interconnect

Interoperable solutions connecting smart homes, buildings, and grids

WP1.1 – Use Cases, Business Models and Services

D1.1

Services and use cases for smart buildings and grids

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SUMMARY OF CHANGES AFTER THE EC REVIEW OF OCTOBER 7, 2021

Here is the list of changes made in response to the reviewers' requests/remarks following the Interconnect project review on October 7, 2020:

1. The document has been restructured and reduced to simplify its reading.

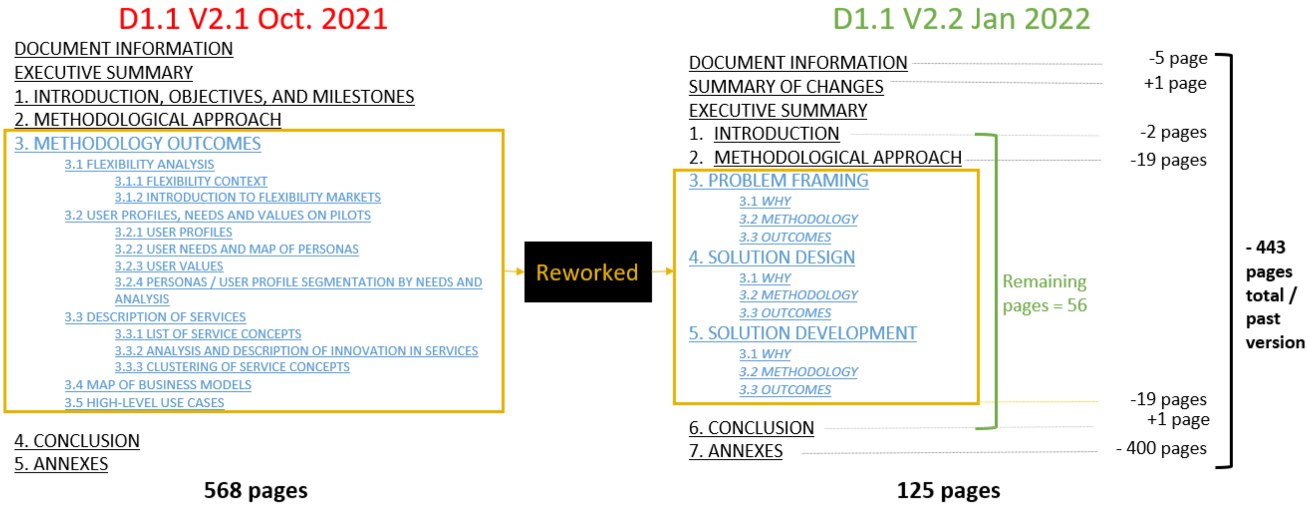

FIGURE 1. RESTRUCTURATION OF THE D1.1

2. The introduction and the conclusion have been updated.

3. The explanation of the Design Thinking methodology has been simplified in chapter 2, "Methodological approach". The three chapters that follow this explanatory chapter focus on the outcomes of the three macro steps of Design Thinking: problem framing, solution design and solution development. Each chapter deals with a macro step and is structured by presenting "why this chapter", "the methodology used", and "the work done/outcomes".

4. The problem framing chapter includes a summary of the path followed by the pilots.

5. To help the reader follow the methodology, a thread has been added in the form of a diagram at the beginning of each chapter, highlighting the Design Thinking stage covered by that chapter.

6. Redundant parts concerning the methodology have been removed.

7. The annexes have been reworked and simplified by keeping them related to the outcomes (the appendix presenting the work used to create these outcomes has been removed). Thus, approximately 85% of the annexes have been removed. Nevertheless, to continue to meet the expectations of the D1.1, the annexes relating to services, business models and High-Level Use-Cases have been maintained.

8. The quality of the images throughout the document has been improved.

9. With all these modifications, the size of D1.1 has been significantly reduced from 568 pages to 125 pages.

EXECUTIVE SUMMARY

Context

The energy domain has been a prosperous field for creativity and exploration to imagine innovative user scenarios and experiences in the past ten years. The problem is that, till now, the most promising use cases hardly cross the chasm to reach to required momentum towards a massive adoption by most users. This is because the candidate services and use cases lacked the required interoperability to have the potential to be adapted and adopted at the European scale. One of InterConnect's goals is to propose innovative user experiences based on services with this interoperable characteristic. The D1.1 explores the potential of this project to solve this problem.

