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Big data for buildings

Building Information aGGregation, harmonization and analytics platform

Project Nº 957047

D7.1- Initial contributions to standardization actions and market analysis

Responsible:	Guillaume PICINBONO (CSTB)
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Executive Summary

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

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

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

This first iteration of WP7's deliverable focuses on the initial contribution tout standardization actions and initial market analysis.

During the first year of the project, Task 7.1 has been focusing on studying the use cases, technical requirements and specifications done in WP2 (general framework) and WP4 (central data model), in order to identify all existing standards, standardization committees and international initiatives that could be of interest for the project. This document gives a technical and organizational descriptions of them. It also describes the future "contribution to standardization phases" that will be addressed during the rest of the project:

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

From the exploitation point of view, Task 7.1 has been focused on implementing an exploitation strategy to facilitate the successful exploitation and adoption of results and benefits within stakeholders. This deliverable offers a business and exploitation plan that will explore the potential sustainability of the project results beyond its execution. This deliverable aims to present the methodology for the complete project exploitation strategy definition, including its phases and execution timing.

Contributors Table

DOCUMENT SECTION	AUTHOR(S)	REVIEWER(S)
I	Guillaume Picinbono (CSTB)	
II	Guillaume Picinbono, Alan Redmond (CSTB) Jordi Carbonell (CIMNE) Pierre Lehanneur (HELEXIA) Alexis David, Nerea Gomez (ECTP) Marion Paraschi, Athanasios Papakonstantinou (HERON)	Bruno Fies (CSTB) María Pérez Ortega (Inetum BE)
III	Marion Paraschi, Athanasios Papakonstantinou, Stathis Efthimiou (HERON) Alan Redmond (CSTB)	María Pérez Ortega (Inetum BE), Michel Hours (Inetum FR)
IV	ALL	

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Table of Acronyms and Definitions

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

I. INTRODUCTION

I.1. Purpose and organization of the document

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

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

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

The document is divided into 2 main parts:

- First part presents the initial contribution to standardization
- Second part focuses on the Initial Market Analysis and Proposed Business Model Approach

I.2. Scope and audience

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

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

II. INITIAL CONTRIBUTIONS TO STANDARDIZATION

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

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

II.1. Introduction to standardization

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

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

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

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

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

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

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

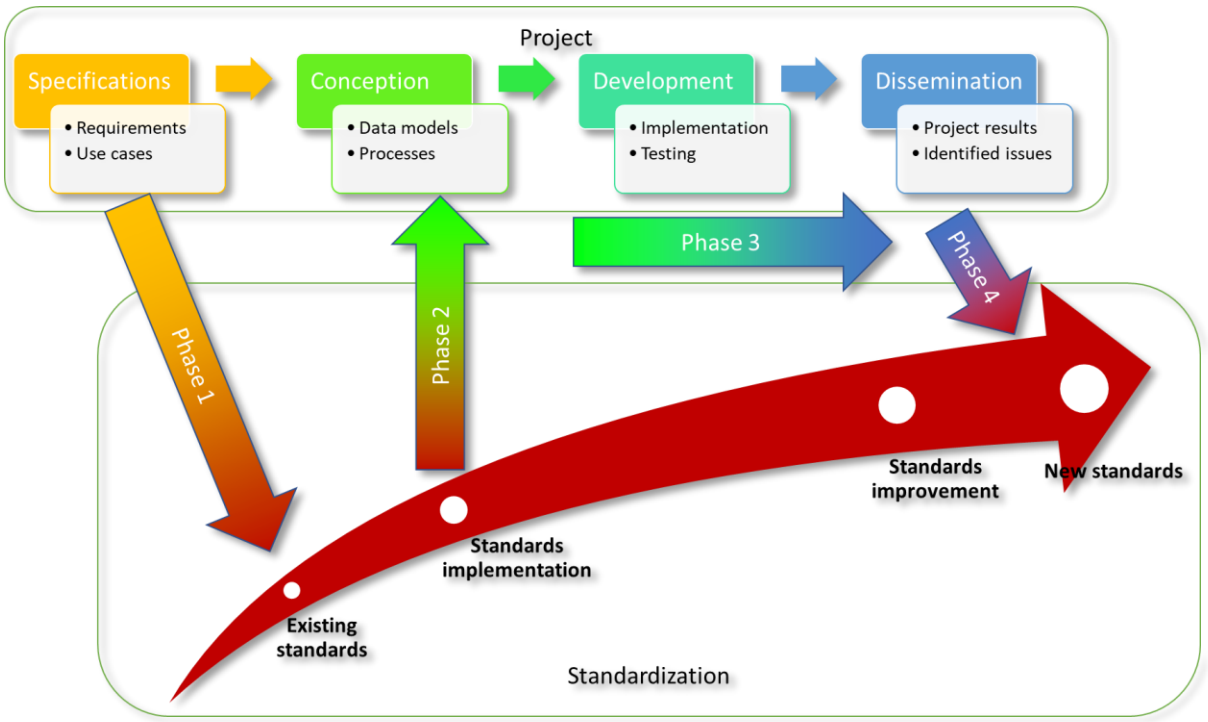

Figure 1 – Link between project and standards

II.2. Economic Impact of standardization

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

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

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

There have been many studies confirming that the benefits of standardization acknowledged by companies include product interoperability, increased productivity, market share gains, and ease of cooperation with public R&D institutions. These benefits can be summarized in the following 5 areas:

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

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

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

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

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

Economics of Software Interoperability in Construction

Integration is a major challenge for software development in buildings and construction, in particular Global Software Development (GSD), as integration failure remains hidden during the development phase and surfaces during system integration. The causes of such failures are attributed to incompatibilities and integration complexities that lead to delays, extra costs and affects the overall quality [II-5]. The National Institute of Standards and Technology 2004 report 'Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry' identified that interoperability issues occur creating a fragmented business process and organizational structure. *It is estimated that the cost of inadequate interoperability in the U.S capital facilities industry is $15.8 billion per year*. In 2002, the value of capital facilities in the U.S. was $374 billion. Of these costs, two-thirds are borne by owners and operators, most of

them occurring during the facility operation and maintenance phase (O&M) [II-6]. The magnitude of this figure suggests that even small improvements in efficiency potentially represent significant economic benefits. The McGraw Hill Construction SmartMarket report defined interoperability, as the ability to manage and communicate electronic product and project data among collaborating firms [II-7]. Beyond the technological aspect, it is the ability to implement and manage collaborative relationships among members of cross disciplinary teams that enables integrated project execution. The report highlights that the traditional method generally focuses its greatest amount of effort during the construction documentation phase, in contrast to the integrated approach, where the team members work closely together during the design phase, resulting in a greater ability to save costs before the construction process. BIGG consortium is built on similar principles, transferring the experience of its partners across multiple disciplines into the development of the multi-layered software architecture under BIGG toolkit.

