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Big data for buildings

Building Information aGGregation, harmonization and analytics platform

Project Nº 957047

D7.3- Final contributions to standardization actions and final 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 were deployed and tested cross pilot and country validation of at least four business scenarios in Spain and Greece.

The BIGG project achieved its targets by developing: 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 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 aimed at setting the foundation for effective exploitation and deployment of results into the market. Its main goal was 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 third iteration of WP7's deliverable provides the final version of contribution to standardisation actions and a final Market2Go strategy including BIGG impact.

During the first year of the project, Task 7.1 focused 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, standardisation committees and international initiatives that could be of interest for the project. During the second and third years of the project, technical work packages started developing new ideas and concepts by collaborating with identified committees and international initiatives, technically implementing the standards in the project and produce "standardizable" results and actively contributing to standardisation by promoting BIGG experiments and results.

From the exploitation point of view, Task 7.2 focused on defining and implementing an exploitation strategy to facilitate the successful exploitation and adoption of results and benefits within stakeholders. This effort was documented in Deliverable D7.2, where 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 was offered. In addition, Exploitable Results which relate to the whole project and facilitate the Use Cases were identified and described.

The current document focuses on Task 7.3 – "Exploitation and Sustainability plans including cost-benefit and impact analysis". Using the results of Task 7.2 as starting point, Business and Use Cases were consolidated into Blocks that better reflect BIGG Market2Go products and services that have been thoroughly tested in BIGG pilot sites. The methodology presented in prior Deliverables (D7.1 & D7.2) has been reworked with the main results updated, in order to fit the new perspective. The three Business Case Block M2G products, have 2 variations depending on whether BIGG Solution is for an end-user or by a provider. Market Analysis and Lean Canvas provide the Market Assessment and Value, Cost and Revenue streams, while Exploitable Results now identify BIGG components which allow IPR protection and agreements to be drafted flowing bilateral agreements among partners as stated in the Consortium Agreement.

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Table of Acronyms and Definitions

Acronym	Definition
BIM	Building Information [Model | Modelling | 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 Organisation for Standardisation
CEN	European Committee for Standardisation (CEN, French: Comité Européen de Normalisation
ESCO	Energy Services Company
UC/BC	Use Case / Business Case
EPC/EnPC	Energy Performance Certification
EPCo	Energy Performance Contract
TRL	Technology Readiness Level
IPR	Intellectual Property Rights
ECMs	Energy Conservation Measures
RES	Renewable 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 organisation of the document

The purpose of this document is to present the work done and the results achieved in work package 7 (WP7) during project implementation.

The main objective of WP7 was to provide the project with an effective exploitation and deployment strategy. It supported the developments by providing a clear picture of needs, requirements and standardisation framework. The specific objectives of WP7 were:

- Create a long-term collaboration framework with standardisation 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 commercialisation and market uptake for each exploitable result contemplating the appropriate business models.

The document is divided into 4 main parts:

- First part presents the final version of contributions to standardisation actions (Section II).
- Second part introduces the methodology towards Business Model definition and Exploitation, consolidating Business and Use Cases into Blocks that are aligned with Pilot tested market-ready products (Section III).
- Third part applies the methodology, aggregating the Exploitable Results, and applying the Market Analysis and Lean Canvas in the consolidated Business Blocks (Section IV).
- Forth part presents Exploitation plans for BIGG partners for the Market ready high TRL services developed as BIGG outcomes (Section V).

I.2. Scope and audience

This third version of WP7's deliverable covers the work done during all three years, on the concrete approach of the project's relation to standardisation, and consolidated Market2Go strategy. To achieve this, WP7 collaborated 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 standardisation and what could be the economic impact of the project outcomes, specifically for Data Science heavy services.

II. CONTRIBUTIONS TO STANDARDISATION

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

It is divided into five sections. Section 1 introduces the bases and motivations of the relation between a European project and standardisation committees. Section 2 gives an overview of the economic impact of standardisation. Section 3 presents the methodology and organisation of task 7.1. The core of this part, section 4, presents the different phases of the collaboration with standardisation. In section 5, we introduce a set of recommendations concerning standardisation 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 standardisation

‘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 Organisations (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 standardisation 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 standardisation 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 standardisation 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 standardisation committees 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 standardisation committees. Depending on the outcome type, these "contribution to standardisation" 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 organisation can easily be adapted to "agile" methods, where several "iterations" are performed.

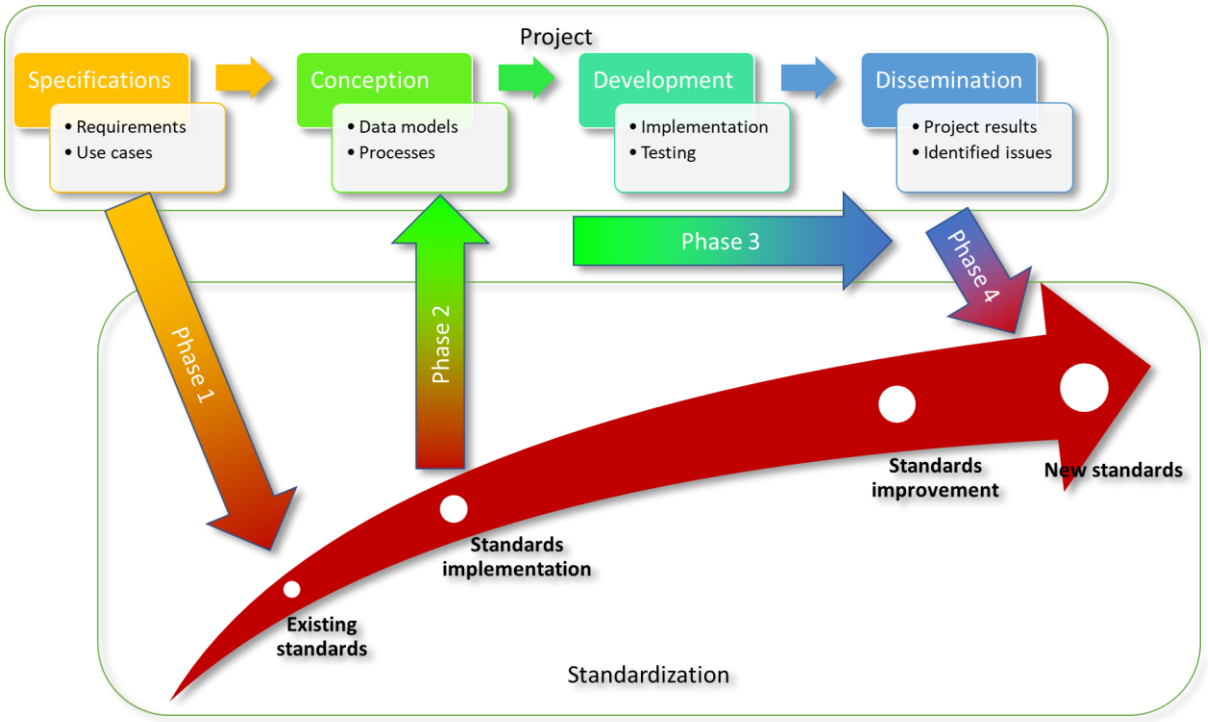

Figure 1: Link between project and standards.

II.2. Economic Impact of standardisation

In economies where technological improvement constitutes the main source of growth, standardisation 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 standardisation 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 standardisation work represents true value.
2. Innovation: Standardisation 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, standardisation provides companies with a genuine passport for exporting their products.
5. Product and service quality: Standardisation 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 standardisation to the growth in a country's economy. In France for example, standards have a stabilising 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 specialisations, industry will have to recognize eventually that it will operate in an environment where interoperability is challenged, especially if 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 organisational interoperability (positioning organisational 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-organisational 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, organisational 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 [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

organisational 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) [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 [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) [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, standardisation 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 utilising 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 standardisation 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.

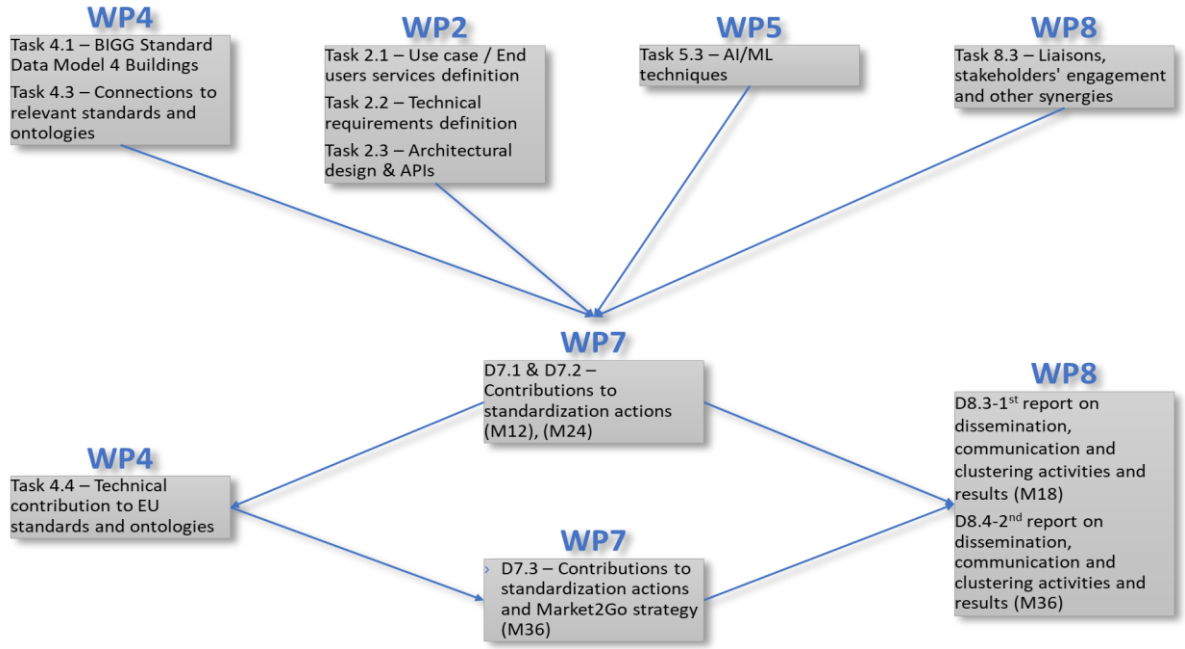

Figure 2: Connection of WP7 with other WPs tasks and deliverables.

Standardisation effort within WP7

Standardisation effort is organized around three main activities:

- Origination of Standardisation Workshops.
- Cooperation with other WP/Tasks
- Specific standard meeting (with selected partners).

Standardisation Workshops aim at:

- Defining the role of the different partners in the task (roles can evolve during the project).
- Identifying the standards & standardisation 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 standardisation 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 standardisation:
    - CSTB focus is on BIM standardisation, especially connected to buildingSMART International standards and Building Linked Data community.
    - CIMNE also involved in BIM standardisation, but more oriented towards Energy Simulation aspects.
    - ECTP itself is not directly involved in standardisation activities but can rely on their members for connection to specific standardisation committees, and 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 standardisation 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 standardisation community". Identified sister projects are presented in section II.4.1.d. and a description of the workshop itself is given in section II.4.4.a.

II.4. Standardisation 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 standardisation", 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 "standardisation needs" of the project. By analysing 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 harmonisation layer, we need to transform incoming JSON data to map them with the BIGG data model.

- RML

These international standards are developed and managed by different specializes pre-standardisation or standardisation 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 is 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 modularisation 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 axiomatisation, SSN and SOSA can 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	*SSN has already been broadly accepted as a de-facto standard for representing sensor data on the Web and has been the inspiration for multiple ontologies layered on top of SSN. With the standardisation of the SSN and SOSA ontologies through the OGC and the W3C and the introduction of different modules for different audiences, we expect the ontology to be used in even more varied use cases, especially for use cases in the Internet-of-Things domain.*
Competitors	• FIWARE NGSI-LD: The FIWARE Foundation provides a set of open standards for context information management, including the NGSI-LD (Next Generation Service Interface - Linked Data) standard. It is used in the context of smart cities and the Internet of Things (IoT). • O&M (Observations and Measurements): The OGC (Open Geospatial Consortium) standard O&M provides a conceptual framework for encoding observations and measurements, and it is widely used in the geospatial domain.
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	• None identified
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	The International Performance Measurement and Verification Protocol (IPMVP) has been a well-established and widely used standard in the field of energy efficiency and renewable energy projects. The IPMVP has undergone multiple updates and revisions to address changing industry needs and advancements in measurement and verification practices. The IPMVP has been adopted globally and is recognized by energy professionals, organisations, and standards bodies. Its maturity is reflected in its widespread use across various sectors, including commercial and industrial buildings, as well as in projects related to demand-side management, energy conservation, and renewable energy.
Competitors	None identified

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	• Complexity: Depending on the project and the selected IPMVP option, implementing the protocol can be complex and may require a detailed understanding of measurement and verification principles. This complexity could be a barrier for smaller projects or organisations with limited resources. • Dynamic Systems: IPMVP may face challenges in accurately capturing the performance of dynamic and interactive systems, especially those with complex interactions and dependencies. Some systems may not fit neatly into the predefined options of IPMVP. • Retrofits vs. New Construction: The protocol's options are often better suited for retrofit projects rather than new construction. There might be a need for more tailored approaches for assessing the performance of energy-efficient designs in new buildings.
Potential improvements	• Simplification: Streamlining the protocol or providing additional guidance for simpler implementation could make it more accessible to a broader range of projects. • Integration with Emerging Technologies: Updating IPMVP to integrate seamlessly with emerging technologies for data collection, analysis, and reporting could enhance its effectiveness in a rapidly evolving technological landscape.
Committees	ONG Efficiency Valuation Organisation (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	GeoSPARQL is a well-established standard developed by the Open Geospatial Consortium (OGC) for representing and querying geospatial information in RDF (Resource Description Framework) data stores. The standard has been widely adopted in the geospatial and semantic web communities, and it has seen implementation in various systems and applications. It's important to note that the maturity of a standard can be assessed based on factors such as its adoption rate, the existence of compliant implementations, and ongoing community support. GeoSPARQL has been implemented in various RDF triple stores, and there are tools and libraries available that support its use.
Competitors	None identified
Use for BIGG	Geospatial data, geospatial context, geolocation (Buildings), geometry description (Buildings footprints parcels).
Limitations	Concerning geoSPARQL 1.0, various serialisations 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 serialisations. 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	Recommended 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	None identified
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 standardisation 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 considered, 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. Considering 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	Recommended 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	None identified
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 serialisations 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 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	None identified
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

Standardisation committee	**buildingSMART International**
Type	BIM Pre-standardisation
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 organisation.
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

Standardisation committee	**CEN/TC 442**
Type	BIM standardisation
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	Standardisation 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.