The deliverable D1.1, "Services and uses cases for buildings and smart grids." is the first deliverable of WP1, "Use cases, business models and services," and represents the outcomes of tasks 1.1 and 1.2 focused on human-centric and grid-centric services and business models definition. This document provides the study and design of mapping existing and new energy and non-energy services and corresponding business use cases. It presents a conceptual work that will feed technological and regulatory improvements in the other Work Packages.

D1.1 is an entry for tasks 1.3 and 1.4 of WP1 in charge of "D1.2 - Mapping between use cases and large-scale pilots" and "D1.3 - System use cases for smart buildings and grids" and for WP7 (large-scale demonstration). In addition, the D1.1 is essential for WP9 tasks focused on go-to-market strategy, business, and societal impacts. This document also makes it possible to validate the decentralised ICT architecture based on the interoperability designed in WP2 using SAREF.

D1.1 provides a collection of services, business models, and High-Level Use Cases (HLUC) designed around the concept of interoperability and flexibility to make the most of this new decentralised architecture. This high-level use case has been provided to the BRIDGE community. All the results presented in D1.1 come from a design thinking approach extended by an exploitation phase. A subset of these high-level use cases, selected from the work described in documents D1.2 and D1.3, will be implemented. The High-Level Use Cases to System Use Cases methodology used in D1.2 and D1.3 aims to produce harmonised System Use Cases. Documents D1.1, D1.2 and D1.3 are used by WP3 to specify and develop the interoperable functions of InterConnect based on the SAREF ontology and the use of graph patterns.

This document presents the major work steps from October 2019 to June 2020 as tasks T1.1/T1.2. You will find in this document the methodology of work defined and based on the design thinking; at each step of this methodology, you will find the outcomes obtained by the partners of T1.1 and T1.2.

Methodological approach

The following diagram presents:

- the different steps of the design thinking methodology used;
- all InterConnect partners use the global process to create services, business models, and high-level use cases and transform them into technical specifications;
- the scope D.1.1 in the WP1 process. This process is described step by step in the document and allows the reader to understand how the partners produced these results.