Economic Impact of interoperability for Smart Homes and Grids

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

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

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

II.3. Methodology

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

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

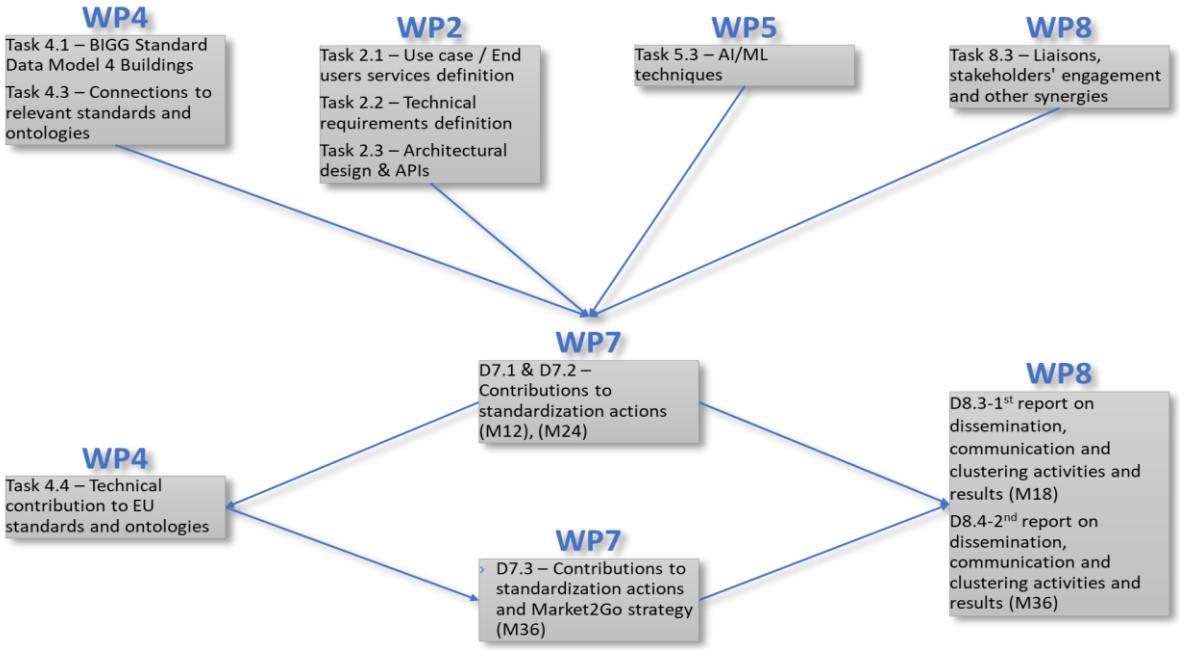

Figure 2 – Connection of D7.1 with other tasks and deliverables

II.3.1. Organization of Task 7.1

Task 7.1 production is organized around three main activities:

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

Standardization Workshops aim at:

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

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

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

II.4. Standardization phases

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

II.4.1. Phase 1 – Requirements lead to standards

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

In WP4, Task 4.1 focuses on the definition of a central data model for BiGG. To meet the requirements and the use cases, this data model should aggregate information about buildings, buildings usage, building energy performance, measurement equipment installed in the buildings, geolocation and weather conditions. WP4 partners have developed a dedicated model, which is the aggregation of parts of existing standards, in particular:

- IFC
- SSN/SOSA
- geoSPARKL

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

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

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

- IPMVP

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

- DEEP
- INSPIRE
- AIOTI
- bSI use case project

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

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

II.4.1.a. Identified standards

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

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

Table 1 – IFC description

Standard name	IFC
Full name	Industry Foundation Classes
Version	4.0.2.1 (Version 4.0 - Addendum 2 - Technical Corrigendum 1)
Status	ISO 16739-1:2018
Documentation	https://standards.buildingsmart.org/IFC/RELEASE/IFC4/ADD2_TC1/HTML
Ontology	https://standards.buildingsmart.org/IFC/DEV/IFC4/ADD2/OWL/index.html

Formats	Express, XSD, RDF, TTL
Description	The Industry Foundation Classes, IFC, are an open international standard for Building Information Model (BIM) data that are exchanged and shared among software applications used by the various participants in the construction or facility management industry sector. The standard includes definitions that cover data required for buildings over their life cycle. This release, and upcoming releases, extend the scope to include data definitions for infrastructure assets over their life cycle as well.
Maturity	• Widely used for building design and construction phases • Starting to be used in building exploitation phase
Competitors	• Standards • Non standards: Revit file format
Use for BIGG	• IFC model will be used as input for the BIGG data model. • A part of IFC ontology is used to describe the building structure in the BIGG data model.
Limitations	• All equipment are not described with the same level of details
Potential improvements	• Define a more homogeneous description of all building equipment.
Committees	buildingSMART International (Table 5), CEN/TC 442, ISO/TC 59/SC 13

Table 2 – SOSA description

Standard name	IFC
Full name	Semantic Sensor Network Ontology / Sensor, Observation, Sample and Actuator (SSN/SOSA)
Version	OGC 16-079 / W3C Recommendation 19 October 2017
Status	W3C recommendation
Documentation	https://www.w3.org/TR/vocab-ssn/
Ontology	https://github.com/w3c/sdw/blob/gh-pages/ssn/rdf/sosa.ttl
Formats	RDF, TTL
Description	The Semantic Sensor Network (SSN) ontology is an ontology for describing sensors and their observations, the involved procedures, the studied features of interest, the samples used to do so, and the observed properties, as well as actuators. SSN follows a horizontal and vertical modularization architecture by including a lightweight but self-contained core ontology called SOSA (Sensor, Observation, Sample, and Actuator) for its elementary classes and properties. With their different scope and different degrees of axiomatization, SSN and SOSA are able to support a wide range of applications and use cases, including

	satellite imagery, large-scale scientific monitoring, industrial and household infrastructures, social sensing, citizen science, observation-driven ontology engineering, and the Web of Things. Both ontologies are described below, and examples of their usage are given.
Maturity	• *[TO BE EVALUATED]*
Competitors	• Standards: • Non standards:
Use for BIGG	• SOSA model will be used as input for the BiGG data model. • A part of SOSA ontology is compatible with BiGG data model to describe the sensor network and measurements context in the
Limitations	• BiGG has its own measurement model but is it aligned with SOSA
Potential improvements	• Stable
Committees	W3C, OGC

Table 3 - IPMVP description

Standard name	IPMVP
Full name	International Performance Measurement and Verification Protocol
Version	Published in three volumes until 2012 Since 2015, published as the IPMVP Core Concepts. Several sections • Renewables: EVO 10200-1:2016 • Uncertainty Assessment for IPMVP: EVO 10100-1:2018 • M&V Issues and Examples: EVO 10300-1:2019 • M&V for Energy Performance contracting (in preparation) • Program Evaluation M&V (in preparation) • Non routine Events and Non-Routine Adjustments in M&V (in preparation) • Water Application (in Preparation)
Status	Additional concepts in preparation
Documentation	https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp
Ontology	*[NOT APPLICABLE]*
Formats	*[NOT APPLICABLE]*

Description	The **International Performance Measurement and Verification Protocol** (IPMVP®) defines standard terms and suggests best practice for quantifying the results of energy efficiency investments and increase investment in energy and water efficiency, demand management and renewable energy projects. The Protocol has become the national measurement and verification standard in the United States and many other countries, and has been translated into 10 languages. IPMVP is published in three volumes, most widely downloaded and translated is IPMVP Volume 1 Concepts and Options for Determining Energy and Water Savings. A major driving force was the need for a common protocol to verify savings claimed by Energy Service Companies (ESCOs) implementing Energy Conservation Measures (ECM). The protocol is a framework to determine water and energy savings associated with ECMs.
Maturity	• *[TO BE EVALUATED]*
Competitors	• Standards: • Non standards:
Use for BIGG	• The BIGG service will leverage the methodology proposed by the IPMVP when quantifying the savings generated by the implementation of an Energy Conservation Measure. Particularly in Business Case 4 and 5.
Limitations	• *[TO BE EVALUATED]*
Potential improvements	• *[TO BE EVALUATED]*
Committees	ONG Efficiency Valuation Organization (EVO)