Contributing partners	• CSTB
	  ○ Member of CEN/TC 442 (through AFNOR PPBIN group)
	  ○

Table 11 - ISO/TC 59/SC 13 description

Standardisation committee	**ISO/TC 59/SC 13**
Type	BIM Standardisation
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 standardisation in the field of buildings and civil engineering works. SC 13 is charged by TC 59 to focus on international standardisation 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.
Contributing partners	• CSTB ○ Member of ISO/TC 59/SC 13 (through AFNOR PPBIN group) ○

Table 12 - W3C description

Standardisation committee	**W3C**
Type	Ontology standardisation
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 organisations, 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	• *Very active in a large field of domains.*
Membership	Organisations 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 organisation 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

Standardisation committee	OGC
Type	Geospatial pre-standardisation
Standards	CityGML
Web site	https://www.ogc.org/
Description	The Open Geospatial Consortium (OGC), an international voluntary consensus standards organisation, originated in 1994. In the OGC, more than 500 commercial, governmental, nonprofit and research organisations 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.

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 organisations 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 standardisation of processes related to investments in energy efficiency projects in buildings at European level.
Interest for BiGG	• Standardisation 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 organisations, 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)
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 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 standardisation policies. AIOTI leads, promotes, bridges and collaborates in IoT & Edge Computing and other converging technologies research and innovation, standardisation 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.
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 organisations at European and international level, as well as with standardisation 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. ○ **Standardisation** (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, industrialisation, deployment or standardisation 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 to achieve a specific result.
Dynamism / activity	• *Quite dynamic. Several European projects have published or are currently published their Use Cases into the database.*
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	• Finally, due to the lack of resources to handle this task, it was decided not to publish our use cases.

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 decarbonisation. 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
Contribution strategy	• Communication and dissemination synergies via each other community • Participation and organisation of joint events • Standardisation sister's projects community. See *Section II.4.3.a. Creation of a "Standardization sister projects community"*.

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, 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
Contribution strategy	• Communication and dissemination synergies via each other community • Participation and organisation of joint events • Standardisation sister's projects community. See *Section II.4.3.a. Creation of a "Standardization sister projects community"*.

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 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 • Standardisation
Contribution strategy	• Communication and dissemination synergies via each other community • Participation and organisation of joint events • Standardisation sister's projects community. See *Section II.4.3.a. Creation of a "Standardization sister projects community"*.

II.4.2. Phase 2 – Adopting the standards

The main objective of this second phase is to adopt the identified standard by participating to standardisation 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.

The following table summarize the active participation of project partners to standards related events.

Table 21 - Partner participation to standardisation committees

Standardisation 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	CSTB, Heron,	Building ontologies	Initiation of collaboration with sister project on contribution to standardisation.

analytics, Tuesday 8th November	ECTP, Inetum		
buildingSMART International Virtual Summit Spring 2022	CSTB	IFC	Better understanding of the very last and future developments of IFC standard
buildingSMART International Rome Summit Spring 2023	CSTB	IFC	Better understanding of the very last and future developments of standard handled by bSI
11th Linked Data in Architecture and Construction Workshop (15 - 16 June 2023)	CSTB	Building, Architecture and construction ontologies	Awareness of the very last "state of the art" use case and standards developments

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 organising data coming from all use cases. 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.
    - Many additional concepts have been taken from or inspired by SAREF 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 year of the project, a list of project outcomes has been developed and consolidated. From that list, we have created a table composed of the more interesting outcomes that could be pushed towards standardisation (see table just below).

Table 22 : List of standardizable project outcomes

BiGG Asset	Action Type	Description	Standard / Committee / Entity	Project Component (WP)	Involved partners	What we are using	What we need
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	W3C	WP4	CIMNE, CSTB	Sensors, observers	Attend LDAC community meetings
BiGG Data Model	Use Standard	BIGG Ontology uses SAREF concepts	ETSI	WP4	CIMNE, CSTB	Sensors, real-time monitoring, time-series	Attend LDAC community meetings
BiGG Data Model	Contribute - Publication	Publish BiGG ontology		WP4	CIMNE, CSTB		Attend LDAC community meetings
BiGG Data Model	Use Standard	Develop a mapping between BiGG ontology and existing concepts	bSI, W3C, ETSI	WP4	CIMNE, CSTB		Attend LDAC community meetings
BiGG Data Model	Build standardization Group	Compare BiGG ontology with other projects	Sister projects	WP4 / WP7 / WP8	CIMNE, CSTB, ECTP	ECTP community	Animate the community
Harmonizer	Use Standard	Harmonizer uses RML		WP3 / WP4	CSTB	JSON to RDF conversion	Support from community
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	
Harmonizer	Contribute - Publication	Publicate our work to the community	bSI, W3C, ETSI	WP3 / WP4 / WP7	CSTB, CIMNE		Write and publish article to domain conferences

II.4.4. Phase 4 – Contribution to standardisation

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

We've identified several types of active contributions, which are detailed in the sections below.

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

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

The BIGG project organized on November 8 the standardisation workshop "Leveraging on standardisation for building data aggregation and analytics" in collaboration with the sister projects MATRYCS and BuiltHub and hosted by BUILDUP.

The aim of the discussion was 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 set the basis of the "sister projects community" and exposed: the intention of taking part together in actions organised by standardisation bodies and regulators; and how the projects could approach, participate in them and actively contribute to standardisation.

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 (111 viewers on 03/11/23)

Figure 3 - First standardisation workshop with sister projects

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 standardisation 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.

The Harmonizer module

The harmonizer module, developed during the project, is not a pure innovation result. It can be seen more like an innovative way of combining existing standards formats and tools to achieve a very useful task: translating and gathering a set of heterogeneous data sources (building description, system and sensor information, time series, …) into a unique data model represented by the BIGG Ontology.

The results of the innovative work have been summarized into scientific articles we are currently trying to publish in domain conferences and journal. A first version of the article was submitted early in 2023 to LDAC 2023 conference, but finally was not accepted due to the very Linked-data oriented scope of the conference. A new version of the article is been submitted to the 2024 European Conference on Computing in Construction, that will take place in Chania, Crete, Greece on the 15-17 July 2024.

II.4.4.c. 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 (standardisation process can be quite long).

BIGG Ontology V2

What we see as the most important standardizable outcome of the BIGG project is the BIGG Ontology. This specific data model has been designed to fulfil the requirement of off BIGG project Use Cases. The first version of the Ontology was completely original, even if many concepts were inspired from existing standards. When we realized that this work could be of interest for the community, we decided to develop a second version of the Ontology, aligned with existing standards. Alignment is the very first, and probably the most important, step into the process of standardising a new Ontology. Linked-data is all about reusing existing component instead of redeveloping then, and the community is very sensitive to this point. This is why we choose to invest quite a large effort in this alignment process. Now, the BIGG Ontology V2 is aligned with all most recognized ontologies in the different domains it addresses (for more details about the BIGG Ontology V2 and the alignment process and results, please refer to BIGG deliverable D4.2).

During all the phase of development of the different version of the BIGG Ontology, CIMNE has been in active collaboration and exchange of information with the Ontology Engineering Group of the Artificial Intelligence department of Universidad Politécnica de Madrid (UPM), which is one of the main participants in the development of SAREF core, SAREF4BLDG, SAREF4CITY, SAREF4AGRI. The collaboration was formalised through a 6 monthly CIMNE's researcher stay in UPM (from September 2022 to March 2023), during which an extensive transfer of information on the BIGG ontology was done, including specific contributions from BIGG that could be used for further extension of the SAREF family of standards. Those contributions, once approved and included in SAREF, would extend its capability to cover the full scope of BIGG tools and use cases.

In addition, CSTB has recently initiated contact with ETSI, the standardisation committee responsible for standardisation of the SAREF Ontology and all its extensions. This will allow us to go further into the “ETSI standardisation process”, that can be summarized by the following steps:

1. Understand ETSI Processes: Familiarize yourself with the ETSI standards development processes. ETSI has specific guidelines and procedures for developing standards, and understanding these processes is crucial.
2. Engage with ETSI: Participate in ETSI events, workshops, and meetings related to your ontology domain. Engaging with the ETSI community will help you understand the current standards landscape and build support for your ontology.
3. Draft a Proposal: Prepare a formal proposal outlining the need for your ontology as a standard, its scope, objectives, and potential benefits. Clearly articulate how your ontology addresses specific challenges or requirements within the telecommunications domain.
4. Conduct a Feasibility Study: Perform a feasibility study to assess the technical and practical aspects of integrating your ontology into ETSI standards. Consider factors such as interoperability, scalability, and potential impact on existing standards.
5. Establish Working Relationships: Build working relationships with key stakeholders within ETSI who may be involved in the standardisation process. This includes contacting relevant technical committees or working groups related to your ontology's domain.
6. Submit a New Work Item Proposal: Submit a New Work Item Proposal (NWIP) to the appropriate ETSI Technical Committee (TC) or Industry Specification Group (ISG). The NWIP should include a detailed description of the ontology, its objectives, and its potential contribution to the telecommunications industry.
7. Participate in Working Groups: If the NWIP is accepted, actively participate in the working groups formed to develop the standard. Collaborate with other experts and stakeholders to refine the ontology and address any issues raised during the standardisation process.
8. Address Comments and Feedback: Be prepared to address comments and feedback from the ETSI community. This may involve revising the ontology or providing additional documentation to clarify its use and implementation.
9. Public Consultation: ETSI standards typically undergo a public consultation process. Ensure that your ontology is made available for public review, and be open to receiving input from a broader audience.
10. Balloting and Approval: The standardisation process involves formal balloting within the relevant ETSI group. If the ontology receives sufficient support and meets the necessary criteria, it may be approved as an ETSI standard.
11. Publication and Maintenance: Once approved, the standard will be published by ETSI. Be prepared to participate in the maintenance of the standard, addressing updates, revisions, and any emerging issues that may arise.
12. Promote Adoption: Actively promote the adopted standard within the industry to encourage its widespread adoption. This may involve collaborating with industry organisations, hosting workshops, and providing resources to facilitate implementation.

II.5. Recommendations about standardisation

As a conclusion to this part of the document, we found it useful to give some recommendations. First about the general management of standardisation 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 standardisation during European Projects

Performing an efficient and well-structured contribution to standardisation 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 standardisation development process can be incompatible with project timing
- The large number of different types of actors involved in the project.
- But standardisation 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 standardisation 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 standardisation 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 standardisation (unless the standardisation 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 the dissemination of the use of the standard that was made during the project.
- Try to involve as many partners as possible
    - Diversity of standardisation approaches is often very constructive
    - SME participation in standardisation should be ensured for these standards to be adapted to SME needs and widely used
- Organize dedicated workshops, really focused on standardisation. It is often much more efficient than a standardisation timeslot in a general project meeting.
- Try to create / animate standardisation communities
    - With sister projects sharing some common standardisation needs or goals.
    - By organising 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 modelling 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 WP7 and WP8

Throughout the duration of the project, synergies have been created between T7.1 and T7.2 from WP7 and T8.3 *Liaisons, stakeholders' engagement and other synergies* from WP8. 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 and T7.2.
- to influence policymakers, regulation bodies, standardisation 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 favour the market opportunities for big data and AI solutions.

II.6.1. Collaboration with the Ontology Engineering Group of the Artificial Intelligence department of Universidad Politécnica de Madrid (UPM)

CIMNE has been in active collaboration and exchange of information on the BIGG ontology with the Ontology Engineering Group of the Artificial Intelligence department of Universidad Politécnica de Madrid (UPM), which is one of the main participants in the development of SAREF core, SAREF4BLDG, SAREF4CITY, SAREF4AGRI. The collaboration was formalised through a 6 monthly CIMNE's researcher stay in UPM (from September 2022 to March 2023), during which an extensive transfer of information on the BIGG ontology was done, including specific contributions from BIGG that could be used for further extension of the SAREF family of standards. Those contributions, once approved and included in SAREF, would extend its capability to cover the full scope of BIGG tools and use cases.

II.6.2. Identified synergies with other projects

In addition to the 3 sister's projects mentioned in *Section II.4.1.d.*, other projects have been identified due to its similarities with the BIGG project:

Table 23 - InterConnect description

Sister project	InterConnect
Full name	Interoperable solutions connecting smart homes, buildings and grids
Type	4,5-year European Project funded under the Horizon 2020 programme
Web site	https://interconnectproject.eu/
Description	The EU energy market is conditioned by digitalisation. New rules and technological developments allow the proliferation of energy service providers in the EU member states with users having full knowledge and control over their appliances. However, interoperability represents a serious problem as a change of provider could mean the replacement of installations. The EU-funded InterConnect project proposes effective energy management using a resilient and practical ecosystem that is user-centric and market-driven. The project involves a range of specialised stakeholders, including advanced technology actors, manufacturers, providers and energy users. Via seven pilots, they will showcase an effective digital market for ensuring energy-efficiency at reduced costs that is beneficial to end-users.
Contact partners	• Laura Daniele, Senior Scientist at TNO (laura.daniele@tno.nl) • Inetum, HERON and IMEC are partners of the Consortium, thus, BIGG has a direct connection with the Interconnect project
Common research topics	• Interoperability framework • Digital technologies (Artificial Intelligence, Blockchain, Cloud and Big Data) based on open standards, such as SAREF • Business models driven by big data • Large-scale pilots leading to market driven deployments • Standardisation
Contribution strategy	Inetum, HERON and IMEC have kept an active communication with the InterConnect. In addition, CIMNE have interacted several times with InterConnect and one of its partners, TNO, as they are in charge of the development of SAREF. Their communications were focused on smart buildings, connecting ontology and standardized communication.

