get rewards for their effort and involvement in the app. There is a strong focus on monetary rewards.

Competition

Direct competition	Other Utilities offer smart monitoring platforms as part of Smart Home products, however there are no demand flexibility / load shifting products yet.
Indirect competitors	Technology companies that can offer independent products (monitoring) and act as DR Aggregators, potentially taking part of a Utility's business.

Legislation / Regulations

For any DR service to be commercially deployed it is required that the DSO has installed a smart meter which is also operated and maintained by it and regulated by the National regulatory authority. The main reason is that billing can only be done based on official meter readings. In addition, dynamic tariffs enable and facilitate DR given that they can create the right price signals for costumers to adapt. The Directive 2012/27/EU related to the entitlement to a dynamic electricity contract, further amended by Directive 2019/944 on common rules for the internal electricity market, requires that dynamic electricity price contracts should reflect the spot and intraday market price fluctuations. Any amendments on the 2012 Directive should be closely monitored.

IV.1.6.b. Use Case 15: Demand Response for Natural Gas

In this use case, end users of legacy natural gas boilers can upgrade their heating systems through the cost-effective heating controller of domX, while enabling their participation in flexibility provision services to the natural gas supplier. Targeted devices include residential and commercial heating devices operating on natural gas, supporting several types of control modes (ON/OFF, power modulation, etc.). The edge controllers are interconnected with a cloud-based energy management system that constantly collects, stores and analyses the collected data. The end users can interact with the upgraded boiler, both through the existing

thermostat and the smartphone application, providing climate comfort limits and collecting real-time feedback on the boiler operation. The proposed concept focuses on the Management of Natural Gas consumption in buildings, by actively controlling and optimizing the indoor environment, with the aim of (a) improving energy efficiency through load reduction and (b) contributing to energy system flexibility providing real-time gas balancing services.

Stakeholder Analysis

Users	Technology savvy, energy cost and environmentally aware natural gas consumers.
Enablers	Regulatory authorities and state legislature that can remove specific legal barriers.
Suppliers	DSO as the deployer and operator of Smart Metering infrastructure. Utility companies supplying energy to their clientele, increasing efficiency in consumption.
Researchers	Technology providers developing innovative products in support of innovation driven services launched from Utility companies.
Beneficiaries	Electricity consumers getting access to greener and / or cheaper electricity and Utilities using innovative products to increase their market share.

Target Market

Market size	Market size 5-10% of a Utility's market share representing the most eager early adopters.
Demographics	Typically, higher educated, 35 years old.
Location	Urban centres
Psychographics	Users expect to get rewards for their effort and involvement in the app. There is a strong focus on monetary rewards.

Competition

Direct competition	Other Utilities offer smart monitoring platforms as part of Smart Home products, however there are no demand flexibility / load shifting products yet.
Indirect competitors	Technology companies that can offer independent products (monitoring) and act as DR Aggregators, potentially taking part of a Utility's business.

Legislation / Regulations

The relative legislation and the subsequent regulations that rule the targeted market must be "thoroughly" described and analysed to intensify at an early stage the constraints and barriers they may impose. The legislation that must be studied includes both the EU' s frame as well as the relative frame of member – state that will be included in the target market.

IV.2. Exploitable Results

Based on the Market Analysis, we extract the appropriate Exploitable Results. While several ERs are restricted to specific BCs/UCs, most of them, predominately the technical ones, relate to multiple BCs/UCs, spread across the spectrum of BIGG technological innovation. In addition, as BIGG progressed it became clear that there are several innovations in relation to specific BIGG components that are not related to a Use Case but are critical requirements for the technical or customer driven BIGG ERs. These are labelled as “BIGG Infrastructure Exploitable Results” to distinguish them from the BC / UC specific ERs.

IV.2.1. Business Case / Use specific Exploitable Results

ER1 C-1	BC1-UC1	Energy Consumption Benchmark
A tool for monitoring and benchmarking of a building’s performance, available to energy managers and building authorities.		
ICAEN		Customer oriented
Serves BIGG UC1		Stand-alone

ER2 T-1	BC1-UC2	Energy Efficiency Measures
A structured approach in storing EEMs easily accessible from building owners and users through a service provided by ESCOs or software developers.		
ICAEN		Technology oriented
Serves BIGG UC2		Stand-alone

ER3 T-2	BC3-UC5	BIM, BMS and CMMS Data Integration
Integration of general building data that can become available to building owners and users through a service provided by ESCOs or software developers.		
CIMNE		Technology oriented
Serves BIGG UC5 + part of project infrastructure: ER BIGG1		Component