Table 4 - geoSPARQL description

Standard name	**geoSPARQL**
Full name	Geographic Vocabulary and Query Language for RDF Data
Version	1.0 Approved 1.1 Draft
Status	Approved OGC Implementation Standard
Documentation	https://www.ogc.org/standards/geosparql (v1.0) https://opengeospatial.github.io/ogc-geosparql/geosparql11/spec.html#_normative_references (v 1.1)
Ontology	geo: http://www.opengis.net/#geosparql geof: http://www.opengis.net/def/function/geosparql/ w3cGeo: http://www.w3.org/2003/01/geo/wgs84_pos# geor: http://www.opengis.net/def/rule/geosparql/ sf: http://www.opengis.net/ont/sf#

Formats	RDF, geoJSON-LD. Compatible with geoJSON, KML, GML, WKT
Description	This ontology is related to other complementary OGC standards and ontologies : WKT, GML, WGS84
Maturity	• *[TO BE EVALUATED]*
Competitors	• Standards: • Non standards:
Use for BIGG	GeoSpatial data, geospatial context, geolocation (Buildings), geometry description (Buildings footprints parcels).
Limitations	Concerning geoSPARQL 1.0, various serializations of geometry data (e.g. KML, GeoJSON, GML) are still expected. Work remains in expanding GeoSPARQL vocabularies with axioms for logical spatial reasoning. Standard processes for converting GML file to RDF would be beneficial.
Potential improvements	The GeoSPARQL 1.1 release incorporates many additions requested of the GeoSPARQL 1.0 Standard, including the use of new serializations. Where GeoSPARQL 1.0 supported GML & WKT, GeoSPARQL 1.1 also supports GeoJSON, KML and a generic DGGS literal. GeoSPARQL 1.1 also supports spatial scalar measurements. Plans for future GeoSPARQL will be discussed and decided by the OGC GeoSPARQL Standards Working Group and related groups.
Committees	ISO, OGC (GeoSPARQL Standards Working Group), W3C

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 5 – bSI description

Standardization committee	**buildingSMART International**
Type	BIM Pre-standardization
Standards	IFC (**Error! Reference source not found.**), IDM, MVD, BCF, bSDD.
Web site	https://www.buildingsmart.org/
Description	buildingSMART is the worldwide industry body driving the digital transformation of the built asset industry. buildingSMART is committed to delivering improvement by the creation and adoption of open,

	international standards and solutions for infrastructure and buildings. buildingSMART is the community for visionaries working to transform the design, construction, operation and maintenance of built assets. buildingSMART is an open, neutral and international not-for-profit organization.
Membership	• Membership in buildingSMART International is open to companies, government bodies and institutions from around the world. buildingSMART International offers three levels of membership. Membership is required for those parties wishing to take an active role in the development of solutions to user or technical requirements. bSI members have voting rights in the standards committee. • Some partners of BIGG project are buildingSMART members: CSTB, …
Dynamism / activity	• Very active on standard evolution • 2 international Summits per year, plus tens of specific meetings • Serval new emerging project every year

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

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

Table 6 - CEN/TC 442 description

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

Dynamism / activity	• *[TO BE EVALUATED]*
Membership	•
Contribution strategy	• *[TO BE DEFINED]*

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

Table 7 - ISO/TC 59/SC 13 description

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

Contributing partners	• CSTB
	  ○ Member of ISO/TC 59/SC 13 (through AFNOR PPBIN group)
	• [Partner]:
	  ○ [Contribution actions]

Table 8 - W3C description

Standardization committee	W3C
Type	Ontology standardization
Standards	RDF, OWL, FOAF, SKOS, DC, PROV, SOSA, QUDT, geoSPARQL
Web site	https://www.w3.org/standards/semanticweb/ontology
Description	The World Wide Web Consortium (W3C) is an international community where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C develops these technical specifications and guidelines through a process designed to maximize consensus about the content of a technical report, to ensure high technical and editorial quality, and to earn endorsement by W3C and the broader community. In addition to the classic “Web of documents” W3C is helping to build a technology stack : the Semantic Web. The Semantic Web is a Web of Data — of dates, titles, properties and any other data one might conceive of. The collection of Semantic Web technologies (RDF, OWL, SKOS, SPARQL, etc.) provides an environment where application can query that data, draw inferences using vocabularies
Dynamism / activity	• *[TO BE EVALUATED]*
Membership	Organizations join W3C to drive the direction of core Web technology and exchange ideas with industry and research leaders. Members can find additional information on the Member site (Member-only). W3C Standards are royalty-free to implement and do not require W3C Membership to use. If an organization has specific requirements, it would like to see addressed by Web Standards, then joining W3C and being active in the work is the best way to achieve that. https://www.w3.org/Consortium/join
Contribution strategy	The Member Submission process allows Members to propose technology or other ideas for consideration by the Team. After review, the Team may make the material available at the W3C Web site. The formal process affords Members a record of their contribution and gives them a mechanism for disclosing the details of the transaction with the Team (including IPR claims). The Team also makes review comments on the Submitted materials available for W3C Members, the public, and the media.
Contributing partners	• CSTB: ○ Member of the Linked Building Data Community Group

Table 9 - OGC description

Standardization committee	OGC
Type	Geospatial pre-standardization
Standards	CityGML
Web site	https://www.ogc.org/

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

II.4.1.c. Identified initiatives

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

- Membership
- Contribution strategy
- Contributing partners

Table 10 - DEEP description

Initiative	DEEP
Type	Europe's largest database of Energy Efficiency investment projects
Web site	https://deep.eefig.eu/
Description	EEFIG comprises over 200 organizations working on energy efficiency investments throughout the European Union. These include financial institutions, investors, bank associations, energy efficiency practitioners, academia and other experts across the finance market. EFFIG works on defining the issue of energy efficiency investments in the context of the EU Energy Union strategy. For this, in 2017, EFFIG launched Europe's largest database of energy efficiency investment projects (DEEP). DEEP, De-risking Energy Efficiency Platform, is an open-source initiative to increase investments in energy efficiency in Europe through improved sharing and transparent analysis of existing projects in buildings and industry. Thus DEEP-Effig is a key initiative in the standardization of processes related to investments in energy efficiency projects in buildings at European level.
Dynamism / activity	• *[TO BE EVALUATED]*
Interest for BiGG	• Standardization of taxonomies of energy efficiency actions and/or projects. • Exchange data between BIGG and DEEP Platform (enriching both initiatives)

Membership	Membership in EFFIG is informal and open to financial institutions, investors, bank associations, energy efficiency practitioners, academia and other experts. But with expectations that members demonstrate their contribution to furthering the objectives of EEFIG, add value to the workings of EEFIG and have a commitment to strengthening the efforts for the European Union to meet its long-term climate and energy objectives through greater investments in energy efficiency. EFFIG Membership form: https://ec.europa.eu/eefig/join-us_en
Contribution strategy	• Becoming a member of EFFIG • Becoming a DEEP-EFFIG data provider
Contributing partners	• CIMNE: ○ DEEP data provider.