Table 24 - DigiBUILD description

Sister project	DigiBUILD
Full name	High-Quality Data-Driven Services for a Digital Built Environment towards a Climate-Neutral Building Stock
Type	4,5-year European Project funded under the Horizon Europe programme
Web site	https://digibuild-project.eu/
Description	The onset of digitalisation across most industrial and private sectors has led to massive amounts of data that are hard to use and store efficiently, especially in sectors with important and numerous data like the construction industry. Unfortunately, traditional data storage options take more space and money while also causing unnecessary emissions. The EU-funded DigiBUILD project offers a solution to this problem. It will develop and support novel digital building frameworks, transforming current data storage options into novel digital and more efficient ones. It will allow for improved ease of use and access to data and reduce emissions and costs.
Contact partners	• Diego Arnone, Head of Smart Energy Projects Research Area at Engineering Ingegneria Informatica Spa (Diego.Arnone@eng.it) • Dimitrios Rovas, Professor in Building Simulation and Optimisation, UCL (d.rovas@ucl.ac.uk)
Common research topics	• Open, interoperable and cloud-based toolbox • AI-based data analytics • Standardisation • Data governance framework • EPBD, European Performance of Buildings Directive • Interoperability framework • Digital Building Logbook • Building performance data collections
Contribution strategy	• Joint webinar organized by DigiBUILD and MODERATE: "*Data-driven innovations for monitoring the performance of buildings*" March 16, 2023. BIGG, represented by CIMNE, was invited together with other related projects (BEYOND, BuiltHub and MATRYCS) to participate in the roundtable discussion, which was mainly focused on the opportunities and barriers related to data sharing and interoperability • Technical workshop organized by DigiBUILD: "*Innovation & Usability – Designing tomorrow's energy efficiency services for building users*" October 25, 2023. BIGG was invited to the workshop and took part of the discussion. This interactive session aimed to gather valuable feedback on the concept and usability of DigiBUILD services for efficiency. • DigiBUILD, together with MODERATE and ENERGATE projects, were invited to take part of the BIGG Final Event (November 24, 2023). As part of the event, the session "*Ontology and AI Toolbox*" was dedicated to explore the aim, advantages and key components of the harmonisation layer of BIGG, based on the White Paper II "*The need for harmonising input data and AI Toolbox revolution in context of smart building management*". The three projects participated in an open discussion focused on the different ontologies developed within the projects.

Table 25 - MODERATE description

Sister project	MODERATE
Full name	Marketable Open Data Solutions for Optimized Building-Related Energy Services
Type	4-year European Project funded under the Horizon Europe programme
Web site	https://moderate-project.eu/
Description	MODERATE will formalize a set of procedures and techniques that enable building owners, policymakers, facility managers, utility companies, etc., to openly share their data, gain insights, and make decisions while complying with regulations such as the General Data Protection Regulation (GDPR). Moreover, MODERATE will enable uniform access to heterogeneous data sources on buildings' performance, usually dispersed in several non-interoperable data silos. MODERATE will develop an open platform, embracing leading-edge technologies, such as artificial intelligence (AI), machine learning (ML), blockchain/distributed ledger technologies, the internet of things (IoT), and many more. This platform will enable its users to analyze real-time building data from various building systems and provide insight into the many dimensions of a building's performance. The use of synthetic data generation techniques, not yet widely applied in the construction industry, is one of the elements that allow open data sharing, enabling more reliable services and generating business opportunities.
Contact partners	• Cristian Pozza, Senior Researcher at EURAC (Cristian.Pozza@eurac.edu) • Daniele Antonucci, Senior Researcher at EURAC (Daniele.Antonucci@eurac.edu)
Common research topics	• Open Data platform • Validation of data platform through large-scale pilots • Standardisation • Interoperability framework • Building performance data collections • EU Building Stock Observatory
Contribution strategy	• Joint webinar organized by DigiBUILD and MODERATE: "*Data-driven innovations for monitoring the performance of buildings*" March 16, 2023. More details can be found in *Table 5: DigiBUILD description* • As mentioned in *Table 5*, MODERATE, DigiBUILD and ENERGATE projects, were invited to take part of an open discussion on ontologies during the BIGG Final Event (November 24, 2023).

Table 26 - ENERGATE description

Sister project	ENERGATE
Full name	Energy Efficiency Marketplace
Type	-year European Project funded under the LIFE programme
Web site	https://www.energate-project.eu/
Description	Although the European Union is taking tangible steps to leverage private funding in energy efficiency investments as can be observed from recent initiatives for the standardisation and benchmarking of sustainable energy efficiency investments and smart energy services. A definite lack of capital flowing to the renovation of the current building stock is still present and is supported by the total value brought by interventions that remain untapped due to lack of funding. For this reason, ENERGATE aims to facilitate the creation of an effective, ICT-enabled, energy efficiency marketplace bringing together energy services and sustainable finance to accelerate the renovation rate of buildings by increasing the chances for projects to be financed. ENERGATE envisions to transform the complex set of decision-making actions for targeted groups, even to non-experts, into a user-friendly and single-entry service.
Contact partners	• Katerina Papapostolou, Senior Research Associate at NTUA (kpapap@epu.ntua.gr) • Marta Maia, Communication Manager at IEECP (marta@IEECP.ORG)
Common research topics	• Energy efficiency aggregation platform • Validation of data platform through large-scale pilots • Standardisation
Contribution strategy	• ENERGATE could exploit the services and business models of BIGG with the aim to facilitate the incorporation of big data in the platform. In terms of promoting EE investments, the BIGG project is dealing with investment data collection and tracking, investment de-risking services and traceable, data-driven approaches for savings' evaluation and risk indicators' calculation. In the meanwhile, BIGG use case for evaluating the real impact of the energy improvement actions could assist ENERGATE in extracting valuable information at the statistical level from the set of EEMs applied and registered in buildings. • As both projects share target countries (Spain and Greece), they can disseminate one another's objectives to their target audiences. • As mentioned in *Table 5*, ENERGATE, MODERATE and DigiBUILD projects, were invited to take part of an open discussion on ontologies during the BIGG Final Event (November 24, 2023).

II.6.3. #SmartEnergyCluster

BIGG was invited to become part of the #SmartEnergyCluster together with other sister projects, to join forces and work together in the framework of the dissemination, communication and exploitation of the projects activities and results, aiming at engaging interested and common target groups.

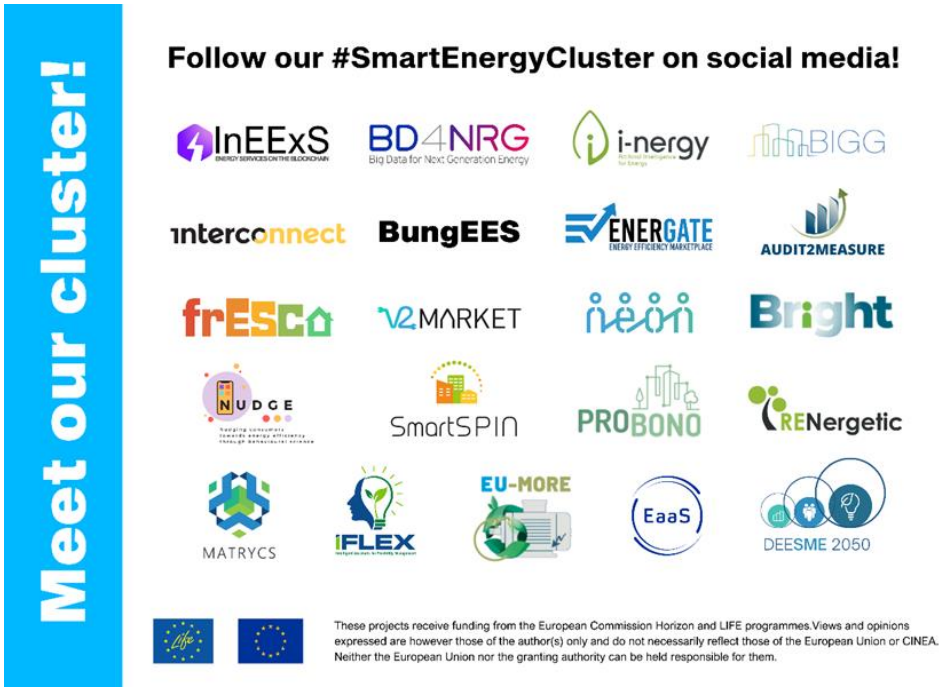

Figure 4: Banner of the #SmartEnergyCluster with the project logos.

Recognising that collaboration and innovation are key, 19 projects pool resources and expertise to accelerate the smart energy transition. The projects share a common objective to develop and deploy new business models and concepts which add value by leveraging integrated energy services. These combine different energy services, such as energy efficiency, distributed generation and flexibility, and/or which integrate energy services with non-energy benefits. Moreover, they aim to overcome the fragmentation of markets and segments and to enhance the cooperation and trust among different services providers and market actors, also across segments that so far do not have common business cases.

The cluster will work together in the framework of dissemination, communication and exploitation of the projects activities and results, aiming at engaging interested and common target groups. These collaborative actions will also aim to multiply the impacts of the benefits of each project, including for example, the integration of new and smart service offers, reduced energy costs for end-users and payback times of investments into sustainable energy.

More information about the 19 projects that shape the #SmartEnergyCluster, including the 4 innovative LIFE projects leading the cluster, here.

II.6.4. Synergies between buildings data projects and EU Buildings Stock Observatory

The EU Buildings Stock Observatory (EU BSO) aims to provide a better understanding of the energy performance of the building sector through reliable, consistent and comparable data. It includes a database, a data mapper and factsheets for monitoring the energy performance of buildings across Europe. The EU BSO is currently in the 3rd phase of development which includes the definition of indicators, data collection and a revamping of the user interface.

A consortium has recently started working to these objectives and they wanted to create synergies with other projects, thus they could contribute on the definition of data architectures, data governance, data security, use cases, data analytics services etc.

Five projects have been invited to initiate the conversations: 3 projects funded under the Horizon 2020 call Big data for buildings (BIGG, BEYOND and MATRYCS), since they develop a reference architecture for buildings data and data analytics services; and 2 projects funded under the Horizon Europe call Advanced data-driven monitoring of building stock energy performance (DigiBUILD and MODERATE), due to their work on data collection practices and data-driven monitoring of buildings performance.

During a first discussion that took place on September 14, it emerged that:

- All projects can provide valuable contributions to a document that lists the suitable solutions to EU BSO priorities
- Providing small datasets to EU BSO is possible, but the main purpose of the action is to showcase methods, use cases, analytics, data models etc… from the different projects as a reference
- It was agreed that BuiltHub project will lead the action, supported by all the projects.
- It was agreed that the objective is to share a mapping between project results (with TRL, description, references, suitability, licensing) and EU BSO priority needs.
- Any additional effort about transferring results from projects to EU BSO is out of scope.

After that, BuiltHub initiated collecting feedback on Eu BSO needs, from the consortium as well as from their offices; where it was highlighted their interest in data including governance and analytics on various aggregation levels.

III. BIGG MARKET2GO EXPLOITATION: METHODOLOGY

BIGG project is conceived with the objective to enable the collection and exchange of valuable building data, focusing on the processing 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 the 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. Based on these services, Business Case specific potential market ready products are introduced as BIGG M2G Business Case Blocks Business Models.

Initially, BIGG Ecosystem as a facilitator of this dual relationship between a development core and market ready products is explained. Based on the BIGG Ecosystem, BIGG M2G Business Model Methodology is introduced in this Section focusing on the different perspectives between Solution end-users and Solution providers.

III.1. BIGG Ecosystem

As mentioned, BIGG has chosen to release its code as Open-source software (OSS) and ensure continuity of BIGG Solutions available to current Solution end-users and prospective ones that Solution technical providers can identify. Open-source software is a technologically driven model that has benefited from commercial innovation. It has become a virtuous cycle, with more business innovation leading to a larger developer community, which drives more technological innovation, which increases the economic incentives for open source. The following schema presents how open source benefited to the BIGG project and its partners:

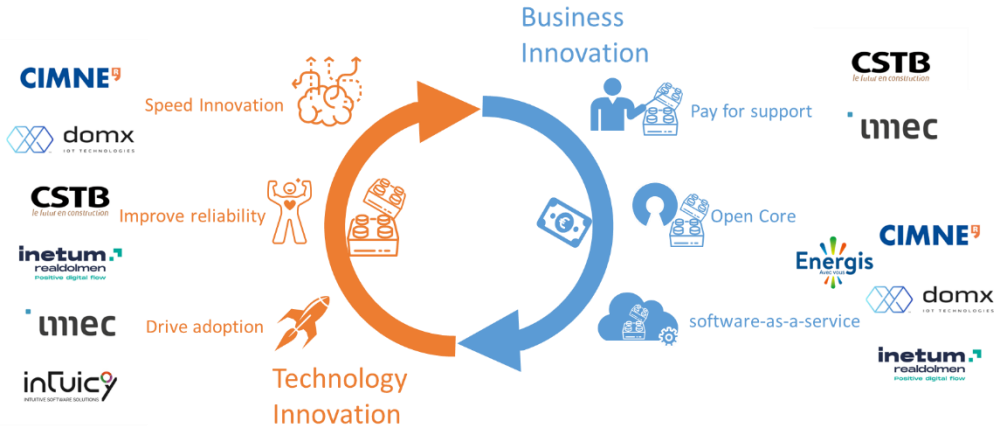

Figure 5: Virtuous Cycle of Open Source in the context of BIGG.