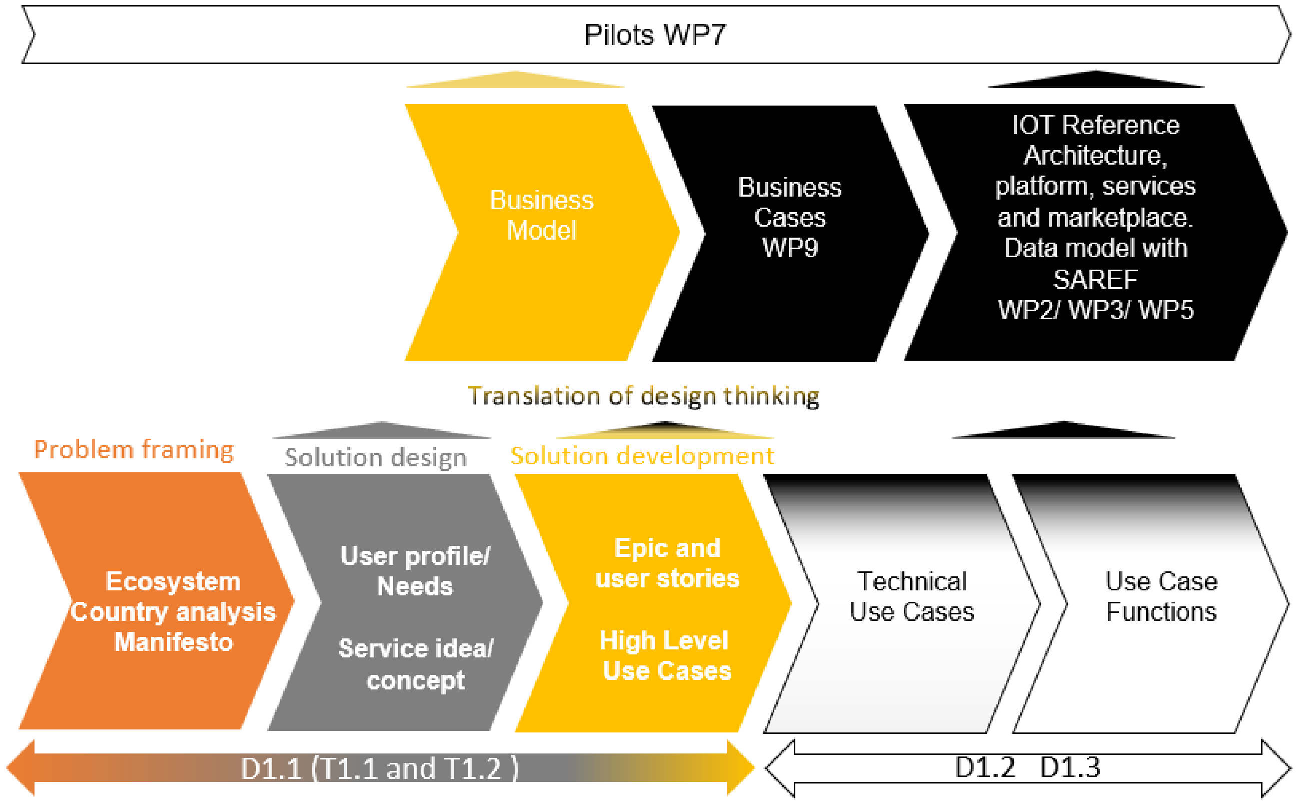

FIGURE 2. METHODOLOGICAL APPROACH

Timeline

This design thinking process and its translation were implemented according to the following timeline. This timeline presents the different milestones/iterations used to generate the D1.1 document.

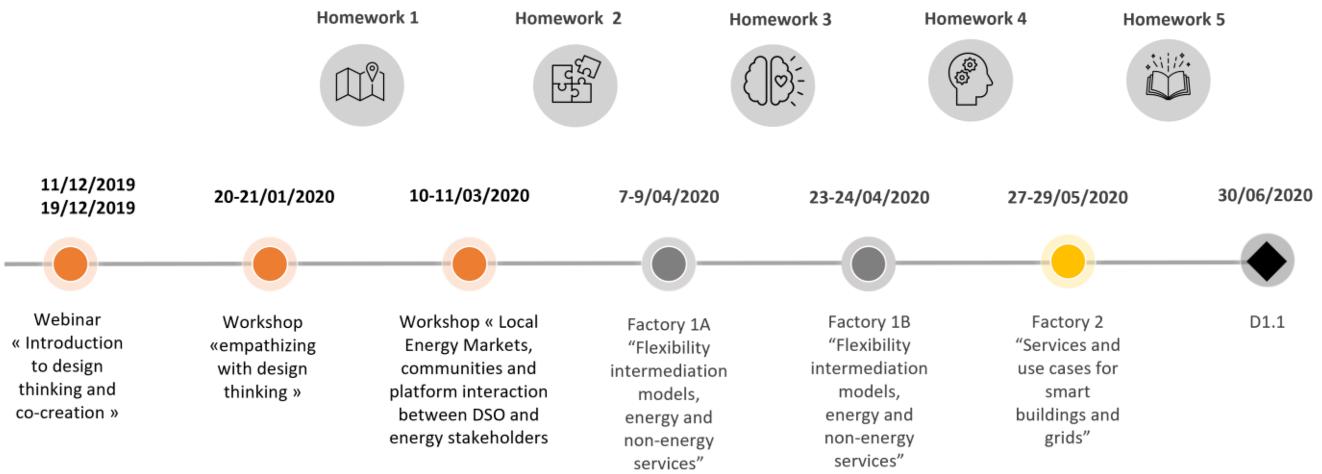

FIGURE 3. TIMELINE

Methodological outcomes

1. **Services**

After our work on the users and the ecosystems, each pilot member conceived during Factory 1 at least three innovative energy and non-energy service ideas coherent with the manifesto and ecosystem map. These service ideas meet the users' needs previously identified. Of these, 36 services were: 57 non-energy sub-services and 59 energy sub-services.