Table 11 - INSPIRE description

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

Contribution strategy	• Becoming INSPIRE EXPERT • Participating in INSPIRE annual conferences • Contacting with national INSPIRE contact points https://inspire.ec.europa.eu/INSPIRE-in-your-Country
Contributing partners	• CIMNE: ○ Non-Monetary Agreement collaboration with JRC, involved in different projects and initiatives related with INSPIRE

Table 12 - AIOTI description

Initiative	AIOTI
Type	European Internet of Things ecosystem
Web site	https://aioti.eu/
Description	The Alliance for Internet of Things Innovation (AIOTI) was initiated by the European Commission in order to develop and support the dialogue and interaction among the Internet of Things (IoT) various players in Europe. The overall goal of the AIOTI is the creation of a dynamic European IoT ecosystem to unleash the potentials of the IoT. This ecosystem is going to build on the work of the IoT Research Cluster (IERC) and spill over innovation across industries and business sectors of IoT transforming ideas into solutions and business models. The Alliance will also assist the European Commission in the preparation of future IoT research as well as innovation and standardization policies. AIOTI leads, promotes, bridges and collaborates in IoT & Edge Computing and other converging technologies research and innovation, standardization and ecosystem building providing IoT deployment for European businesses creating benefits for European society. AIOTI co-operates with other global regions to ensure removal of barriers to development of the IoT & Edge Computing market, while preserving the European values, including privacy and consumer protection.
Dynamism / activity	• *[TO BE EVALUATED]*
Interest for BiGG	The project BIGG implies the use of big data technologies, as well as IoT, for the complete buildings life-cycle. Thus, it seems necessary to be aligned with recommendations and standards on IOT. AIOTI collaborates on different levels with a range of organizations at European and international level, as well as with standardization activities (CEN/CENELEC, OGC, ETSI SmartM2M, …). Furthermore, being member of the AIOTI will offer the opportunity to influence the requirements development, technology adoption, and future direction of the IoT by joining with leaders in technology, R&D and academia in AIOTI Groups. The Working Group 13 **Smart building & Architecture** seems to be aligned with the topics tackled by the project. It covers IoT technologies and solutions deployed in buildings and districts of buildings to improve life of the occupants by addressing and optimising elements such as comfort, light, temperature, air quality, water, nourishment, fitness and energy usage. • Identified Horizontal Groups that could be of interest for BIGG:

	○ **Digital for Green** (aioti.eu/dfg/). The scope of this group is to define the value of using IoT and edge computing in supporting Green Deal policies. ○ **Policy and Strategies** (aioti.eu/wg_ps/). To further contribute to a stable, predictable, reliable and enabling IoT Policy Framework across Europe which will stimulate innovation, build trust and dynamic assurance while mitigating risk, accelerate human-centric IoT uptake and thus strengthen European society, economy, resilience and competitiveness. ○ **Standardization** (aioti.eu/wg_standardization/). This group aims at being recognized as a major contributor to the worldwide interoperability, security, privacy and safety of IoT systems and applications, and particularly for the development of the market in Europe. More specifically, two activities could be aligned with *BIGG: WP2 High Level Architecture and WP5 Security (in cooperation with WG Policy & Strategies*). • Identified Vertical Groups that could be of interest for BIGG: ○ **Buildings** (aioti.eu/wg_buildings/) (covering all types of buildings, residential and non-residential, as well as existing buildings and newly constructed buildings). The purpose is to work on the application of IoT solutions and understand how they can benefit the various stakeholders, the occupants being top priority.
Membership	AIOTI has two membership types: • **Full member.** Any legal entity can become Full member, enjoying tall membership rights, including voting rights at the General Assembly as well as the right to be elected in the Management Board. Two of the criteria required to become a Full member are to be involved in Europe based research and development, innovation, demonstration, industrialization, deployment or standardization of technologies and services related to or relevant for the IoT; or to Contribute as a partner in projects of a European Framework Program for Research and Innovation. • **Associate member.** Any legal entity (including any public entity and/or public administration) can become an Associate member. However, Associate members cannot vote at the General Assembly or be elected in the Management Board.
Contribution strategy	Being part of the AIOTI community will be a dissemination tool for the project. A member has the opportunity to participate in AIOTI events and receive special discounts on third-party IoT conferences, reports and subscriptions, where to promote BIGG. AIOTI members will benefit from: access to reports, white papers, industry scenarios and other deliverables produced by the AIOTI; network with other members and industry experts to create collaborations and improve your business; create and lead new testbeds or join existing AIOTI-member testbeds.
Contributing partners	• [ECTP: ○ ECTP is already member of AIOTI. Thus, an ECTP member (to be named at a larger state) could take advantage of it in order to communicate about BIGG and establish a link with AIOTI ecosystem.

Table 13 - UCM description

Initiative	UCM
Full name	Use Case Management
Type	buildingSMART International project
Web site	https://ucm.buildingsmart.org/use-case-management
Description	The Use Case Management of buildingSMART has the goal to exchange experiences from already implemented or ongoing BIM/VDC projects among experts. Thus, a best practice is generated from individual practical experiences. Use cases are not related to individual project phases but consider the entire value chain (planning / construction / operation / deconstruction). Each Use Case follows a clear objective and focuses on a specific outcome or benefit. The information requirements for the various actors are determined for each project phase. It is defined who needs what information at which point of time in which format and in which level of detail in order to achieve a specific result.
Dynamism / activity	• *[TO BE EVALUATED]*
Interest for BiGG	• Develop a standard description of the of the project's Use Cases • Exchange experiences around Use Cases development
Membership	• For members of bSI or active members in a bSI Room: to start a project with the UCM, just contact bSI and get full access to the UCM Co-Creation Space for free. • Companies, associations, and institutions can purchase access to the UCM and develop your own brand inside the platform • Chapter leader or part of a buildingSMART Chapter: help develop the UCM for your region and better help support your end-users.
Contribution strategy	• To be defined
Contributing partners	• [Partner]: ○ [Contribution actions]

II.4.2. Phase 2 – Adopting the standards

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

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

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

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

Table 14 - Partner participation to standardization committees

Standardization event	Partner	Standards	Interest for the project
buildingSMART International Technical Summit Spring 21	CSTB	IFC	Better understanding of the very last and future developments of IFC standard
LDAC2021 / CIB W78	CSTB	IFC	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.

At this early stage of the project, it is still difficult to see exactly what the real outcomes of the project will be, and even more which of them would be interesting to push to standardization.

In the following table, we've initiated a list of our first ideas of project outcomes that would be interesting for standardization. This list will, of course, be updated while the project goes on.

Table 15 - "Potentially standardizable" outcomes

Work package	Project outcome	Potential contribution to standardization
WP 6	Use cases	• Select some use case that could be submitted to bSI Use-case database project
WP 4	BiGG data model ontology	• Creation of a standard data model for Energy Performance Certificate? • Presentation of the aggregation of IFCOWL and SSN/SOSA ontologies
WP5	AI toolbox of functions for analytics	• Use of the IPMVP protocol for savings calculations

II.4.4. Phase 4 – Contribution to standardization

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

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

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

II.4.4.a. Demonstrating standard use

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

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

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

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

II.4.4.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 (standardization process can be quite long).

II.5. Alignment between T7.1 and T8.3

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

- to make sure that BIGG tools are aligned with the existing standards and regulations. Even though a 1st listing of potential standards and regulations has already been identified in the early stages of T8.3, they will mostly be identified during the work carried out in the technical WPs of the project and in particular within T7.1.
- to influence policymakers, regulation bodies, standardization bodies and experts (energy sector companies CTOs/CIOs, ICT-providers, …) in the building sector, so that they take into account the findings or recommendations made by BIGG within future standards and regulations. This shall favor the market opportunities for big data and AI solutions.