The BIGG European project has enabled technical collaboration between various partners to provide an OSS toolbox for collecting, harmonising, and processing building energy data from diverse sources. The open innovative context of the project has speeded the innovation process, improved the reliability of the delivered-code (with peer work) and drove easiest adoption of building energy data services with BIGG components provided under OSS licences.

As depicted in Figure 5 the technological innovation of the project is accompanied with a business innovation outcome where some of the technical partners could be paid to support

the integration of BIGG-created OSS components, some other partners can use an “open core model” to leverage shared BIGG core components to build specific energy management solutions for clients and maybe even operate then as a software as a service on their behalf.

Figure 6 presents the layering of the BIGG consortium partners regarding their economical positioning in the BIGG project context.

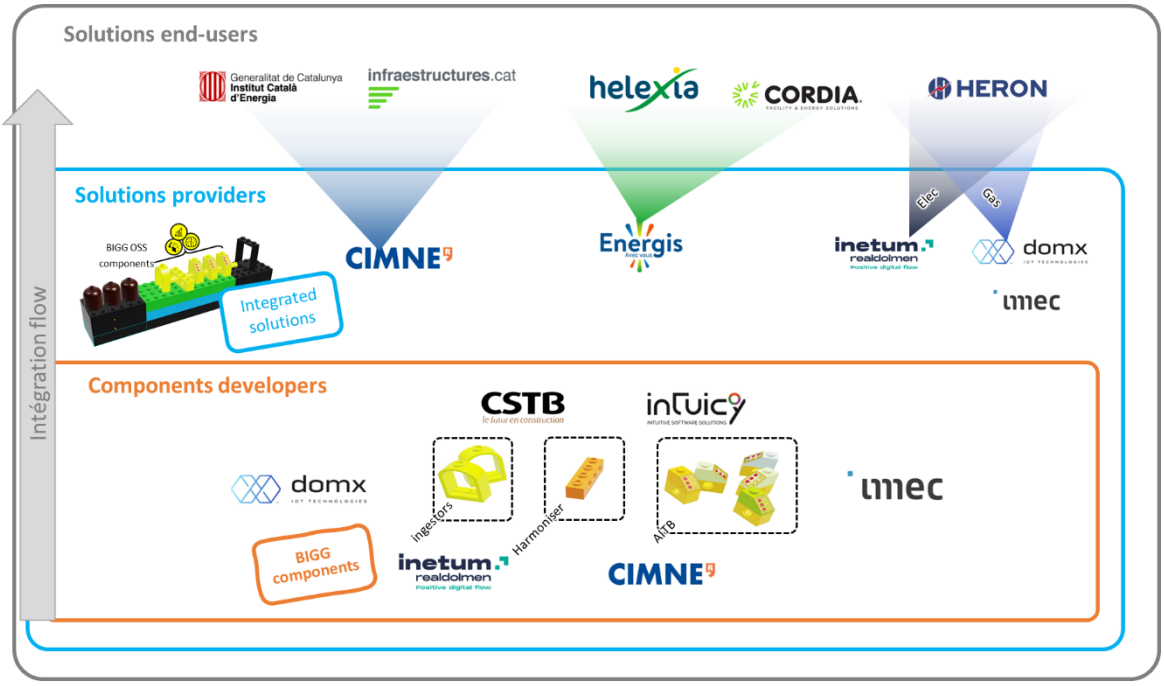

Figure 6: BIGG partners business roles in BIGG context.

1. **Solution end-users** are organisations that are looking to deploy technical solutions to provide added-value services to their customers. In the context of BIGG, these solution end-users are energy market services & building managers, such as ICAEN/ICAT, Helexia/Cordia, and Heron. These organisations are using a variety of innovative services, including:

    - Unified big data services: These services enable energy market services managers to collect, harmonize, and analyze data from diverse sources to gain insights into energy consumption and performance.
    - Building utility services: These services provide building owners and operators with tools to manage their energy consumption and costs more effectively.
    - Gas and electricity management applications: These applications demonstrate the potential of the BIGG platform to support innovative energy services, such as demand response and energy efficiency monitoring.

2. **Solution providers** can understand their clients' energy-related use cases and provide tailored applications operated in production (on premises or in the cloud). Examples of solution providers in the BIGG ecosystem include CIMNE, Energis, Inetum, and Domx/Imec. These organisations are leveraging the BIGG RAF and

BIGG OSS components[1] to develop custom solutions that address specific clients' issues. They can leverage BIGG applications such as:

- Energy benchmarking and efficiency measures assessment
- Baseline identification for Energy Performance Contracts
- Occupancy pattern detection
- Energy consumption forecasting
- Gas demand response

to create business opportunities.

3. **BIGG Components developers** are research centres and solution providers that are working together to create open-source blueprints and toolkits for optimising energy consumption and improving building performance. These organisations are playing a critical role in the BIGG project by developing the underlying infrastructure and tools that enable solution providers to build innovative energy services.

We can see that BIGG project has created a collaborative ecosystem of stakeholders from across the energy sector. By working together, these organisations have accelerated the development and adoption of innovative solutions that can help to achieve a more sustainable energy future.

III.2. Business Model Methodology

In BIGG project demonstration activities cover multiple Business Cases with its developed products combining multiple elements of the energy domain. While it is known that building data management solutions are already available in the market, BIGG solutions differentiate from existing market products by focusing on a complex ecosystem as demonstrated in Figure 6. For example, several of BIGG's Business Cases, focus on building sector applications which are integrated in a global energy context. That is, BIGG services break the silos of the individual Business Cases, by combining elements across multiple Business and Use Cases. To capture this integrated approach and facilitate BIGG's successful market up-taking, BIGG M2G Business Models refer to blocks of relevant Business Cases, allowing the developed BIGG Solutions to go one step beyond the current offer to ensure interoperability among a high number of actors, while being able to cope with the huge amount of data that the ecosystem manages.

In this context, Deliverable D7.3 builds upon, and significantly extends the Business Model methodology introduced in D7.1 and D7.2 [10], [11] consolidating the analysis from the specific Business / Use Cases, to Business Case Blocks. These Business Case blocks correspond to to BIGG energy services demonstrated in BIGG pilots.

This section introduces the toolset that will deliver Value Propositions to identified Customer Segments, by defining new relationships between relevant actors, and then proceed to characterize the key resources, activities, partners, channels, costs, surpluses, and revenues.

As a starting point the specific Business Case Exploitable Results that were extracted in relation to applicable Use Case, or Business Case in D7.2 are consolidated for the M2G Business Case blocks. This process is then extended to Market Analysis, and Lean canvas for BIGG M2G products from both the perspectives of Solution end-user and Solution provider.

[1] See D2.3 Final technical specifications and description of the integrated BIGG solution

III.2.1. BIGG Exploitable Result Aggregated Matrices

Exploitable Result (ER) Matrices were introduced in D7.2 in conjunction with the Market Analysis as the initial steps towards the Business Model Methodology [11]. During a workshop conduced in parallel to the BIGG PMB meeting held in Lyon from 22/10/2022 to 24/10/2022, an initial list of ERs was drafted based on an extended list that identified more than 15 potential ERs which were directly related to specific technological contributions and innovations as the project progressed.

Following that physical meeting, virtual meetings were organised to collect feedback from each consortium partner for the D7.2 Use Case Market Analysis. During this process, the initial number of ERs was reduced, in alignment with Business and Use Cases that could lead to prospective product driven ERs.

In this context, the key BIGG outcomes that could find commercial applications after the completion of BIGG were nominated as ERs based on a common roadmap among the involved partners. Each ER from D7.2 is presented based on the following template, also present in D7.3. However, here ERs are combined to align with the consolidated M2G Business Case Blocks as seen in Table 34, Table 39, Table 44, and Table 49.

In the template below, 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.

BC/UC in relation with	**Short name**	**Partner**
Description		
Component / Stand-alone (can it be launched as an independent product or is it a component)	Technology or customer oriented	

Table 27: Exploitable Result Matrix based on Use Cases.

However, the above classification excludes any mention to BIGG Reference Architecture Framework, the foundation upon which BIGG components which lead to BIGG solutions were built as described in Figure 6. Acknowledging that excluding Use Cases which had a supportive role without leading to concrete and marketable Exploitable Results, limit BIGG's impact, led to the consolidation of the ER/ Base Case/ Use Case specific Business Model Methodology as described in D7.1[10] and D7.2 [11]. It became clear that while ERs are excellent tools to detail how BIGG's components lead into marketable processes, they introduce severe complexity when reviewing the business potential and impact of complete products, as expected by the BIGG Exploitation Strategy introduced in the Grant Agreement and iterated in D7.2 [11]. To this end, BIGG M2G Exploitation Methodology requires that ERs are aggregated in BIGG M2G Solutions based on blocks of Business Cases / Use Cases, which in turn, include groups of ERs.

This showed that there are several innovations in relation to specific BIGG components, developed as parts of BIGG Reference Architecture Framework (RAF), that are not related to a Use Case but are critical requirements for the technical and user driven BIGG M2G Business Models. These were labelled as "BIGG Infrastructure Exploitable Results" to distinguish them from the BC / UC specific ERs and form the bottom layer of BIGG Ecosystem shown in Figure 6. Table 28 considers the three core BIGG RAF components as an ER template demonstrating the method.

BIGG RAF1	Ingestion + Harmonizer block	CSTB, Inetum (Core)
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) 2. Conversions: converts multiple data sources and formats to BIGG's open data model standard		
All BIGG Component developers are involved in various stages.	Technology oriented ~ Component of BIGG RAF	
BIGG RAF2	Standard Model 4 Buildings	CIMNE, CSTB (Core)
The BIGG Standard Data Model 4 Buildings capitalises on a the strengths of EU Initiatives in Standardisation, extending them so that in conjunction with existing EU and US Building Energy ontologies it creates an open, democratised and interoperable building Ontology.		
All BIGG Component developers are involved in various stages + IMEC & Energis (Solutions providers).	Technology oriented ~ Component of BIGG RAF.	
BIGG2 RAF3	AI & Analytics Toolbox	CIMNE, CSTB (Core)
The BIGG AI & Analytics Toolbox develops processes of cleaning, transforming, and modelling data to discover useful information for business decision-making based upon the data analysis. It consists of 4 components: 1. Data democratisation, 2. Baseline calculation, 3. Building Occupancy estimation, 4. Cross-vector consumption		
All BIGG Component developers are involved in various stages + IMEC & Energis (Solutions providers) + HELEXIA & ICAEN (end-user).	Technology oriented ~ Component of BIGG RAF and stand-alone product that can be used without RAF 1 & 2.	

Table 28: BIGG RAF as Exploitable Results template.

To this end, the Business Model Methodology presented here, aggregates the ERs identified in D7.2 [11], into the BIGG M2G Business Case driven Business Models in Section IV.

III.2.2. Business Model Market Analysis

Following the aggregated ERs, D7.3 also consolidates the Use Case specific Market Analysis in D7.2, for the BIGG M2G Business Models. Market Analysis is a key part of any business plan as it offers a quantitative and qualitative assessment of a market. It investigates 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.

Typically, Market Analysis consist of the following parts:

1. **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.

2. **Target Market** describes the ideal customer is described.

3. **Competition** outlines competition and their weaknesses.

4. **Legislation / Regulations** analyse existing and prospective constraints and barriers and at National and European level.

The template is presented as follows.

Market Analysis BIGG M2G Business Case Block	
Stakeholder Analysis	
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	Policy makers at all levels: - Local and regional organisations (CPMR, Energy Cities) and public buildings management agencies; - National ministries; - European Associations (AEEBC, EBC, EuroACE, etc), Standard Development Organisations and regulators (TNO, ETSI, CEN-CENELEC, etc) and Building data stock managers (EU BSO).
Suppliers	Those who bring the technical context to integrate a solution 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.
Target Market	
Market size	How many potential customers are there for the BIGG Exploitable Result.
Demographics	Target group's age, gender, education, income level, and 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 behaviour?
Competition	
Direct competition	Companies that are offering very similar products and services. The potential customers are probably currently buying from these companies.
Indirect competitors	Alternative approaches and solutions that competitors may have to the same problem.
Legislation / Regulations	
The relative legislation and the subsequent regulations that rule the targeted market must be "thoroughly" described and analysed 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.	

Table 29: Template of Market Analysis for a BIGG M2G product.

III.2.3. BIGG Business Model Lean Canvas

A business model is a conceptual structure that supports the viability of the business and explains who the business serves to, what it offers, how it offers it, and how it achieves its goals. All the business processes and policies that a company adopts and follows are part of the business model. In other words, a business model is a description of how a company creates, delivers, and captures value for the customer as well as itself.

An ideal business model usually conveys four key aspects of the business which is presented using a specialized methodology / tool called Business Model Lean Canvas. The Business Model Lean Canvas was developed by Alexander Osterwalder and Yves Pigneur in the context of the Business Model Framework [9] and is considered an established way for describing and visualising business models, by emphasising in the rationale of how an organisation creates, delivers and captures value. The key aspects of a business model are customers, value proposition, operating model, and revenue model. Precisely, a business model answers the following key questions:

1. Who is the customer?
2. What value does the business deliver to the customers?
3. How does the business operate?
4. How does the business make money?