During Factory 2, service concepts were clustered according to a particular set of critical dimensions for the project: flexibility service (27%), grid stabilisation service (13%), monitoring service (23%), comfort services (16%), self-consumption (5%), and other services (16%).

a. Innovation assessment

Our batch of 36 innovative and interoperable services is considered an innovation tank at the beginning of the project innovation funnel. As defined below, these candidate services have been described into a unique template and assessed by a committee of seven experts selected among our members within a two-stage evaluation process:

- At first, we ran a blind individual evaluation for each service. Then, the individual results were collected to see the standard deviation among the experts' evaluations.
- The second stage was a meeting of the evaluation committee, where we had discussions about our most apparent discrepancies. The idea here was to understand the origins of our divergences, to have a deeper understanding of the innovation material created during InterConnect.

Innovation may expand in two directions: novelties in technology maturity (often assessed with a TRL, a Technological Readiness Level) and novelties in the field of uses (often described using the TALC, the Technology Adoption Life Cycle). Those two directions for innovation are used as two axes to build an **innovation matrix** (see below a summary of the innovation and the repartition according to the energy and non-energy sub-services). Our 36 services are distributed into this classical matrix (*see Design-Driven Innovation*, by Verganti 2009) that depicts four distinct types of innovation (sustained, incremental, radical and disruptive).

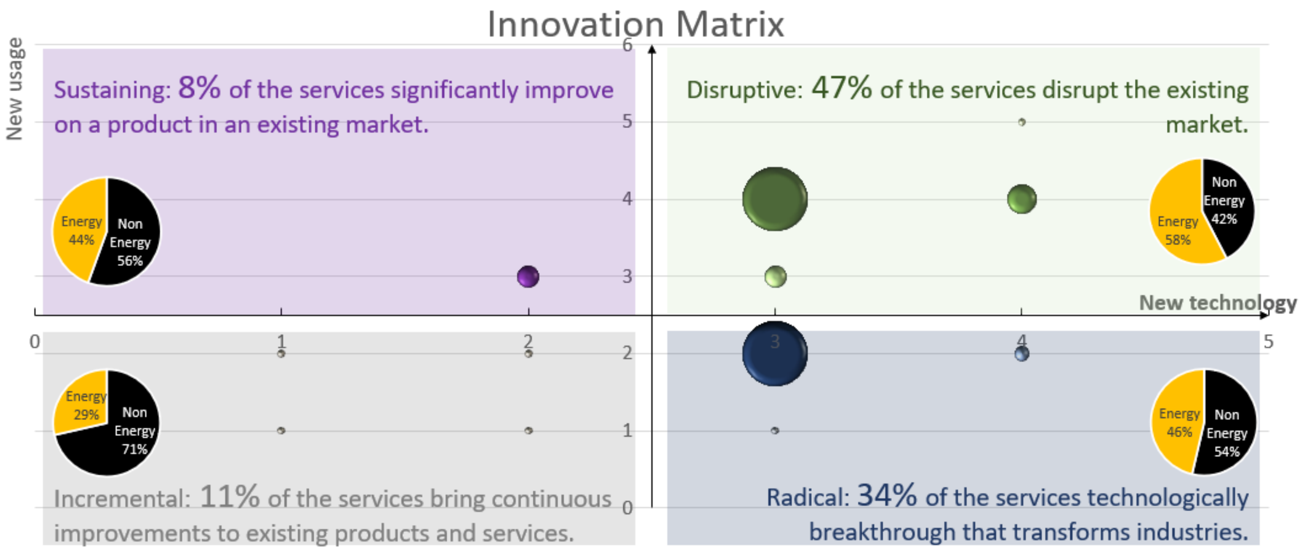

FIGURE 4. INNOVATION MATRIX

One of the reasons why 81% of the dots are located on the right part of the graph is that most of the services are designed to be compatible with SAREF ontology, which can be considered a core component to bring more innovation in terms of connectivity for smart home and grid. By enriching SAREF ontology, InterConnect is solving a crucial technological barrier. Also, it will allow the recruitment of a vast range of devices involved in the Smart Grid and its services. Moreover, services are oriented to allow the large-scale implementation of components/results that barely exceeded the stage of prototypes or small-scale demonstrators or have connectivity problems that prevent implementing new business models. Thus, they may potentially disrupt the current *status quo* in the European energy market by democratising advanced use cases.