Table 16 - Standardization bodies and regulators identified in T8.3

Standard	Some key elements
INSPIRE	Create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment.
CEN/TC 442	BIM, Structured semantic life-cycle information for the built environment. A structured set of standards, specifications and reports which specify methodologies to define, describe, exchange, monitor, record and securely handle asset data, semantics and processes with links to geospatial and other external data.
CEN/TC 442 / prEN 17632	CEN Semantic Modelling and Linking Standard (SMLS) for data integration in the built environment

EN ISO 23386	Development of properties using dictionaries
EN ISO 23387	Data Templates for Construction Objects
SAREF	Smart Appliances REFerence ontology. A shared model of consensus that facilitates the matching of existing asset (standards/protocols/datamodels/etc.) in the smart appliance domain
Industry Foundation Classes (IFCs)	Standardized, digital description of the built asset industry (open, international standard: ISO 16739-1:2018)
ISO/TC 59/SC 13	Organization and digitization of information about buildings and civil engineering works, including BIM
ETSI SmartM2M Technical Committee	Developing standards to enable “Machine-to-machine” services and applications and certain aspects of the IoT
CEN-CENELEC Focus Group on AI	European Committee for Standardization (CEN); European Committee for Electrotechnical Standardization (CENELEC)

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

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

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

- initiatives suggested by the European Commission (e.g. BRIDGE),
- projects funded under the same call
- standardization bodies meetings
- information meetings
- training
- other dissemination events (e.g. contractors’ workshops, briefing days, etc. related to H2020)
- …

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

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

Topic	Policies / legislations / directives	Some key elements
	Energy Performance of Buildings Directive	Decarbonize the national building stocks by 2050 Support massive buildings renovation &

Energy consumption of buildings	(EPBD, 2010 - revised 2018)	modernization (promote smart technologies + installation of building automation & control systems + health/well-being) Common EU scheme for rating the smart readiness of buildings -> SRI
	Energy Efficiency Directive (2012)	Promotes: Zero-emission building stock target by 2050; SRI; E-mobility infrastructure; Tackle energy poverty Protect consumers' right to receive easy & free access to data on real-time and historical energy consumption Rules on metering & billing of thermal energy (simpler & clearer for consumers)
	Renewable Energy Directive	Make households and energy communities become clean energy producers
	Regulation & Directive on the Internal Market for Electricity	More flexibility to integrate an increasing share of RenE in the electricity grid Smart meter and a dynamic price contract (clearer & cheaper for consumers)
	Fit for 55 Package?	
Waste management and the circular economy	Waste Framework Directive (2008/98/EC)	Framework towards a European recycling society (high resource efficiency, increase construction & demolition waste re-use/recycling/recovery
	EC's Circular Economy Action Plan 2.0 (2015)	Includes measures to stimulate Europe's transition towards a circular economy Identification of Construction as key sector Incorporation of circular economy & life cycle principles in the design/construction of new/renovated buildings
EU Strategic Energy Technology Plan	Strategic Energy Technology Plan (SET-Plan)	Accelerate the development & deployment of low-carbon technologies
	EC's Communication for an Integrated Strategic Energy Technology Plan (2015)	Identify 10 priority actions to accelerate the energy system transformation
Policy framework for climate neutral cities	Pathway towards Positive Energy Districts (defined in SET Plan Action 3.2)	Targets at least 100 Positive Energy Districts (PED) deployed in Europe and synergistically connected to the energy system by 2025
	EC Mission for Climate Neutral & Smart Cities	By 2030, 100 cities should reach a net zero greenhouse-gas-emission balance
	Urban Agenda for the EU	City led partnerships and initiatives in the areas of Circular Economy, digital and energy transition. Many of the pilots could be improved through R&I and scale up.

Policy framework for decarbonized transport & related infrastructures	Roadmap to a Single EU Transport Area (“Towards a competitive and resource efficient transport system”), 2011	10 goals to reduce by min. 60% by 2050 transport sector’s GHGs (compared to 1990) Relies on cleaner urban transports and modal shifts, and the required adaptation of the related infrastructures
Directive for industry	EU Energy-Intensive Industries’ 2050 Masterplan	Sets out how EU industry can become climate-neutral while staying competitive.
Directive for finance	Sustainable Finance Action Plan and EU Green Taxonomy	Tool to reorient capital flows towards sustainable investment Buildings are identified in the Taxonomy as “a critical cross-cutting issue” with “relevance to the emissions performance of almost all economic activities”
Other	Paris Agreement on Climate (COP21)	Common legally binding agreement Integrated with frameworks for action on resilience and adaptation
	EU Green Deal	Renovation wave’ and circular economy are among the key focus
	Clean Planet for all	Spatial planning supporting reduced pollutant concentrations

III. PRELIMINARY EXPLOITATION FRAMEWORK. INITIAL MARKET ANALYSIS AND PROPOSED BUSINESS MODEL APPROACH

The purpose of this section of the deliverable is to describe the instruments that will help see the big picture and understand the exploitation objectives of the project, that will be fully developed in the next periods of the project. It presents market analysis approach and develop an initial business model framework, with the use of the Business Canvas and SWOT methodologies using an example of a solution that could developed by BIGG. As the project progresses, there will be an in-depth market analysis across different actors for the key technologies that can be packaged as final products in BIGG's toolbox, followed by business model assessment as part of deliverable D7.2.

III.1. Activities included in the BIGG Exploitation Strategy

The activities are represented in the diagram below:

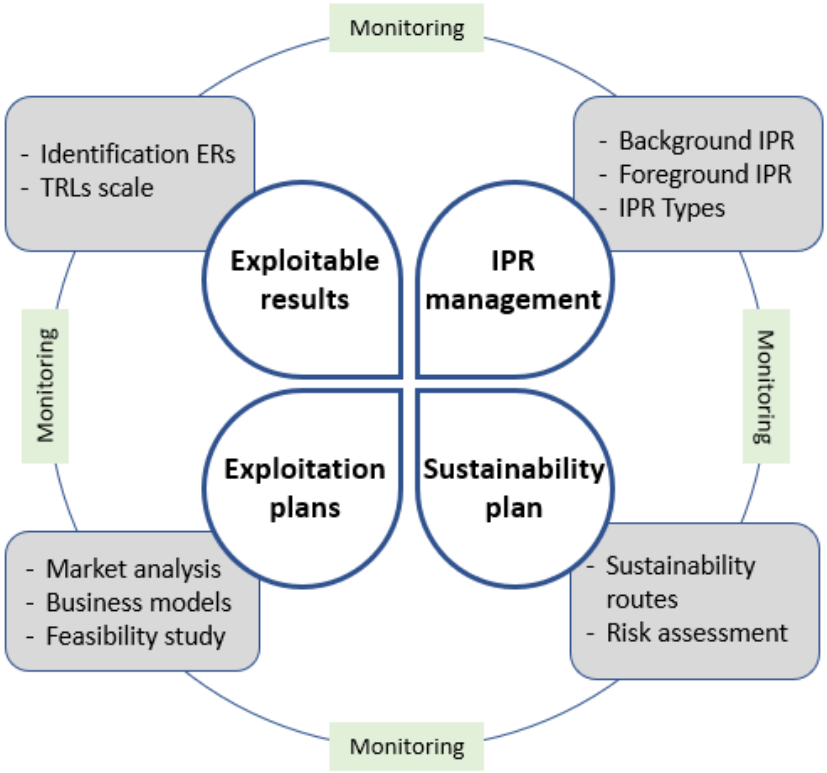

Figure 3 – BIGG project exploitation activities

III.1.1. Identification of exploitable results

The first step of the process is aimed to support the partners in identifying the exploitable results of the project, and then those they are interest in. This step was executed during the first project period and therefore its results are reported in this document section 4. Specifically, the baseline was the BIGG outputs already identified in the Description of the Action. The exercise continued with the identification of additional results that may arise during the project execution and were not foreseen at the beginning.