ER4 T-2	BC3-UC6	BIGG Interoperability with EEFIG-DEEP
Integration of data provided from buildings in DEEP so that it can by used building owners and users through a service provided by ESCOs or software developers.		
CIMNE		Technology oriented
Serves BIGG UC6 + part of project infrastructure: ER BIGG1		Component

ER5 T-3	BC3-UC7	BIGG Interoperability with EUBSO
Alignment of BIGG Data with the EUBSO taxonomy and structure that can facilitate adoption of BIGG Exploitable Results		
CIMNE		Technology oriented
Serves BIGG UC7 + part of project infrastructure: ER BIGG1		Component

ER6 ID T-4	BC4-UC8	Data asset management in relation to EPCs
Data collection in relation to the storage of all relevant information for the management of both on-going EPC contracts and new EPCs in the kick-off phase.		
HELEXIA, CORDIA		Technology oriented
Serves BIGG UC8		Component and stand-alone to by used by ESCOs

ER7 C-2	BC4-UC9	Efficiency (savings) tracker
Quantify the impact of ECMs and tracking of deployed ECMs based on dashboards and analytics		
HELEXIA, CORDIA		Technology and customer oriented depending on whether it is used as a component or as stand-alone product
Serves BIGG UC 9 + part of project infrastructure: ER BIGGX		Component and Stand-alone (can it be launched as an independent product or is it a component)

ER8 C-3	BC5-UC11&12	Forecast based optimisation
Optimisation of energy consumption under specific levels of comfort for occupant		
CORDIA, HELEXIA		Customer oriented
Serves BIGG UC11&12 + part of project infrastructure: ER BIGGX		Stand-alone service with a variety of possible users. It can also be used as a component for recommendations for BMS / EMS systems

ER9 T-5	BC5-UC13	Price forecast optimisation
Optimization using energy price forecasts on top of the weather and occupancy forecasts (UC 11 & 12)		
HELEXIA, CORDIA		Technology oriented

ER for BC5 and part of project infrastructure: ER BIGGX	Component for recommendations for BMS / EMS systems

ER10 C-4	BC6-UC14	Demand Response for Electricity
DR management for residential electricity consumers as a service based on consumption, market, meteorological and sensor data		
HERON		Customer oriented
Serves UC14		Stand-alone product aimed towards consumers

ER11 C-5	BC6-UC15	Demand Response for Natural Gas
Deployment of edge controllers to monitor natural gas consumption as part of NG EMS system consisting of a thermostat and a mobile app application providing climate comfort limits and collecting real-time feedback on the boiler operation.		
DomX		Customer oriented
Serves UC15		Stand alone product aimed towards consumers, building managers and NG boiler installers

IV.2.2. BIGG Infrastructure Exploitable Results

The BIGG Data Reference Architecture 4 Buildings currently under development includes an operational database for storing a wide range of heterogeneous dynamic and static building data and an open analytics toolbox capable to exchange data with a variety of external applications and to support third party services related with improving the energy performance of buildings. The architecture is based on proven, 100% open source software technologies, and will be publicly available for replication and further development after the project.

The analytic toolbox will be open, modular and extensible, allowing to incorporate new open source and/or proprietary tools, thus enabling new cloud-based services. The components of the framework architecture, BIGG Harmonizer, AI & Analytics toolbox and Security layer are considered a BIGG Exploitable Results influencing all Use Cases and the project as a whole after its completion. In turn, the components of each of the three BIGG ERs are linked with one or more technical driven ERs developed to serve specific UCs but forming part of the wider BIGG infrastructure.

ER12	**BIGG1**	BIGG Harmonizer
The BIGG Data Harmonizer is a part of the BIGG Data Reference Architecture (RAF) for buildings. It consists of 2 components: 1. Connectors: facilitate ingestion of data (integration of data formats) ~ **CSTB** 2. Conversions: converts multiple data sources and formats to BIGG's open data model standard **~ Inetum**		
Inetum, **CSTB** All partners are involved in various stages of development and testing		Technology oriented ~ Component of BIGG RAF which could be launched as a stand-alone product or part of a wider application