The services were also analysed according to different scales on interoperability[1] and the European interactions. As a result, 97% of the services described in the D1.1 are based on SAREF and InterConnect interoperability framework. Also, 28% of the services defined in D1.1 can be cross-country at the European level.

InterConnect interoperability framework provides a set of integrated tools allowing to characterise, govern, and ease establishing an interoperable ecosystem. It is geared by semantic data exchange, bridging the integration gaps "within" (among platforms and services) and "between" (across domains) the IoT and the energy domain. As a result, industrial stakeholders, such as system integrators, service providers, manufacturers, application developers, and digital platform operators, will be empowered to adopt semantic interoperability. Furthermore, the semantic interoperability will enable them to create multi-domain energy and non-energy services centred around knowledge exchange. For instance, smart homeowners and digital service users will gain freedom of choice by avoiding vendor lock-in when deploying or updating smart appliances, shifting between home automation and energy services running on their smart systems; and empowering them to choose GDPR compliant digital services.

b. <u>Innovation per pilot's services</u>

Departing from semantic interoperability[2], the InterConnect pilots bring the following innovations at the service level:

- **Portugal**. Integration of SAREF-compliant demand-side flexibility (DSF) and behind-the-meter data (i.e., exchange of interoperable collective data) from B2C customers into the operation of distribution grids using a standardised DSO interface; cross-sector business model with supermarkets offering EV charging as-a-service to their customers and integrating DSF from EV and refrigeration systems in grid management.
- **Belgium**. The flexibility of retrofitted thermal loads, accompanied by other flexible devices (heat pumps, PV, EV), via the interoperability framework and the services' SAREFization, is a significant barrier to integrating behind-the-meter heterogeneous devices and systems. Cross-sector and multi-utility business rule engine for integrating many interlinked assets, including a cost-driven heat vs electricity optimisation and tracking environmental benefits (water saved, avoided CO2

[1] Dibowski, Henrik. (2017). Semantic Interoperability Evaluation Model for Devices in Automation Systems. 10.1109/ETFA.2017.8247709.

[2] The ability of digital systems to exchange data with unambiguous, shared, and agreed meaning.

emissions). Combination of several energy management systems engaging in a SAREF-based peer-to-peer market.

- **France**. The design and implementation of a Smart Orchestrator, in a dynamic tariff context, allowing the intelligent and remote control in the same household of different energy management microservices from various service providers and considering aggregated flexibility from other sources (space and water heaters, EV, white goods) in real-world conditions. Implementing a blockchain-based platform to reward PV surplus with green coins, enabling exchanges within the community, e.g., the baker could exchange his products with his customers by using green coins.
- **Germany**. The demonstration of the entire chain of bidirectional end-to-end communication from the DSO to interoperable devices in residential and commercial environments via BSI-certified (Federal Office for Information Security) smart meter gateway infrastructure, considering a fully interoperable negotiation of energy consumption plans with devices that have their intelligence (EVs or heat pumps) to avoid loss of comfort, inefficiency, or conflicts with internal processes.
- **Italy**. The interoperable architecture of a monitoring and control IoT platform that covers the specific case of residential social housing and digitalisation of energy behaviours at the community level introduces and testing the role of a social aggregator to capitalise on inclusion and capability in accessing the emerging market of flexibility services, considering only white goods (e.g., washing machine) as a source of flexibility (which are more common to find in social housing).
- **The Netherlands.** Living-as-a-service interoperable platform (Ekco) for multi-domain heterogeneous services where users can easily connect all types of devices autonomously powered by FIWARE standards, including a data marketplace where data users/suppliers have wallets to hold loyalty tokens for transfer of data-value using InterConnect interoperable framework. REFLEX platform used by aggregators to maximise the value of flexible energy assets across multiple energy markets, merging S2 flexibility standard (prEN50491-12-2) with SPINE flexibility concepts in SAREF.
- **Greece**. Design and implement an end-to-end architecture (based on InterConnect reference architecture) combining the SAREF-ized services with existing open-source home automation systems (e.g., OpenHAB, home assistant) offering interoperability across a wide range of commercial energy/ non-energy sensors from different vendors and including consumer feedback. This architecture will leverage information from providing non-energy services (e.g., home comfort, physical security) to residential users for energy efficiency purposes. Moreover, innovative DSF services, based on machine learning algorithms, will be implemented to exploit high-temporal resolution measurements and crowdsourcing mechanisms (e.g., incentivise users to submit their predictions).