In workshops that took place in parallel with BIGG PMB meetings in Madrid 2/2/2023-3/2/2023 and in Nice 13/6/2023-14/6/2023 Business Models where drafted based on the Exploitable Results, Market Analysis and Business Case / Use Case assessment in D7.1 and D7.2. In D7.3 these Business Models consolidate to the BIGG M2G Business Models based on the Business Case blocks, resulting in dual perspective Lean Canvases, distinct for the Solution End-users and the Solution Providers. Below, a generic Lean Canvas for BIGG OSS Framework, acting as the template for the specific BIGG M2G Business Model Lean Canvases.

Lean Canvas BIGG Reference Architecture Framework

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Value Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>Maintain updated analytic libraries to access to Building / Energy Data
Define sustainable Building relate Energy data models
Maintain custom tool chain to train Building / Energy data related models</td><td>BIGG Reference Architecture Framework (RAF) to ingest, harmonise, process data
A curated Analytics toolbox with AI libraries.</td><td rowspan="2">Software components from RAF + AI toolbox act as foundations to advanced Building / Energy Efficiency services.</td><td>Integrated services based on innovative components tested in BIGG.</td><td>Solution end-users (Utilities, ESCOs etc)
Solution providers (technology, innovation companies)</td></tr>
<tr><td>Existing Alternatives</td><td>Key Metrics</td><td>Channels</td><td>Early Adopters</td></tr>
<tr><td>Customised -fit for specific purposes- analytics libraries
Customised data models for specific business</td><td>Number of Business / Use Cases supported by RAF components</td><td>Promotion through professional networking, open workshops.</td><td>Innovation driven solution end-users</td></tr>
<tr><td colspan="2">Cost Structure</td><td colspan="3">Revenue Structure</td></tr>
<tr><td colspan="2">Effort required to keep RAF components updated and tested.</td><td colspan="3">Consulting fees on employing contributors to update and integrate RAF components for Solution provides
Consulting fees on deploying a service based on RAF for Solution end-users</td></tr>
</table>

Table 30: Lean Canvas for BIGG RAF as a template for BIGG M2G products.

III.2.4. Exploitation and IPR Management

The exploitation and commercialisation strategies of BIGG are crucial to secure the highest impact of the project with a well proven methodology for technology and innovation transfer to the industries and market, based on the experience of the consortium members and the undertaken innovation management activities. To achieve this, four exploitation objectives have been set: (i) contribute to infrastructure providers and regulatory bodies assisting them to better operate, safeguard and manage building-related data, (ii) demonstrate the technological and business impact of deployments, (iii) create new, feasible, and applicable business models, and (iv) provide a strategy for design, development, and replication strategies for clinical research operatives and policy makers.

The tools presented so-far in this Section achieve objectives (i)-(iii) by presenting the methodology followed to derive a Business Model toolbox to assist consortium partners in exploiting their effort within BIGG following its conclusion by indicating the pathways towards successful commercial exploitation. BIGG exploitation strategies are entitled to define the route

each Business Case Block takes towards the market, including the analysis of its positioning and the development of its business model.

Variables such as scalability, replicability of BIGG trials experience, cost and usability were considered so that BIGG results can be exploitable with a reasonably affordable investment from the partners if they choose to do so, considering also the IPR agreements that may occur. The general exploitation guidelines following the conclusion of the project are described as follows:

- Internal exploitation
  - BIGG's outputs, such as business models and guidelines, can be potentially internally adapted to the existing services or products of the organisation;
  - Further development: continue the research to improve the existing products or services;
  - Identification of stakeholders that can use the guidelines created by BIGG to improve data modelling based on established standards.
- Collaboration with other BIGG partners
  - Collaboration with other BIGG partners by providing the services or products using business models created in BIGG;
  - Further development of the services or products by collaboration with other BIGG partners.
- Collaboration with partners other than BIGG
  - Collaboration with partners other than BIGG by providing the services or products;
  - Further development of the products or services by collaboration with partners other than BIGG.
- Spin-off opportunities
  - To establish a new company;
  - To launch a new service or products;
- Commercialisation through:
  - Selling products or service globally;
  - Licensing to an existing company;
  - Selling license of the products or services.

Exploitation plans, both at project level - with results combining IPR from several partners - and individual partners, ensure that all activities relevant to exploitation are manageable and achievable. It becomes apparent therefore that for BIGG IPR plays an important role in facilitating the transfer of innovative technology to the marketplace as innovations generated by partners are transferred into IPR and products. The issues involved have been monitored at different levels in the project following the recommendations of the European Commission for H2020 projects[2]. ERs have been mapped to their owners and key contributors in D7.1 and D7.2 as the consortium worked towards building BIGG RAF and the services that were demonstrated in the pilot sites. The IPR process conducted in WP7 Workshops during BIGG Consortium meetings addressed the IPR ownership for each ER, and as ERs, BCs and UCs were consolidated to adequately reflect market-ready products of high quality and TRL, IPR ownership has been tracked and attributed to their owners as shown in Section IV.2. .

[2] http://www.iprhelpdesk.eu/sites/default/files/documents/EU-IPR-Guide-to-IP-in-Horizon-2020-EN.pdf

As already mentioned, BIGG has concluded to four Market2Go products with two variations depending on the role of the consortium member (solution end-user or provider). To be able to take to the market the final BIGG outcomes access rights to IPR must be managed by partners and external users to ensure the research findings are protected and avoid unforeseen obstacles related to confidentiality or competitiveness. The issues addressed include:

- The background knowledge that partners have brought to the project;
- The foreground knowledge that partners have involved in their products during the project;
- IPR types such as trade secrets, utility models, patents, trademarks, geographical indications; industrial designs, copyright and related rights;
- IPR Ownership;
- Risk assessment of IPR.

In order to achieve the aforementioned exploitation targets based on the presented structure in this Section, the Consortium Agreement (CA), signed by all partners before the project starting date has established certain process. That is, Section 9.4 of the CA, addresses the following:

- Access Rights to Results if Needed for Exploitation of a Party's own Results shall be granted on fair and reasonable conditions.
- Access Rights to Background if Needed for Exploitation of a Party's own Results, including for research on behalf of a third party, shall be granted on market conditions under a separate written agreement.
- A request for Access Rights may be made up to twelve (12) months after the end of the Project or, after the termination of the requesting Party's participation in the Project.

Ownership of IPR and access for the deployment of the developed services after the conclusion of BIGG, following each partner's business role in BIGG as identified in Figure 6: BIGG partners business roles in BIGG context., can be given in the following tables which list all the relevant information. For Solution end-users, column "Agreement" denotes whether an agreement following the exploitation of the service is in place with an explanation of actual actions below.

BC Block	BIGG M2G Product	End-user	Provider	Agreement
				*
** Explanation of nature of Agreement*				

Table 31: Template for Solution end-user exploitation mapping.

BC Block	BIGG M2G Product	Provider	IP dependencies

Table 32: Template for Solution provider exploitation mapping.

RAF Component	Component Developers	BC Block

Table 33: Template for BIGG OSS component mapping.

IV. BIGG MARKET2GO BUSINESS MODEL

Having defined the Methodology in Section III, here BIGG Market2Go Business Models are introduced and analysed based on the aforementioned methodology. Initially, relevant Business and Use Cases are consolidated in blocks and their Exploitable Results are aggregated. Then, Market Analysis and Lean Canvas charts are initiated for the new M2G Blocks.

IV.1. BIGG Market2Go Business Models

IV.1.1. BIGG M2G for Business Cases 1, 2 & 3: Energy Savings Solutions for Building Clusters

Business Cases 1 – 3, consolidate on a product offering services that improve energy efficiency of large clusters of 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.
- **Integration of Building Energy Performance Certification** data and its combination with other external data such as INSPIRE cadastral data.
- **Interoperability** with the integration of disaggregated data within buildings (building areas, zones, equipment and sensors) and data and results obtained with external systems such as DEEP or EuBSO.

To achieve this, there are several business and technical requirements to be met, further elaborated in the Use Case summary below.

Use Case 1: Benchmark and monitoring of Energy Consumption

Use case 1 develops tools and systems that enable advanced building benchmarking and monitoring both of building's performance and energy efficiency trends utilising large amounts of data, typically dispersed in multiple databases.

Use Case 2: Energy Efficiency Measures: registration and evaluation

Use Case 2 develops an Energy Efficiency Measures (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.

Use Case 3: Integration of INSPIRE spatial data with Energy Performance Certification (EnPC)

Use Case 3 adapts existing EnPCs to the INSPIRE standard in order to improve the credibility of the results of the certifications and facilitate the reuse of the data, either in future certificates on the same building or in the exploration of all together.

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

Use Case 4 expands a set of existing building certification indicators, according to the European Level(s) framework - Level(s).

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

Use Case 5 integrates data from the systems commonly used in buildings throughout their useful life. 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, better control and data processing improves energy efficiency in buildings.

Use Cases 6: Interoperability of BIGG with EEFIG-DEEP

Use Case 6 integrates 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.

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

Use Case 7 integrates data from Building Performance Certificates national Hubs with European Building Stock Observatory [i]. The results in of this effort are in formats directly compatible and importable by DEEP.

IV.1.1.a. Aggregated Exploitable Results

BC1-UC1	**Energy Consumption Benchmark**	ICAEN
A tool for monitoring and benchmarking of a building's performance, available to energy managers and building authorities.		
Stand-alone	Customer oriented	
BC1-UC2	**Energy Efficiency Measures**	ICAEN
A structured approach in storing EEMs easily accessible from building owners and users through a service provided by ESCOs or software developers.		
Stand-alone	Technology oriented	
BC3-UC5	**BIM, BMS and CMMS Data Integration**	CIMNE
Integration of general building data that can become available to building owners and users through a service provided by ESCOs or software developers.		
Component	Technology oriented	
BC3-UC6	**BIGG Interoperability with EEFIG-DEEP**	CIMNE
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.		
Component	Technology oriented	
BC3-UC7	**BIGG Interoperability with EUBSO**	CIMNE
Alignment of BIGG Data with the EUBSO taxonomy and structure that can facilitate adoption of BIGG Exploitable Results		
Component	Technology oriented	

Table 34: BC 1, 2 & 3 Aggregated Exploitable Results.

IV.1.1.b. Market Analysis

Market Analysis BC 1, 2 & 3: ICAEN, ICAT	
Stakeholder Analysis	
Users	Building owner's and building user's, aimed a large building portfolio.
Enablers	Efficiency Obligations legally enforces by National or European laws (akin to EU Energy Efficiency Obligation Schemes – EEOS).
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	Energy efficiency facilitators teams within public institutions, such as ICAEN's own team. In general, building owners, ESCOS, Buildings and facilities managers (INFRA), even policy makers.
Target Market	
Market size	Any building with smart meter.
Demographics	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	Buildings that have integrated Energy Efficiency services in their Facility Management, potentially offering benefits / quality of life improvements to tenants.
Indirect competitors	Maintenance companies and installer companies that may influence the ESCO market.
Legislation / Regulation	
The main legislation affecting energy efficiency services refers to data protection (GDPR) 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. 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 considered and closely monitored.	

Table 35: BC 1, 2 & 3 Market Analysis for BIGG Solution end-user.

Market Analysis BC 1, 2 & 3: CIMNE	
Stakeholder Analysis	
Users	Any building owner with buildings with smart meter infrastructure
Enablers	Data protection legislation may apply. Regulatory authorities and state legislature that can apply legal frameworks to facilitate the access and integration of data. For example, force to different providers to standardize the data formats and communication channels.
Suppliers	Energy efficiency facilitator teams within public or private organisations that own or control buildings.
Researchers	CIMNE
Beneficiaries	Building owner's and building occupants having access to energy efficiency and comfort services.
Target Market	
Market size	5-10% of current users of a M&V (Measure & Verification) protocol are potential clients for a related product.
Demographics	Building owners.
Location	No limits.
Psychographics	Users expect to be able to track the savings obtained after implementing energy efficiency measures.
Competition	
Direct competition	Other companies that offer energy efficiency & monitoring services such as Dexma.
Indirect competitors	ESCOS, Buildings and Facility Management companies using inhouse products.
Legislation / Regulation	
The main legislation affecting energy efficiency services refers to data protection (GDPR) 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. 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.	

Table 36: BC 1, 2 & 3 Market Analysis for BIGG Solution provider.

IV.1.1.c. Business Model Canvas

Lean Canvas BC 1, 2 & 3: ICAEN, ICAT

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>Limited access to the results of application of Energy Efficiency Measures in buildings to take them as a reference.

Lack of services sufficiently flexible to link building data from multiple sources and make it available for energy management.

Lack of analytical models for comparison and evaluation of applied measures to be used in building monitoring systems.</td><td>Easy access to large EEM portfolio.

Access to flexible services to collect and join data from buildings that are currently unlinked.

Streamlined tools to simplify the benchmarking modelling and monitoring for buildings and EEMs.</td><td rowspan="2">Minimisation of the amount of manual work to do for each contract, specially for large building stocks and increase of customer trust.

Increase market share by allowing to bring new potential clients.</td><td>Flexible solution for large building portfolios.</td><td>Organisations with large building stocks aiming to reduce operating costs, meet sustainability objectives and validate them.</td></tr>
<tr><th>Existing Alternatives</th><th>Key Metrics</th><th>Channels</th><th>Early Adopters</th></tr>
<tr><td>Traditional energy management systems with limited capacities to join different data resources.

Fragmented solutions requiring manual data collection and analysis</td><td>Number of buildings and EEMs modelled and monitored.

Time and effort reduction to manage large building stocks.</td><td>Advertisement through social media

Professional networking</td><td>Professionals with a keen interest in data-driven solutions</td></tr>
<tr><th colspan="3">Cost Structure</th><th colspan="2">Revenue Structure</th></tr>
<tr><td colspan="3">CAPEX: Feasibility study / Data resources connection / Cost for monitoring building and EEMs performances, Energy Efficiency certificates, and building systems data / Set-up of software & operational processes (100 – 500€/y for a building)

OPEX: software licence costs / human services the data performance (150 – 200 €/y for a building)</td><td colspan="2">There is no direct revenue structure given that this service is offered to building owners and managers. However, it can improve savings and comfort to tenants, which can be indirectly partially passed in rents if applicable.</td></tr>
</table>

Table 37: BC 1, 2 & 3 Lean Canvas for BIGG Solution end-user.