ER13	**BIGG2**	BIGG AI & Analytics Toolbox
The BIGG AI & Analytics Toolbox is a part of the BIGG Data Reference Architecture (RAF) for buildings. The available tools consist of processes of cleaning, transforming, and modelling data to discover useful information for business decision-making based upon the data analysis. In the context of a stand-alone product they consist of 4 components: 1. Data democratisation ~ **CSTB** 2. Baseline calculation ~ **ICAEN** 3. Building Occupancy estimation ~ **HELEXIA** 4. Cross-vector consumption ~ **HELEXIA**		
CSTB, ICAEN, HELEXIA All partners are involved in various stages of development and testing		Technology oriented ~ Component of BIGG RAF which could be launched as a stand-alone product or part of a wider application

ER14	**BIGG3**	BIGG Security Layer
The BIGG Security Layer is a part of the BIGG Data Reference Architecture (RAF) for buildings. The security layer focuses on holistic analysis of Cybersecurity and provides guidelines on implementing solutions that facilitate possible upgrades based on specific recommendation.		
Inetum		Technology oriented ~ Component of BIGG RAF which could be launched as a stand-alone product or part of a wider application

ER15	**BIGG4**	Dashboards and visualisations
Significant effort has been invested in presenting pilot outcomes through elaborate dashboards that visualise analytics across all the Use Cases.		
HELEXIA, CIMEN All partners		Technology oriented ~ primarily developed as part ER7 C-2 in BC4-UC9. The results of this effort are used across BIGG and can be used as stand-alone products

ER16	**BIGG5**	Multi-disciplinary collaboration
BIGG has been a demonstration for the collaboration of multi-disciplinary teams across academia, technology domain, consulting services, public organisations and energy retailers. This valuable expertise can be documented as an experimental process which consists of communication and progress logging that monitor the collaboration between tech provider and "customer.		
HELEXIA		Customer driven – Consultancy based.

V. CONCLUSION

All things considered within the framework of WP7 aim at setting the foundation for effective exploitation and deployment of results into the market, D7.2 did deliver its objectives. The two principle supporting roles acumen to WP7 decision process; i) a clear picture of already existing standards, and ii) all the tools and support for ensuring greater market impacts of the exploitable results developed, has been identified in this deliverable under the core sections of 'economic impact of standardization, methodology, and standardized phases.' However, prior to the economic impact of standardization, an introduction to standardization was presented as means to highlight the importance of standardization and interoperability to the European Digital Market. A business logic of how standards will be utilized and evolved in the BIGG project is also provided as an indicator to comply with the industry needs and more importantly stake holders requirements. The assumption is to absorb standards into all aspects of development as means to ensure successful Verification, Validations, and Integration (VV&I).

The economic impact of standardization section successfully highlighted the benefits of standardization such as product interoperability, increased productivity, market share gains, and ease of cooperation with public R&D institutions. Further analysis within the domain of economics of software interoperability in construction demonstrated the detrimental impact of inadequate interoperability and lack of collaboration leading to technical inefficiency and ability to save costs. From a smart homes and grid perspective, the challenges to the energy sectors such as existing practices, development procedures and business models were addressed under ICT, Industry 4.0 recommendations. This section pronounced the unique selling point of BIM properties to unlock cost, resources, and CO2 emission savings through intelligent management.

The methodology section produced a work plan (to be influenced by project partners) contribution to achieving the focus of the BIGG project. Where WP2 will provide use cases analysis, technical requirements, and architectural design, WP4 for central data model definition and WP5 for specific Artificial Intelligence and Machine Learning developments. To achieve WP7 specific aim other key indicators within T7.1 where emphasized; Origination of Standardization workshops and cooperation with other WP/Tasks specific standard meeting (with selected partners). The phases associated with securing successful outcomes of WP7 (phase 1 – requirements lead to standards, phase 2 – adopting the standards, phase 3 – using standards & building standardizable outcome, and phase 4 – contribution to standardization) were all addressed individually with supporting details of their contribution to the BIGG project.

Section III "Exploitation Framework: Market Analysis and Proposed Business Model Approach" analyses the ability of transferring such operational tasks into market reality. The market awareness of identifying exploitable results, TRL maturity, IPR management, market analysis (i.e., target market) will enable a competitive advantage to the BIGG project successful outcomes. Market awareness is further analysed in Section IV, while TRL and IPR related subjects will be addressed in D7.3. Section IV "Market Analysis and exploitable results" implements the methodology outlined in the previous section to introduce specific analysis for BIGG Use Cases and identify the emerging Exploitable Results.

Effort undertaken in D7.2 lays the groundwork for D7.3 which will address the overall business approach based on the identified ERs concluding through the sustainable/bankable assessment that targets and controls; economic, technical, legal, and scheduling aspects to ascertain the likelihood of successful project development.

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