Virtual meetings were organised to collect feedback about the results.

III.1.2. Identification of the technology maturity, TRL scale

Technology Readiness Levels (TRLs) are indicators of the maturity level of particular technologies. This measurement system provides a common understanding of technology status and addresses the entire innovation chain. There are nine technology readiness levels; TRLs 1 being the lowest and TRLs 9 the highest (see Figure 2). This indicator is therefore used as an indicator for monitoring and assessing the development status against the target levels and informing the BIGG partners of the engagement required to achieve the next level of readiness throughout the project timeline.

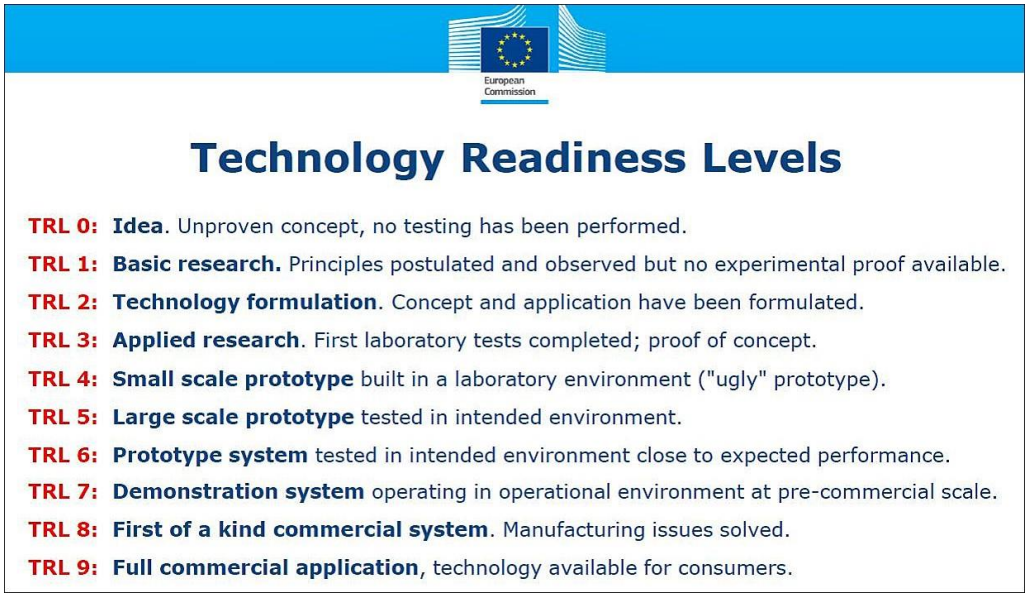

Figure 4 - TRL Levels Horizon 2020[1]

The BIGG results are expected to span from TRL level 2 to 9, as identified in the DoA. Most tangible products/services brought to the project are currently at level 4-6, whereas most intangible research knowledge is in the early development stage and therefore is at a low level.

Under this activity, the initial TRL (at the beginning of the project) and the target TRL (at the end of the project) of each ER should be defined and will be monitored on a regular basis to detect problems, so as to find solutions as early as possible in order to reach the expected TRL (KPI).

From the identification of exploitable results and TRL positioning, a table following the template below should be completed:

Table 17 - Identification of Exploitable Results

ID	Potential Exploitable Results	Description	TRLs	
			Current	Target
ERx	[ERx_name]	[ERx_shortdescription]	x	x
ERy	[ERy_name]	[ERy_shortdescription]	x	x

This table will serve to feed the next step, related to a more detailed definition of the ERs.

[1] European Commission

III.1.3. IPR management for protection of project results

IP plays an important role in facilitating the transfer of innovative technology to the market place. The issues involved will be monitored at different levels in the project to ensure adequate strategies are implemented. In BIGG, this management follows the recommendations of the European Commission for H2020 projects[2] .

IPR process will be conducted throughout all phases in the project at both consortium and partner levels, addressing the IPR ownership for each exploitable result and managing the access rights to the IPR by partners and external users to ensure the research findings are protected and avoid unforeseen obstacles related to confidentiality or competitiveness. The issues addressed will 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, layout designs of integrated circuits, copyright and related rights;
- IPR Ownership;
- Risk assessment of IPR.

The IPR information of each potential exploitable result will be obtained from the corresponding partners using the templates provided (see example in Table 18).

This process will be regularly monitored and updated throughout the project.

Table 18 - Identification of IP per Exploitable Result

<table>
<tr><th rowspan="2">ER#</th><th rowspan="2">Exploitation Type</th><th colspan="2">IPR ownership/types</th><th colspan="2">TRL level</th></tr>
<tr><th>Background</th><th>Foreground</th><th>Current</th><th>Target</th></tr>
<tr><td rowspan="3">ERx</td><td>Commercial / Non-commercial</td><td>n/a</td><td>Consortium / List of partners</td><td>x</td><td>y</td></tr>
<tr><td colspan="2">Partners involved</td><td>WPs/ Tasks</td><td colspan="2">Expected date</td></tr>
<tr><td colspan="2">List of partners</td><td>WPx, WPy, WPz</td><td colspan="2">Mx</td></tr>
</table>

This exercise will consider the arrangements and conditions established in the CA signed by all partners before the project starting date.

III.1.4. Market Analysis

BIGG project is conceived with the objective to enable the collection, exchange, and to increase the ability to process valuable building data of highly heterogeneous sets of data sources (local energy production, energy consumption, physical infrastructure, weather, materials, etc.) through a universal data science toolkit for enhancing data-driven approaches in business. It develops an open source software solution for overcoming several of the key

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

barriers for development of innovative data-driven models and services such as: interoperability between databases and tools; operational storage of heterogeneous static and dynamic building data; configurable and modular service solutions over open analytic toolbox; security and advanced data access management allowing the configuration of different 3rd party services.

A key part of any business plan is Market Analysis. Market Analysis is a quantitative and qualitative assessment of a market. It looks into the size of the market both in volume and in value, the various customer segments and buying patterns, the competition, and the economic environment in terms of barriers to entry and regulation. A thorough Market Analysis should address the following areas:

1. Stakeholder analysis

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

Major actors that are impacted by data-driven energy solutions and are considered as prospective BIGG users:

Users: Building professionals: mainly building managers and operators and other technical experts involved in the whole building life-cycle such as designers, builders, energy services and maintenance companies.

Enablers: Those who bring the regulatory and standardization conditions. Policy makers at all levels: - Local and regional authorities organizations (CPMR, Energy Cities) and public buildings management agencies; - National ministries; - European Associations (AEEBC, EBC, EuroACE, etc), Standard Development Organizations and regulators (TNO, ETSI, CEN-CENELEC, etc) and Building data stock managers (EU BSO), project networks (MEDNICE).

Suppliers: Those who bring the technical context to integrate BIGG in the market e.g. Utilities, energy retailers, IoT devices manufacturers, cloud providers, systems integrators, etc.

Researchers: Big data processing and AI related expertise including AI experts and data scientists both from academic and industry.

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

2. Target Market

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

Market size: how many potential customers are there for BIGG's product / service.