Finally, a **cross-border demonstration** will be promoted in InterConnect to highlight the **technological and economic advantages of cross-border interoperability**, and the use case consists in aggregating flexibility resources (e.g., loads, RES, DSF, and storage) from the country-level pilots to a simulated TSO for the provision of ancillary services. The main innovations are:

- implementing a SAREF-ized flexibility aggregation platform that facilitates cross-border flexibility data exchanges;
- leveraging the InterConnect interoperability framework to expand the flexibility markets to new participants and stakeholders at the LV and MV level, enabling pan-European adoption.

2- Business models

Each pilot team identified the business models based on the service concepts developed and discussed under Factory 1B workshop. The homework from Factory 1B resulted in fifty-one building blocks for creating future business models. Clusters were made to understand the main items that will make them successful or failing.

The work carried out on task 1.1 is preparatory work for developing detailed business models, which will occur in task WP9 as planned in the grant agreement and based on the services and HLUCs selected into the D1.2 D1.3 documents. Therefore, this document presents the first step in creating the project's business model building blocks.

3- High-Level Use Cases (HLUCs)

During Factory 2 and based on this work and the use cases already existing (as state of the art in Europe in May 2020), the InterConnect partners transformed their service concepts into 112 HLUCs after a multi-stage refinement process.

The results were analysed and mapped with the different use cases according to two different sets of criteria, one focused on the solution (named 'solution centric') and the other on social aspects (named 'social'). More than 26% of the HLUCs are related to monitoring, about 20% are related to flexibility and comfort, about 13% are related to network stabilisation, 6% are related to self-consumption, and 15% are other HLUC types. Concerning the solution-focused mapping: about 21% is related to consumption reduction, 10% to decentralisation, 27% to democratisation, 21% to deregulation, and 18% to disruption.

Many relevant HLUCs support energy flexibility at the household level that may be common to most pilots. There is a strong emphasis on integrating renewables (including self-consumption) to minimise costs, reduce carbon footprint and optimise grid operations.

Through a collective and creative process, the Work Package 1 team has created a broad and rich set of HLUCs that can cover the needs of InterConnect. However, not all these HLUCs will be tested as part of the project. Instead, similar HLUC will be aggregated and consolidated first. Those that will be eventually implemented will be selected, refined, adjusted later in task 1.3 based on the work on HLUC started in task WP1 task 1.1 / 1.2. The work on business models started in task WP1 task 1.1 / 1.2 will be continued in WP9.