Lean Canvas BC 1, 2 & 3: CIMNE

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>Data from energy performance certificates of buildings are not integrated. It is not reusable in other phases of the building's life cycle.

Data from BMS, CMMS and BIM models for large building portfolios are not integrated. These data are not reusable in other phases of the building's life cycle.</td><td>Definition and implementation of a standard building data model and creation of tools to automate the data processing into the right KPIs.

Automation of the data collection process form multiple external resources (DDBB, Systems, etc...).

Visualisation environment that allow service providers to present the results to their customers.</td><td rowspan="2">It provides a friendly end-users interface for monitoring their energy and financial savings.

Smart monitoring can reduce energy consumption and the risk of human mistakes which could result to significant economic and energy losses.</td><td>Energy Managers develop a strong relationship with their customers (residents) that can last a long time.</td><td>Large building portfolio owners or managers (public, commercial, health, academic)

ESCO's, Energy Managers and maintenance companies and Installers which are not ESCOs (e.g. facility management</td></tr>
<tr><th>Existing Alternatives</th><th>Key Metrics</th><th>Channels</th><th>Early Adopters</th></tr>
<tr><td>Until now, there is no commercial product to facilitate the aggregation of all building cycle data for large building portfolios.

Most building portfolios are managed with different tools and DDBB</td><td>Building data integration.

Monitoring and Benchmarking (buildings and EEMs performance).

KPI’s presentation.

Data exchange</td><td>Networking, participation in open calls, participation in professional fairs.</td><td>Large building portfolio owners or managers (public, commercial, health, academic), ESCO's, Energy Managers and maintenance companies.

Other platforms or service providers that need buildings data.</td></tr>
<tr><th colspan="2">Cost Structure</th><th colspan="3">Revenue Structure</th></tr>
<tr><td colspan="2">R&D cost: cost for SW development = number of days * daily rate (250€/day)

ICT cost: dedicated server via hosting provider

Staff costs (customer support, sales, marketing, management) = number of days * daily rate (250€/day)</td><td colspan="3">The subscription fee per year starts around 2000€/yr which includes a platform for 100 buildings and basic applications for monitoring and benchmarking, possible to applying volume discount.

Price for extra buildings or other data to be integrated and applying volume discount.

Remote services yearly fee from 500€/yr for 100 buildings and including alerts treatment, data analysis, reporting.</td></tr>
</table>

Table 38: BC 1, 2 & 3 Lean Canvas for BIGG Solution provider

IV.1.2. BIGG M2G for Business Cases 4 & 5: EnPC Contract Management and Efficiency services automation

Business Cases 4 & 5, consolidate on a product offering services that manage EnPC contracts from storing and organising data related to any EnPC assets, tracking achieved savings and generate reports. Savings emerge by utilising offered data to optimize energy consumption while keeping the same comfort level within large tertiary buildings. Access to the data required for the optimisation, is facilitated by the automated EnPC process.

The developed product enables smooth communication between the ESCO managing the EnPC contract and the end customer who must be notified in case of any major savings deviation or when corrective actions are required.

To achieve this, there are several business and technical requirements to be met, further elaborated in the Use Case summary below.

Use Case 8: Storing, viewing, and updating relevant EnPC assets

Use Case 8 enables users to store, access, view and manage all relevant data regarding the management of an EnPC. This Use Case provides structure in the data collection process to enable the storage of all relevant information for the management of both an on-going EnPC and a new EnPC in the kick-off phase and throughout the lifetime of the EnPC.

Use Case 9: Actual savings tracking and periodic monitoring

Use Case 9 quantifies the impact of an Energy Conservation Measure (ECM) on a given building through an accurate modelling of the building consumption and enables the user to track the implemented ECMs in time and their impact on the managed asset. Based on baseline data and calculations, it offers verification of the outcome of the undertaken ECMs.

Use Cases 11 & 12: Forecast based optimisation

Use cases 11 & 12 are merged into one larger use-case, as both use-cases optimize energy consumption while keeping the same level of comfort for occupant. These Use Cases provide weather forecasts 24 hours in advance while adding occupancy forecasts to the optimisation logic as inputs for the service analysed in BC 4 & 5 Business Models. Use Case Market Analysis

Use Case 13: Optimisation using price forecast

Use Case 13 develops an optimisation method using price forecasts that add energy prices information on top of the weather and occupancy forecasts (Uses Cases 11 & 12). In doing so BC 4 & 5 service can switch between the most sustainable and/or cheapest energy use.

IV.1.2.a. Aggregated Exploitable Results

BC4-UC8	**Data asset management in relation to EPCs**	HELEXIA, CORDIA
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.		
Component and stand-alone to by used by ESCOs	Technology oriented	
BC4-UC9	**Efficiency (savings) tracker**	HELEXIA, CORDIA
Quantify the impact of ECMs and tracking of deployed ECMs based on dashboards and analytics		
Component and Stand-alone (can it be launched as an independent product or is it a component)	Technology and customer oriented depending on whether it is used as a component or as stand-alone product	
BC5-UC11&12	**Forecast based optimisation**	CORDIA, HELEXIA
Optimisation of energy consumption under specific levels of comfort for occupant		
Stand-alone service with a variety of possible users. It can also be used as a component for recommendations for BMS / EMS systems	Customer oriented	
BC5-UC13	**Price forecast optimisation**	HELEXIA, CORDIA
Optimisation using energy price forecasts on top of the weather and occupancy forecasts (UC 11 & 12)		
Component for recommendations for BMS / EMS systems	Technology oriented	

Table 39: BC 4 & 5 Aggregated Exploitable Results.

IV.1.2.b. Market Analysis

Market Analysis BC 4 & 5: HELEXIA, CORDIA	
Stakeholder Analysis	
Users	Commercial and Industrial building owners seeking guaranteed energy savings and performance. Organisation with aim to reduce energy costs / usage.
Enablers	National and EU Regulations and Policy objectives setting efficiency targets (i.e. Energy Efficiency Directive EU/2012/27, revised Energy Efficiency Directive, EU/2023/1791).
Suppliers	Technical providers offering EnPC processing, facility management, efficiency services.
Researchers	Specialised facility managers, energy auditors contributing in product / services functional requirements.
Beneficiaries	Commercial buildings' owners reducing occupants' carbon footprint and energy costs while they improve their overall well-being. Building occupants with reduced energy costs.
Target Market	
Market size	5-10 % commercial buildings. Up to 50% of tertiary buildings due to low coverage of needed technology.
Demographics	Younger generation mid-level professionals (30-45 yrs.) sustainability driven and digital adept.
Location	Typically countries with older building stock and lack of automation (so-called low hanging fruit due to increased potential).
Psychographics	Users expect to manage and monitor with a more efficient and effective way their facilities to achieve energy costs and CO_2 emission reductions. Savings may be achieved without compromising comfort.
Competition	
Direct competition	Other ESCO and facility management companies offering similar technologies and platforms to their customers.
Indirect competitors	IoT and BMS companies that can offer monitoring equipment with reduced features that do not any include efficiency services.
Legislation / Regulations	
Typical GDPR issues with acquiring, processing and storing sensitive smart-meter data, especially if it considers tenants as the not direct beneficiaries and owners of the service. Monitoring of National and EU Regulations on Efficiency targets.	

Table 40: BC 4 & 5 Market Analysis for BIGG Solution end-user.

Market Analysis BC 4 & 5: ENERGIS, HELEXIA	
Stakeholder Analysis	
Users	ESCO and Facility Management companies Planners and policy makers at various government organisations.
Enablers	DSOs responsible for the roll-out of smart metering infrastructure. National and EU Regulations and Policy objectives setting efficiency targets (i.e. Energy Efficiency Directive EU/2012/27, revised Energy Efficiency Directive, EU/2023/1791) that can mobilise building owners, hence creating a market for ESCOs/ Facility Managers. 2002/91/CE EPBD directives enforce the use of BMS solutions making efficiency driven services easier to deploy.
Suppliers	BMS and IoT equipment providers.
Researchers	Big data processing and AI related expertise including AI experts and data scientists both from academic and industry with access to hight quality data for service development and validation.
Beneficiaries	ESCO companies getting access to innovative products that enable them to improve their energy monitoring services and increase savings.
Target Market	
Market size	10-15 % of ESCO companies.
Demographics	Depending on the demographics of staff at ESCOs and Facility Management companies, as the service's principal users.
Location	Typically countries with older building stock and lack of automation with an active ESCO market.
Psychographics	Users expect to manage and monitor their EnPCs with a more efficient way, in order to reduce energy cost and usage and are expected to manage their clients' (owners and tenants) expectations (i.e. savings vs comfort).
Competition	
Direct competition	Companies that are offering very similar products and services. BMS and IoT providers offering monitoring solutions without efficiency / savings objectives.
Indirect competitors	ESCOs, Utilities, Facility Management companies producing inhouse tools. Ultra-low consumption buildings with improved energy efficiency and insulation that do not require much energy for heating / cooling.
Legislation / Regulations	
For some countries comfort levels are defined by local authorities (i.e. 19oC for tertiary buildings, 5 oC for warehouses etc.). European Efficiency directives becoming more ambitious prompt ESCOs to deploy services and allow technical providers to develop them based on smart monitoring infrastructure (BMS, smart meters)	

Table 41: BC 4 & 5 Market Analysis for BIGG Solution provider.

IV.1.2.c. Business Model Canvas

Lean Canvas BC 4 & 5: HELEXIA, CORDIA

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>Limited access to ESCO project financing and turnkey solutions.

High upfront investment and operational burden for customers.

Lack of efficient EnPC contract modelling and monitoring tools for ESCOs.</td><td>Performance guarantees and guaranteed energy savings.

Access to project financing options and delivering turnkey solutions to reduce upfront investment and operational burden for customers.

Streamlined tools to simplify EnPC contract modelling and monitoring processes for ESCOs.</td><td rowspan="3">Minimisation of the amount of manual work to do for each contract based on ready to use solutions for monitoring EnPC Contracts.

Guaranteed energy savings and performance guarantees.

Access to project financing, turnkey solutions, and specialized knowledge</td><td>Integration of advanced EnPC contract modelling and monitoring tools within a comprehensive energy efficiency platform

Expertise and knowledge accumulated through the development and implementation of the BIGG project</td><td>Commercial and industrial building owners seeking guaranteed energy savings and performance.

Organisations aiming to reduce operating costs and meet sustainability objectives.</td></tr>
<tr><th>Existing Alternatives</th><th>Key Metrics</th><th>Channels</th><th>Early Adopters</th></tr>
<tr><td>Energy management systems with limited EnPC modelling capabilities

Independent energy auditing services with limited comprehensive project financing.

Fragmented and manual data collection and analysis services</td><td>Number of EnPC contracts modelled and monitored

Energy savings achieved for customers through implemented solutions

Customer satisfaction ratings on guaranteed energy savings and performance guarantees</td><td>Direct sales and marketing efforts targeting building owners.

Partnerships with industry associations, energy efficiency organisations, and financial institutions</td><td>Sustainability / tech driven customers.

Customers wanting to advertise the use of new integrated digital solutions and services in the market.</td></tr>
<tr><th colspan="3">Cost Structure</th><th colspan="2">Revenue Structure</th></tr>
<tr><td colspan="3">CAPEX: Feasibility study and contract modelling / Retrofit installation, works / HW cost for monitoring of EnPC / Set-up of software & operational processes (15 – 500k€/y for a medium size tertiary building)

OPEX : software licence costs / human services for follow-up of EnPC performance (1500 – 2000 €/y for a medium size tertiary building)</td><td colspan="2">Revenue from EnPC Fees and revenue-sharing models based on guaranteed energy savings and performance guarantees between 5 and 15% of CAPEX</td></tr>
</table>

Table 42: BC 4 & 5 Lean Canvas for Bigg Solution end-user.

Lean Canvas BC 4 & 5: ENERGIS, HELEXIA

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Value Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>No tracking of an EnPC real time online and no automated reports.

Managing EnPC contracts is time consuming (managed with Excel) and prone to errors.

Sub-optimal energy use of equipment to ensure comfort.</td><td>Definition of a standard EnPC structure and creation of tools to automate the data processing into the right KPIs

Creation of generic dashboards and reports

Installation of sensors, meters and controllers for monitoring real time data, consumption and indoor conditions and application of control rules to optimise comfort and energy at the same time.</td><td rowspan="3">It enhances trust and allows prospective users to bring new potential clients.

Minimizes the amount of manual work to do for each contract.

It provides a friendly end-users interface for monitoring energy and financial savings that itself can reduce energy consumption and the risk of human mistakes which could result to significant losses.

.</td><td>Customers acquire a turn-key solution for EnPC management.</td><td>ESCO & Facility Management companies.

Large portfolio owners (with internal energy management team

Energy Managers</td></tr>
<tr><th>Existing Alternatives</th><th>Key Metrics</th><th>Channels</th><th>Early Adopters</th></tr>
<tr><td>Until now, there is no product to combine smart monitoring and automated EnPC management along with forecasting.

Most EnPC contracts are managed with Excel</td><td>Realised savings (both for ESCO and customer)

Comfort conditions</td><td>Advertisement through social media</td><td>Sustainability / tech driven ESCO & Facility Management companies, building owners.</td></tr>
<tr><th colspan="2">Cost Structure</th><th colspan="3">Revenue Structure</th></tr>
<tr><td colspan="2">R&D cost: cost for SW development = number of days * daily rate (750€/day)

ICT cost: typically around 120€/month for dedicated server via hosting provider

Staff costs (customer support, sales, marketing, management) = number of days * daily rate (750€/day) + variable costs based on result</td><td colspan="3">Subscription fee per year which starts at 9600€/yr which includes platform for 50 sites or 100 meters and applications for savings monitoring.