Demographics: target group's typical age, gender, education, income level, and lifestyle preferences.

Location: Which countries, regions, states, cities, will be our target groups base.

Psychographics: of the people of the target group. Which are their needs, and how they'll react. What are their likes and dislikes? How do they live? What's their personality and behavior?

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

3. Competition

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

Direct competition: These are companies that are offering very similar products and services. The potential customers are probably currently buying from these companies.

Indirect competitors: it refers to alternative approaches and solutions that competitors may have to the same problem.

4. Legislation / Regulations

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

III.1.5. BUSINESS MODEL APPROACH

At this point, each identified exploitable result is so far monitored in terms of its TRL, their markets, competitors and their IPR opportunities. Based on these previously identified results, a comprehensive exploitation plan is developed both at a consortium level for each shared result - which is outlined in the tables below, and at individual partner level for each of the remaining results, which is presented in the next section.

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 Canvas. The Business Model 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 emphasizing in the rationale of how an organization 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?

Via brainstorming workshops, the goal is to initiate the creation of business models for each of the exploitable results, based on the input of the partners involved in it. These business models will be created for all ERs regardless their ownership; therefore the key resources that are required to offer a certain value proposition could belong to a single partner or be co-owned. The Business Model Generation methodology will be applied and will conclude on the delivery of one Business Model Canvas **Error! Reference source not found.** per ER.

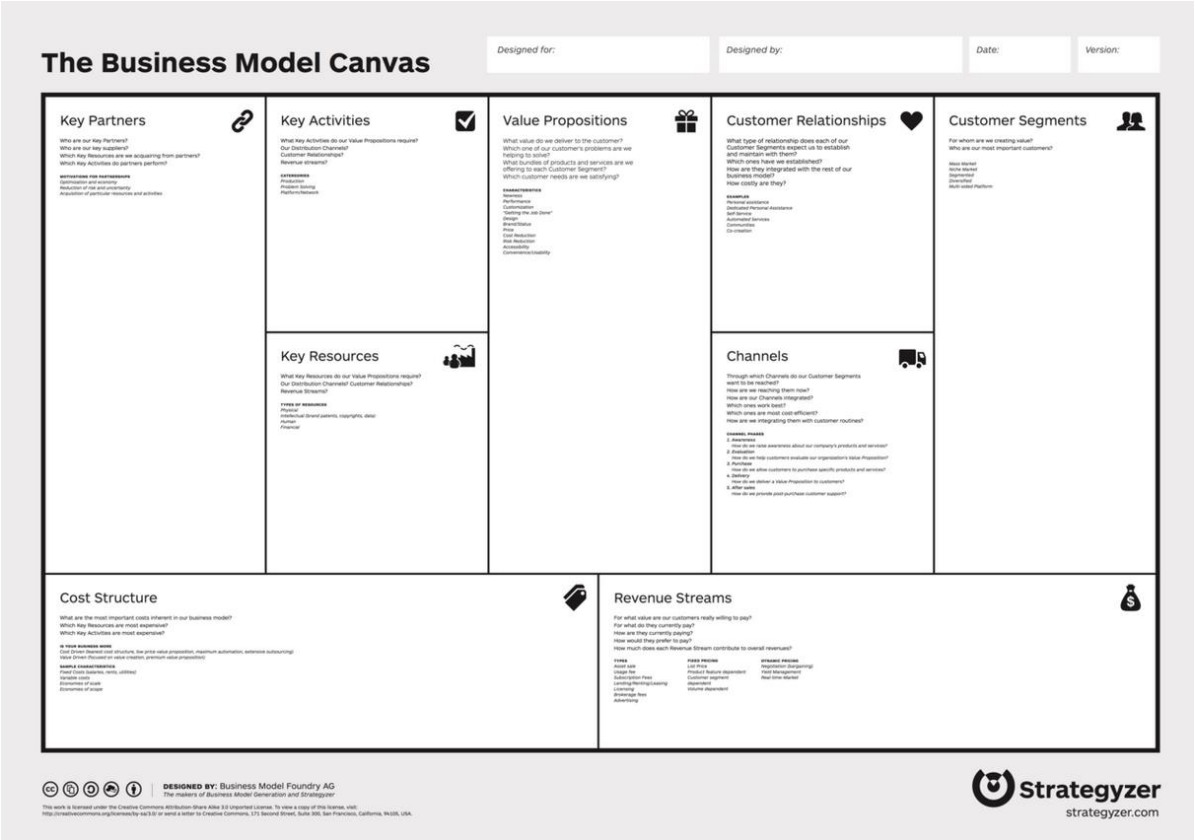

Figure 5 - The Business Model Canvas[3]

This approach will introduce new business models for new energy services which will be demonstrated in the selected pilot sites. For example, one of the demonstration activities covering multiple Business Case, focuses on the provision of balancing services to a utility (gas or electricity supplier) during specific periods (peak events, high RES etc), by effectively reducing the consumption of end-consumers. The new energy service can be directly applicable to the consumer portfolios of energy suppliers, creating new opportunities for residential and commercial consumers to participate in the relevant energy market.

In the context of energy related products that fall into BIGG's domain, it is known that building data management solutions are already available in the market. However, BIGG solutions differentiate from existing market products by focusing on complex ecosystems. Several of BIGG's Business Cases for example, focus on building sector applications which are integrated in a global energy context. For the successful market up taking of such Business Cases, the developed big data solutions must go one step beyond the current offer in order to ensure interoperability among a high number of actors, while being able to cope with the huge amount of data that the ecosystem manages.

BIGG aims to develop specific business models to deliver Value Propositions to identified Customer Segments, starting by defining new relationships between relevant actors, and then proceed to characterize the key resources, activities, partners, channels, costs, surpluses, and revenues. Market Analysis and Business model assessment are critical in achieving these objectives, although they require BIGG energy services to be further developed than their current status.

[3] Template Business model generation 2010 - Alexander Osterwalder & Yves Pigneur - [Amsterdam] In-text: (Osterwalder, Pigneur and Clark, 2010).

III.1.6. SWOT analysis

SWOT is strengths, weakness, opportunities, and threats. It matches internal strengths and weaknesses up against opportunities and threats. Strengths and weakness are internal factors which can be controlled. And opportunities and threats are external factors that businesses cannot be controlled but can however impact on. When using strengths and weakness, businesses need to collect raw data to get information. Businesses can get information by customer feedback, employee surveys. Furthermore, businesses also can identify the capability if it is weakness or strengths, resources and process. Opportunities and threats are the external factors. Business can get information from secondary data like environmental information, industry information and competitive data. The purpose of the business use the SWOT analysis is to get the information from it and match each other to develop the ideas and get into goal statement to form strategic development.

III.1.7. Feasibility Study and Exploitation Plan

A feasibility study is an analysis that assesses the practicality of a proposed plan or project by considering economic, technical, legal, and scheduling aspects to ascertain the likelihood of successful development. Whether a business proposition is feasible or not depends on several factors, including the identified cost structures and value propositions through the Business Model Canvas stage, and the return-on-investment assumptions. The output of the analysis will signal whether the plan under assessment can generate enough revenue or sales considering the involved risks.

BIGG will introduce a Business Model toolbox available to consortium partners so that they can evaluate feasibility of the developed solutions associated with the considered Business Cases. The feasibility study assessment will build upon Business Model Canvas and SWOT analysis, following the Market and Stakeholder analysis for each of the evaluated BIGG aspects.

Each guideline has a different focus to allow partners to formulate feasibility studies for their individual exploitation plans and to indicate pathways towards successful exploitations in research or industry. The research knowledge exploitation mainly focuses on opportunities for teaching or further research, whereas industrial exploitation is mostly market-oriented and focus is placed on transfer of outputs to the market.

For research partners including planning authorities and associations

The research partners in BIGG mainly focus on research-related outputs. The planning authorities' exploitation activities include supporting the CAV deployment by implementing relevant policies based on BIGG guidelines. Associations, on the other hand, offer seminars or workshops with topics related to the projects. The exploitation activities for research partners include:

- Internal exploitation
  - To create new research opportunities for existing researchers with topics related to the project;
  - To attract new researchers and Masters or PhD students with topics related to the project.
- Collaboration with other BIGG partners
  - Further development of the BIGG research outputs by collaboration with other BIGG partners;
  - To create new projects for further funding opportunities with the experience gained from the project.
- Collaboration with partners other than BIGG

- Further development of the BIGG research outputs by collaboration with partners other than BIGG;
- To create new projects for further funding opportunities with the experience gained from the project.

For commercial results

BIGG exploitation strategies are entitled to define the routes for each exploitable result including the analysis of its positioning and the development of its business model. Exploitation plans, both at project level - with results combining IP from several partners - and individual partners, will be determined to ensure that all activities relevant to exploitation are manageable and achievable.

The industrial partners in BIGG mainly focus on market-oriented outputs. For industrial partners, the guidelines at this stage of the project are general and 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 organization;
  - 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 CAV acceptance.
- 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;
- Commercialization through:
  - Selling products or service globally;
  - Licensing to an existing company;
  - Selling license of the products or services.

For each partner, the following elements of the individual exploitation plan will be produced:

Exploitable Result	**Exploitation Type**	**IPR ownership/types**		**TRL level**	
		Background	**Foreground**	**Current**	**Target**
ERx ER_name (ERx)	Commercial / Non-commercial	n/a	Consortium / List of partners	x	y
	Partners involved		**WPs/Tasks**	**Expected date**	

	List of partners	WPx, WPy, WPz	Mx
	Detailed description		
	IPR Potential		
	Technical risk assessment		
	Market risk assessment		
	Competitors (non-exhaustive list)		
	Target groups		
	Feasibility study		
	Economic	**Technical**	
	Legal	**Scheduling**	

III.2. Baseline case

We introduce a Baseline Case to demonstrate key concepts of the methodology underlying BIGG's Business Model approach. The introduced baseline acts as a blueprint for the analysis that will be conducted in Phases 2 & 3 of the project, leading to D7.2 (MS6) and D7.3 (MS10) by November '22 and '23 respectively. One of BIGG's core strengths is the development of technical solutions which can be used in multiple Business Cases as part of a multi-disciplinary toolbox. As an example of such a service we provide some preliminary Business Model assessment of DR as a service, provided by a developer to prospective clients such as Energy Suppliers (Utilities), DR / RES Aggregators or system operators.

In a typical DR setup, the power/heat retailer companies estimate power reservation requests based on metering data that comes from the power/gas distribution supply operator (DSO) or by privately installed smart meters, as it is the case for BIGG, and sets the retail prices for power/heat consumers. Consumers of electricity and heat services participating in a DR initiative, are expected to understand their load patterns, choose appropriate tariff schemes and which devices to buy, ultimately deciding when to use the appliances for satisfying their needs in a cost-effective manner. Assuming that the retailer does not have the capacity to develop and maintain DR-related infrastructure, a DR-related Software provider could operate under the following business model:

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
▪ Vendors of smart devices	▪ Control smart devices ▪ Visualise	▪ Automated Demand-	Direct	▪ Aggregators ▪ ESCOs

<table>
<tr>
<td>▪ Standardization organizations
▪ Other software providers
▪ Data providers (open or license based)</td>
<td>▪ consumption/ production history and profile
▪ Hyper-local weather forecast
▪ Wholesale price forecast</td>
<td>Response campaigns
▪ Accurate weather forecast
▪ Accurate wholesale price forecast</td>
<td></td>
<td>▪ Retailers</td>
</tr>
<tr>
<td></td>
<td>Key Resources
Algorithms</td>
<td></td>
<td>Channels
Via app stores</td>
<td></td>
</tr>
<tr>
<td colspan="3">Cost Structure
▪ Sunk: hardware
▪ Repetitive (static): personnel</td>
<td colspan="2">Revenue Streams
▪ Repetitive (static): SW license
▪ Repetitive (variable): customer/session price number of customers/sessions</td>
</tr>
</table>

Expanding the example of DR-related software provider, a SWOT analysis would take the following form:

(A) Strengths:

- Exploit, low incremental costs for enabling DR for at least industrial and commercial consumers. Also, incremental costs for enabling battery-only vehicles with bidirectional power flow is relatively low (where applicable).
- Advances in ICT has reduced the cost of technology, have expanded the range of loads and appliances that can be used for DR with plenty vendors operating in the market and offering a variety of products.
- The software provider can take fix revenues from DR Aggregator without facing its costs and business and operational risks.
- DR aggregators provide a capacity resource that offers minimal carbon footprint and enabling such endeavours by securing technical requirements, share the same trait.

(B) Weaknesses:

- Highly specialised product in a relatively close market and limited pool of prospective clients (Utilities, DR Aggregators) may reduce negotiating power
- Requirements for continuous development and support due to constant technological evolution

(C) Opportunities

- Develop expertise on topics of very high demand (data science, AI, forecasting etc) that can be utilised in multiple projects not necessarily in the Energy sector
- Collaborate with organizations that can provide long-term contracts and financial stability due to long-term partnerships
- Additional revenue streams to standard software development by tapping on the provision of flexible capacity into the market, better utilization of RES source and tangible rewards for consumers

(D) Threats

- Lack of smart meter communication standards and the existence of multiple IoT devices using different protocols may lock the developed solution into specific vendors, possibly reducing an already limited pool of prospective clients

- Lack of standard market participation rules and regulatory ambiguity may require significant updates of the solution beyond a manageable versioning / update cycle
- Lack of a coherent European regulatory framework may restrict a highly specialised solution with a limited pool of customers to a single country

IV. CONCLUSION

All things considered within the framework of WP7 aim at setting the foundation for effective exploitation and deployment of results into the market, D7.1 did deliver its objectives. The two principle supporting roles acumen to WP7 decision process; i) a clear picture of already existing standards, and ii) all the tools and support for ensuring greater market impacts of the exploitable results developed, has been identified in this deliverable under the core sections of 'economic impact of standardization, methodology, and standardized phases.' However, prior to the economic impact of standardization, an introduction to standardization was presented as means to highlight the importance of standardization and interoperability to the European Digital Market. A business logic of how standards will be utilized and evolved in the BIGG project is also provided as an indicator to comply with the industry needs and more importantly stake holders requirements. The assumption is to absorb standards into all aspects of development as means to ensure successful Verification, Validations, and Integration (VV&I).

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

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

The final section 'primary exploitation framework, initial market analysis and proposed business model approach,' analysis the ability of transferring such operational tasks into market reality. The market awareness of identifying exploitable results, TRL maturity, IPR management, market analysis (i.e., target market) will enable a competitive advantage to the BIGG project successful outcomes. While addressing the overall business approach this deliverable also suggests the injection of an end-game plan (sustainable/bankable) assessment that targets and controls; economic, technical, legal, and scheduling aspects to ascertain the likelihood of successful project development.

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