Price for extra sites (50€/site) or meters (25€/meter) and applying volume discount (on demand).

Remote services yearly fee which starts at 4400€/yr for 50 sites/100 meters and which includes alerts treatment, data analysis, reporting.</td></tr>
</table>

Table 43: BC 4 & 5 Lean Canvas for BIGG Solution provider.

IV.1.3. BIGG M2G for Business Case 6 UC14: Implicit Demand Response for Residential consumers on electricity

Business Case 6 demonstrates and exploits the flexibility potential of residential and commercial buildings across the two main energy vectors of electricity and natural gas. This Business Case develops two Use Cases: Use Case 14 and 15, for electricity and natural gas respectively, with each Use Case leading to two distinct Business Models, that is for Solution end-users and for BIGG Solution providers. The common foreground for both Use Cases is the energy flexibility potential and the fact that a Solution end-user is an Energy Supplier seeking to enhance the services and products offered to its clients.

Use Case 14: Implicit Demand Response for Electricity

It has been challenging to monetise residential Demand Response services, especially in markets in which the DSO has not yet deployed smart meters and the regulatory framework only considers Night / Day Time of Use (ToU) tariffs as a means of initiating load shifting. However, such ToU tariffs, incentivise consumers to consume during the night, where often (or at least for countries in high Solar Power shares), renewable energy shares are the minimum.

The service developed for Use Case 14, allows an Energy Supplier to offer recommendations via an SMS to its consumer on which hours within the day they should reduce their consumption to minimise their carbon footprint. To do so, Use Case 14 implements a green tariff scheme, akin to a dynamic market tariff, which aims to incentivise consumers to shift their electricity demand during “greener” hours. For the proposed green tariff, peak hours are not hours with highest market price, or critical loads, but hours with the lowest renewable energy share in the system.

A critical element of this Use Case is forecasting the offered flexibility, as limited as residential flexibility can be, by using occupancy and home usage forecasts and the optimisation of demand management through the DR platform based on the consumers preferences to increase probabilities that its recommendations are being followed. To achieve this, the BIGG products associated with the Use Case, integrate AI algorithms that can accurately predict the future demand for energy for the next 24-48 hours per household and public data available from the National TSO on the renewable shares. Based on a threshold set on the energy usage, the solution sends recommendations for either increasing or reducing the energy consumption with the objective of maximising consumption during high renewable energy shares. The service consists of a set of recommendations which are made available via an API.

IV.1.3.a. Aggregated Exploitable Results

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

Table 44: Use Case 14 Specific Exploitable Result.

IV.1.3.b. Market Analysis

Market Analysis BC6 UC14: HERON	
Stakeholder Analysis	
Users	Technology savvy and environmentally aware electricity consumers, early adopters.
Enablers	Regulatory authorities and state legislature that can remove specific legal barriers (smart meters, handling of GDPR sensitive data). DSO as the responsible for Smart Metering infrastructure. Utility companies supplying energy to their clientele, increasing efficiency in consumption.
Suppliers	Technical providers developing the service / product.
Researchers	Technology providers developing innovative products in support of innovation driven services launched from Utility companies. Utility Business Development and R&D departments defining functional requirements and thresholds in recommendations.
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 as the most eager early adopters.
Demographics	Typically higher educated, 35 years old.
Location	Urban centres.
Psychographics	Users are driven by commitment to sustainability; however they expect to get rewards for their effort which is monetary driven. Smart monitoring reduces consumption by making users proactive as long as they are engaged with service.
Competition	
Direct competition	Other Utilities offer smart monitoring platforms as part of Smart Home products, however there are no demand flexibility 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.	

Table 45: BC 4 & 5 Market Analysis for BIGG Solution end-user.

Market Analysis BC6 UC14: Inetum	
Stakeholder Analysis	
Users	Energy Suppliers / Utilities, energy community managers.
Enablers	Regulatory authorities and state legislature that can remove specific legal barriers (smart meters, handling of GDPR sensitive data). DSO as the deployer and operator of Smart Metering infrastructure. Utility companies supplying energy to their clientele, increasing efficiency in consumption.
Suppliers	Utility sharing access to Smart Metering infrastructure required for technical solutions in addition to knowledge of local electricity markets for determining tariffs.
Researchers	Big data processing and AI related expertise including AI experts and data scientists both from academia and industry.
Beneficiaries	Energy Suppliers / Utilities increasing their consumer base by offering innovative services.
Target Market	
Market size	All Energy Suppliers are potential clients.
Demographics	No limitations, depending on business strategy of suppliers.
Location	Countries with limited smart monitoring infrastructure are restricted in following such services due to reduced monetisation prospects.
Psychographics	Utilities that see that such services act as customer retention and acquisition programs with less costs than conventional retention and acquisition tactics are likely to keep the program.
Competition	
Direct competition	Other technical service providers.
Indirect competitors	Energy Suppliers / Utilities developing in-house services.
Legislation / Regulations	
For any DR service to be commercially viable for an Energy Supplier 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.	

Table 46: BC6 UC14 Market Analysis for BIGG Solution provider.

IV.1.3.c. Business Model Canvas

Lean Canvas BC6 UC14: HERON

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Value Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>Volatility in electricity market does not allow for stable / long term relationship with customers.

Customer acquisition and retention expensive in a highly competitive market.

Single dimensional business models focusing on EUR/kWh harm long-term prospects (reduce margins).</td><td>A Recommendation / DR product engaging customers and keeping them based on a portfolio of digital services that focus on cost reduction driven sustainability

Adapt in various degrees of infrastructure and engagement: from a single SMS to a wider customer base based on system data, to SMS / App notifications tailored on Smart Meter data.</td><td rowspan="2">Means of acquiring and retaining customers.

For the Customer:

a loyalty program linked to sustainability driven recommendations rewards customers for shifting their consumption towards periods of high RES shares</td><td>Being the first to offer such a service prepares the supplier for the advent of DSO issued smart meters.

Customers having invested time and money in a smart home platform may be less willing to change supplier.</td><td>Energy Supplier customers (households and businesses)

ESCOs offering efficiency services on behalf of the Supplier</td></tr>
<tr><th>Existing Alternatives</th><th>Key Metrics</th><th>Channels</th><th>Early Adopters</th></tr>
<tr><td>Currently there aren’t any products combining smart monitoring and sustainability driven recommendations</td><td>Followed recommendations per day / month

kWh of heavy energy loads not consumed during CO2 peak hours</td><td>Targeted advertisement through SoMe</td><td>Tech savvy customers (gadgets and visualisations)

Customers with environmental sensitivity</td></tr>
<tr><th colspan="3">Cost Structure</th><th colspan="2">Revenue Structure</th></tr>
<tr><td colspan="3">CAPEX

Mobile App development 100,000 EUR

Smart Monitoring Database development 50,000 EUR

OPEX

3phase meter 80 EUR / Installation 40 EUR per meter

Server requirements 10,000 EUR per year per 1000 customers

Staff costs (customer support, sales) 12,000 EUR per year per 200 customers</td><td colspan="2">The use of the service as customer retention tool can potentially save the company of 150 EUR cost to retain a customer and up to 1000 EUR had the customer left the company

The customer covers the cost of meter + installation, which can be recuperated from discounts based on following given recommendations (~ 120 EUR)</td></tr>
</table>

Table 47: BC6 UC14 Lean Canvas for BIGG Solution end-user.

Lean Canvas BC6 UC14: Inetum

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Value Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>Forecasting energy consumption lead cost-effective energy systems, taking advantage of customer’s flexibility.

Exploiting such flexibility often requires specific infrastructure attached to significant CAPEX.</td><td>API Recommendation service integrating AI/ML residential forecasts developed inhouse, and public data on RES share of electricity mix.</td><td rowspan="2">Provision of a service for energy retailers, able to provide recommendations to their customers about how to optimize energy consumption based on different criteria such as % of renewable energy available in the grid or dynamic tariffs.

Easy to deploy and integrate with clients’ existing Smart Monitoring infrastructure</td><td>Keeping the infrastructure on the solution provider’s side, it can be replicated for other Utilities.</td><td>Energy Suppliers

Energy aggregators

Energy community managers</td></tr>
<tr><th>Existing Alternatives</th><th>Key Metrics</th><th>Channels</th><th>Early Adopters</th></tr>
<tr><td>Currently there aren’t any products combining smart monitoring and sustainability driven recommendations.</td><td>Following daily recommendations. Confirmation via Smart Devices.

Post-analysis (D+1) of energy consumption actual change.</td><td>Professional networking and targeted advertisement in professional SoMe or specialist fairs / conferences.</td><td>Data Driven and Innovation focused Utilities / Aggregators</td></tr>
<tr><th colspan="2">Cost Structure</th><th colspan="3">Revenue Structure</th></tr>
<tr><td colspan="2">With an estimation for an MVP in approx. 20 working days we estimate a cost of 46850 eur.

Azure infrastructure: approx. 6000 eur/year**

**for Pilot case. Subscription based, pay as you use</td><td colspan="3">Providing the solution as an Infrastructure as a Service (IaaS). Cost is dependent on how many devices you want to integrate.

Maintenance of the service and APIs.

The solution can be coupled with BI (Business Intelligence) analytics (custom software or other standard tools like Power BI/Grafana).

Cross selling additional products (Gold partnership with Microsoft).

Additional functionality can be offered if needed through negotiable rates.</td></tr>
</table>

Table 48: BC6 UC14 Lean Canvas for BIGG Solution provider.

IV.1.4. BIGG M2G for Business Case 6 UC15: Explicit Demand Response for Residential consumers on natural gas

In line with the main objective of Business Case to demonstrate and exploit the flexibility potential of residential and commercial buildings Use Case 15 focuses on Natural Gas.

Use Case 15: Demand Response for Natural Gas

The product associated with Use Case 15 offers a solution that allows end users of legacy natural gas boilers to upgrade their heating systems through a cost-effective smart heating controller that allows them to participate 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 smartphone application provides the main communication interface for interacting with the demand-response (DR) management system and the services that allow indirect inference of the users' preferences based on smart metering data.

The proposed concept focuses on the Management of Natural Gas consumption in buildings, by actively controlling and optimising 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.

IV.1.4.a. Aggregated Exploitable Results

BC6-UC15	**Demand Response for Natural Gas**	DOMX, IMEX, HERON
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.		
Stand alone product aimed towards consumers, building managers and NG boiler installers	Customer oriented	

Table 49: Use Case 15 Specific Exploitable Result.

IV.1.4.b. Market Analysis

Market Analysis BC6 UC15: HERON	
Stakeholder Analysis	
Users	Technology savvy, energy cost and environmentally aware natural gas consumers. Preferably relative high consumption.
Enablers	Regulatory authorities and state legislature that can remove specific legal barriers (smart meters, handling of GDPR sensitive data). DSO as the operator of Smart Metering infrastructure. Utility companies supplying energy to their clientele, increasing efficiency in consumption.
Suppliers	Technical providers developing the service / product.
Researchers	Technology providers developing innovative products in support of innovation driven services launched from Utility companies. Utility Business Development and R&D departments defining functional requirements and thresholds in recommendations.
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	No limitations
Location	No limitations
Psychographics	The service introduces direct monetary savings for users participating in DR events and indirectly by optimising consumption. Given the cost of the solution, users should be aware of the savings they achieve (higher baseline consumption brings higher savings, hence shorter investment recuperation period).
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), potentially taking part of a Utility's business.
Legislation / Regulations	
GDPR issues need to be properly monitored and addressed. National and EU Regulations and Policy objectives setting efficiency targets (i.e. Energy Efficiency Directive EU/2012/27, revised Energy Efficiency Directive, EU/2023/1791) can introduce (or remove) financial incentives for users and Utilities to engage in such services.	

Table 50: BC6 UC14 Market Analysis for BIGG Solution end-user.

Market Analysis BC6 UC15: DOMX	
Stakeholder Analysis	
Users	Energy Suppliers / Utilities, energy community managers.
Enablers	Regulatory authorities and state legislature that can remove specific legal barriers (smart meters, handling of GDPR sensitive data). DSO as the operator of Smart Metering infrastructure. Utility companies supplying energy to their clientele, increasing efficiency in consumption.
Suppliers	Utilities / Energy Suppliers offering a product linked to satisfying EEOS, which is critical for its financing. Regulatory Authorities validating the energy savings methodology.
Researchers	Electronic and automation engineers for developing the controller. Big data processing and AI related expertise including AI experts and data scientists both from academia and industry.
Beneficiaries	Energy Suppliers / Utilities increasing their consumer base by offering innovative services and satisfying their EEOS (potentially reducing penalties associated with not meeting obligations).
Target Market	
Market size	All Energy Suppliers with a NG business are potential clients.
Demographics	No limitations, depending on business strategy of suppliers.
Location	Countries with limited smart monitoring infrastructure are restricted in following such services due to limited validation. It is important to have Regulator onboard.
Psychographics	Utilities that see that such services assist them in customer retention and acquisition with less costs than conventional retention and acquisition tactics are likely to keep the program. This adds value to the product if EEOS are satisfied (hence no additional opportunity losses to be covered)
Competition	
Direct competition	Other technical service providers.
Indirect competitors	It is unlikely that Energy Suppliers / Utilities will develop an in-house product such this, given the manufacturing expertise required.
Legislation / Regulations	
GDPR issues need to be properly monitored and addressed. National and EU Regulations and Policy objectives setting efficiency targets (i.e. EEOS, Energy Efficiency Directive EU/2012/27, revised Energy Efficiency Directive, EU/2023/1791) can introduce (or remove) financial incentives for users and Utilities to engage in such services.	

Table 51: BC6 UC15 Market Analysis for BIGG Solution provider.

IV.1.4.c. Business Model Canvas

Lean Canvas BC6 UC15: HERON

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Value Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>Small margins on Natural Gas and competition saturate a market that focuses solely on prices.

Energy suppliers are obliged through Article 7 to improve the energy efficiency and offer energy-effective measures</td><td>Natural gas is the leading energy source for households heating and accounts for 32.1% or residential EU consumption.
HERON offers a Natural Gas Smart Monitoring product that turns a legacy NG boiler into a smart one that can be remotely parametrised and controlled though a mobile app</td><td rowspan="2">For the Supplier: unique product for
- market differentiation and
- achievement of EEOS obligations
For the Customer: smart heating service able to deliver:
- up to 30% of savings
- improved thermal comfort
- detailed consumption insights</td><td>Being the first to offer such a service provides unique market differentiation potential, while achieving their EEOS obligations.
Even not-tech savvy consumers are equally positioned to experience the advantages of smart heating, by just tuning their comfort limits through a simple thermostat.</td><td rowspan="2">Energy Supplier residential consumers (households and businesses)</td></tr>
<tr><th>Existing Alternatives</th><th>Key Metrics</th><th>Channels</th><th>Early Adopters</th></tr>
<tr><td>Smart thermostats do not offer efficiency options or consumption monitoring. Smart thermostats are typically restricted to comfort setting and scheduling.</td><td>Energy use reduction (kWh)
Energy cost reduction
CO2 reduction
Amount of EEOS achieved (ktoe)</td><td>Targeted advertisement through SoMe</td><td>Energy or environmentally aware consumers.</td></tr>
<tr><th colspan="3">Cost Structure</th><th colspan="2">Revenue Structure</th></tr>
<tr><td colspan="3">OPEX: smart heating controller 120 EUR / Installation 50 EUR per controller (a cost that can be recuperated from the customer)
Staff costs (customer support, sales) 12,000 EUR per year per 200 customers
We need to add the cost of the service licence.</td><td colspan="2">The Energy supplier initially covers the cost of heating controller + installation, which can be gradually paid back as a fixed cost that can be added on top of the monthly bill.</td></tr>
</table>

Table 52: BC6 UC15 Lean Canvas for BIGG Solution end-user.

Lean Canvas BC6 UC15: DOMX

<table>
<tr><th>Problem</th><th>Solution</th><th>Unique Value Proposition</th><th>Unfair Advantage</th><th>Customer Segments</th></tr>
<tr><td>Energy suppliers & utilities are obliged through Article 7 to improve the energy efficiency and reduce the costs of end-use through cost-effective measures.

There is an open market for AI-driven products that can monetise efficiency potential.</td><td>The DOMX heating controller builds on widely applicable protocols (>70% market share), to optimally manage the boiler operation, by considering the users' comfort limits as set by the room thermostat, and local climate conditions as captured by device sensors.

The DOMX smartphone application enables gas consumers to understand how energy is consumed and to achieve long-term consumer behaviour change through nudging interventions.</td><td rowspan="2">For the Service Provider: reliable product offering cost-cutting services.</td><td>Expand in a network of installers as a means of offering installer specific services (such remote monitoring and maintenance).</td><td>Utility companies offering a service / products to customers.

Building managers (e.g. rental properties) of multiple residential buildings.

Installers and boiler technicians.</td></tr>
<tr><th>Existing Alternatives</th><th>Key Metrics</th><th>Channels</th><th>Early Adopters</th></tr>
<tr><td>The market lacks services for energy suppliers that can automatically quantify the impact of energy efficiency investments for natural gas consumers.</td><td>Energy use reduction (kWh)

Energy cost reduction

CO2 reduction

Amount of EEOS achieved (ktoe)</td><td>Networking, tech / energy fair participation.</td><td>Tech driven utility companies.</td></tr>
<tr><th colspan="2">Cost Structure</th><th colspan="3">Revenue Structure</th></tr>
<tr><td colspan="2">CAPEX: Annual server related costs 5,000 EUR

60 EUR material and assembly costs per consumption point</td><td colspan="3">Monthly service fee per consumption point (1€/month) ~ Total 12.000 EUR per year per 1.000 consumption points

120 EUR per device controller</td></tr>
</table>

Table 53: BC6 UC15 Lean Canvas for BIGG Solution Provider.

IV.2. BIGG Market2Go Exploitation Plan

This Section presents the M2G Exploitation Plan for the specific products that were identified in Section IV based on the consolidated Business Case Blocks. The methodology, that has been presented in Section III.2.4. is currently applied.

IV.3. IPR and Exploitation for Solution end-users

In BIGG, solution end-users are the organisations that are expected to deploy BIGG services to their customers. For example, it can be an owner of a large cluster of buildings, an ESCO company or a Utility. Such organisations typically procure the technology they deploy, unless they choose to participate in co-funded Research and Innovation projects or direct invest in R&D activities. In doing so, BIGG Solution end-users have had the opportunity to dive into the ecosystem-driven world of technology and specialisation forging collaborations based on innovative business models, that will eventually bring the much-required edge in their competition.

However, for such collaboration to be meaningful and productive, as already mentioned in Section III.2.4. , it is important to attribute IPR and outline the agreements (if any) towards the exploitation. Table 54: Solution end-user exploitation mapping. presents this information.

BC Block	BIGG M2G Product	End-user	Provider	Agreement
BC 1, 2 & 3	Energy Savings Solutions for Building Clusters	ICAEN	CIMNE	Yes[1]
		ICAT	CIMNE	Yes[2]
[1] ICAEN has agreed with CIMNE on the use the BIGG M2G Product for 5 yrs and working towards converting it for use at a permanent basis.				
[2] ICAT has agreed with CIMNE on the use the BIGG M2G Product for 1 yr and review at yearly basis				
BC 4 & 5	EnPC Contract Management and Efficiency Services Automation	CORDIA	INTUICY	TBD[3]
		HELEXIA	INTUICY	TBD[4]
[3] CORDIA is in discussions with INTUICY on the use of BIGG M2G Product on a commercial building managed by CORDIA.				
[4] HELEXIA is in discussions with INTUICY on integrating aspects of BC 4 & 5 M2G Product in the ESCO services and products they offer in their prospective clients.				
BC6 UC14	Implicit DR for Electricity Residential Electricity Consumers	HERON	INETUM	Yes[5]
[5] HERON and INETUM have agreed on the trial use of INETUM's SMS Service for 3 months end evaluation of HERON's need following that period. INETUM has provided a detailed fee structure based on the effort required initially for maintenance of their BIGG product with an option to update it depending on HERON's requirements. HERON and INETUM have collaborated in 3 H2020, Horizon Europe proposals. HERON and CIMNE collaborate in one Horizon Europe project (DEDALUS GA 101103998).				
BC6 UC15	Explicit DR for Natural Gas Residential Consumers	HERON	DOMX	Yes[6]

[6] HERON and DOMX have agreed on a commercial pilot of DOMX's Smart Controller, Thermostat and Application for 2024 Winter with a prospect of integrating it in HERON's service portfolio.

HERON and DOMX collaborate in one Horizon Europe project (DEDALUS GA 101103998).

Table 54: Solution end-user exploitation mapping.

IV.4. Exploitation for Solution providers

The dependencies M2G BIGG products offered by solution providers have on BIGG OSS components, as parts of BIGG RAF or stand-alone products, are given in Table 55: Solution provider exploitation mapping. This, provides a path for exploitation for component developers and solution providers given that in BIGG project, solution providers can leverage the BIGG OSS outputs in an **"Open Core" Model**. In this context, they can layer value-added proprietary code on top of the core open source BIGG components to build robust specific solutions. This is a good model the sell on-premises custom solutions to their clients.

They can even expect more revenues if they can add the **"SaaS model"** to the top of "Open Core" model where they operate the entire solution for their clients in the cloud, including the daily operation of BIGG OSS components.

BC Block	BIGG M2G Product	Provider	IP Dependencies
BC 1, 2 & 3	Energy Savings Solutions for Building Clusters	CIMNE	Ingestors & Harmonizer AI Toolbox Standard Model 4 Buildings
BC 4 & 5	EnPC Contract Management and Efficiency Services Automation	ENERGIS INTUICY	Ingestors AI Toolbox Standard Model 4 Buildings
BC6 UC14	Implicit DR for Electricity Residential Electricity Consumers	INETUM	Ingestors & Harmonizer AI Toolbox Standard Model 4 Buildings
BC6 UC15	Explicit DR for Natural Gas Residential Consumers	DOMX IMEC	Ingestors & Harmonizer AI Toolbox Standard Model 4 Buildings

Table 55: Solution provider exploitation mapping.

IV.5. Exploitation for Component developers

As depicted in Figure 6, we can see that most of the BIGG components developers are solution providers. It seems to be natural because solution providers found a way with the BIGG project to put their efforts in common with other solution providers to build an OSS toolbox that can be used by each of them to progress from a technological point of view and improve their energy-related technical offers.

The dependencies solution providers have in BIGG components can be seen in Table 56. The exploration path for these players is clear as they want to sell integrated technical solutions to help their clients to manage energy matters in buildings (cf. “Open Core” Model + “SaaS model”, see Section IV.4.).

Some other partners like research centres (e.g., CSTB, IMEC) can find other ways to exploit the results of the BIGG project:

- They can **be paid for support about BIGG OSS components** by any existing or new-coming solution providers that want to leverage BIGG components and are expecting some help in the form of **consultancy and/or maintenance missions**. For instance, CSTB has designed the harmonizer module and can help integrators of this module to write specific mapping file or create custom functional extensions to it if required. IMEC has designed gas related AI applications for BC6 solutions.
- They can **use BIGG OSS components in their internal or partnership research project** (e.g., reuse of the AITB).
- If the business opportunity appears, they can **build a commercial service using some of the versatile BIGG OSS components** and blueprints that they master via BIGG.

RAF Component	Component Developers	BC Block
Ingestors	Inetum, CIMNE, CSTB, DOMX, Helexia, Intuicy, IMEC	BC 1, 2 & 3, BC 4 & 5 BC6 UC14 & UC15
Harmonizer	CSTB	BC 1, 2 & 3, BC 4 & 5 BC6 UC14 & UC15
AI Toolbox	Inetum, CIMNE, IMEC	BC 1, 2 & 3, BC 4 & 5 BC6 UC14 & UC15
BIGG Standard Data Model 4 Buildings	Inetum, **CSTB**, CIMNE, Helexia, IMEC, Intuicy	BC 1, 2 & 3, BC 4 & 5 BC6 UC14 & UC15

Table 56: BIGG OSS component mapping.

CONCLUSION

All things considered within the framework of WP7 aim at the effective exploitation and deployment of BIGG results into the market. D7.1 and D7.2 set the foundations of this process by providing 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. D7.3 concludes this process by finalising on the standardisation process and their economic impacts and by consolidating the Business and Use Cases that led to Pilot specific Exploitable Results, and those that led to BIGG Reference Architecture Framework into Business Case Blocks that reflect on BIGG market ready products.

In this context, an introduction to standardisation was presented as means to highlight the importance of standardisation and interoperability to the European Digital Market. A business logic of how standards will be utilised 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 standardisation section successfully highlighted the benefits of standardisation 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 CO_2 emission savings through intelligent management.

Further in Section II, a work plan that would facilitate achieving the focus of the BIGG project was produced. Where WP2 provided 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 aims other key indicators within T7.1 and T7.2 where emphasized, incl. origination of standardisation workshops and cooperation with other WP/Tasks at specific standards 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 standardisable outcome, and phase 4 – contribution to standardisation) were all addressed individually with supporting details of their contribution to the BIGG project.

Section III presents the methodology towards the exploitation of the BIGG innovations. It uses the methodology presented in previous versions of the deliverable (D7.1, D7.2) as a starting point, but overhauls it quite significantly. D7.1 and D7.2, as part of the effort undertaken in Tasks 7.1 and Tasks 7.2, defined BIGG Exploitable Results and did a Market Analysis of several Business Cases and Use Cases. However, this approach was considered too complex and unproductive, as it could lead to potentially 10-15 Business Models, with most of them not necessarily having a commercial impact that could lead to their successful market up-take. To address this realisation, ERs and Business Cases were consolidated into Blocks of Business Cases that accurately described a market ready, high TRL, product that was tested and validated across BIGG pilot sites. In addition to introducing this consolidation, Section III also introduces the Methodology behind the Market Analysis and Lean Canvas (expanding those in D7.1 and D7.2) and the Exploitation and IPR Management process.

Section IV introduces BIGG Market2Go Business Models by applying the methodology introduced in Section III, in the consolidated BC Blocks that constitute BIGG M2G products. First, the BC Blocks are introduced and the D7.2 Exploitable Results are aggregated into the newly created Business Case Blocks to accurately identify the effort each consortium partner undertakes in developing BIGG outputs. Then, the standard tools of Market Analysis and Business Model Lean Canvas are applied. Market Analysis allows to identify a) trends, size

and growth rates for the aggregated BC blocks, b) Stakeholders, c) Competitors, other barriers and opportunities, d) Differentiators with competitors, e) Key success factors. The Lean Canvas method facilitates drafting the business models prototypes that include the potential customer segments and their challenges, the value proposition offered to them, the customer relationships and delivery channels that can be set-up, the key resources, activities and partners, the cost structure and the potential revenue streams.

Finally, Section V applies the Exploitation Methodology introduced in Section III, in the consolidated BC Building Blocks. Based on the interactions between BIGG consortium partners and their role, they are classified as solution end-users, solution providers and component developers. Naturally, solution end-users offer the service provided by solution providers to their clients. Nevertheless, BIGG integrated approach fuses the effort of several partners into services that other partners use to offer a service to an internal or external end-users. Here, the methodology introduced in Section III and the analysis in Section IV are very useful in attributing the effort and the corresponding IPR where it is due. Critically, Section V presents the Open Core and SaaS models as potential paths for component exploitation, while it outlines the state of bilateral collaboration between solution end-users and providers.

V. REFERENCES AND INTERNET LINKS

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