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ABBREVIATIONS AND ACRONYMS

aFRR/mFRR	automatic /manual Frequency Restoration Reserve.
AI	Artificial Intelligence.
Appliance	Electrical apparatus intended for household or similar use. Examples: refrigerators, dishwashers, clothes washers, clothes dryers, air conditioners, water heaters, circulation pumps, or others.
Aggregator	Manage demand response of multiple loads accumulated from industrial, commercial, and residential end-users.
BM	Business Model
BRP	Balance Responsible Party.
BUC	Business Use Case.
CAPEX	Capital Expenditures, commonly known as CapEx, are funds used by a company to acquire, upgrade, and maintain physical assets such as property, buildings, an industrial plant, technology, or equipment.
Congestion	Arises if the power flows implied by the geographic distribution of generation and load are too large to be transmitted by the grid.
Congestion management	Any measure undertaken by system operators, regulatory authorities, or lawmakers aims to influence power flows by operational security constraints [12].
Country Analysis	The country analysis illustrates the country's peculiarities in local regulations and value chains. It is organised around analysing national contexts in statistical surveys that shape the extraction of user profiles.
Data model	Definition of possible data (data structures, values) for the exchange of information (especially for communications systems).
Demand-Side Flexibility (DSF)	The ability of a customer (prosumer) to deviate from its average electricity consumption (production) profile in response to price signals or market incentives [4].
DSM	Demand-Side Management.
DSO	Distribution System Operator.
DR	Demand Response.
Ecosystem map	The ecosystem describes the intermediation model to define the relationships between stakeholders.
EMS	Energy Management System.
EPIC	To arrive at the user stories, we need to position ourselves on the point of view of different user profiles and actors.
EV	Electric Vehicle.
FCR	Frequency Containment Reserve is a production capacity (or any other machine) reserved for reducing or increasing energy output to contain possible frequency deviations. This reserve needs to respond quickly and accurately [6].
FRR	Frequency Restoration Reserve (FRR); RR can be distinguished between reserves with automatic activation (aFRR) and reserves with manual activation (mFRR).
Feed-in tariffs (FITs)	Generation-based, price-driven incentives. The grid operator must buy the electricity produced by the renewable source either at a price determined by the RES-E national or regional system [5].
Flexibility Operator (FO)	The Flexibility Operator is an entity that buys flexibility from a Flexibility Owner, structures it, and sells it as a commodity (energy or capacity) on the markets. The energy sold must be purchased from the retailer.
Flexibility Owner	The Flexibility Owner is a consumer, a producer, or a storage operator that can adapt its consumption or injection according to an external signal. This entity can sell this ability explicitly or implicitly.

Flexibility Service Provider (FSP)	The Flexibility Service Provider is an entity that buys flexibility from a Flexibility Owner structures it. It sells it to an entity needing flexibility services such as a TSO or a DSO. The structuration performed by the FSP can be an aggregation of several flexibilities from different Flexibility Owners.
GR	Governance Regulation.
HEMS	Home Energy Management System.
HLUC	High-Level Use Case.
HBEMS	Home Building Energy Management System
ICT	Information and Communication Technology.
LV	Low Voltage.
ML algorithm	Machine Learning algorithm.
MV	Medium Voltage.
NGSI	Next Generation Service Interface.
NGSI-LD	Next Generation Service Interface – Linked Data.
P2P trading	Sale of renewable energy between market participants using a contract with pre-defined conditions governing the automated execution and settlement of the transaction, either directly between market participants or indirectly through a certified third-party market party, e.g., aggregator.
Pilot	Area in Europe where a demonstrator is taking place
Prosumer	The entity that is consuming electricity can proactively adapt its consumption and can also produce electricity.
PV Panel	Photovoltaic Panel.
OPEX	Operating Expenses refer to the ongoing costs associated with the daily operations of business products, services, and systems.
RES	Renewable Energy Source.
SAREF	The Smart Appliances REFerence.
Service provider	The entity is providing a service to a Prosumer or a Flexibility Owner.
SMGW	Smart Meter Gateway.
SoA	Service-oriented Architecture.
SPINE	Safe Programmable and Integrated Network Environment.
SUC	System Use Case
TALC	Technology Adoption Life Cycle.
ToU	Time of Use tariffs: customers can adjust their electricity consumption voluntarily (either through automation or manually) to reduce their energy expenses.
TSO	Transmission System Operator.
TRL	Technology Readiness Level.
Use case	Textual description of a re-usable functionality consisting of more messages from one or more participating actors. It may be visualised with a sequence diagram.
Use Case Functions	Use Case Functions group basic functionalities that had been derived from use cases. These functions provide the entire information exchange required to implement the used cases and user stories.
vREG	Vlaamse Reguleringsinstantie (Dutch: Flemish Regulation Entity for the Electricity and Gas market, Belgium).
VPP	The Virtual Power Plant, aggregation, or vRES energy generation plants supply the desired demand reliably.
Wired cover	Allow identifying the values characterising each Pilot and build a vision about the desired outcome.

1. INTRODUCTION

The deliverable D1.1, "Services and uses cases for buildings and smart grids." is the first deliverable of WP1, "Use cases, business models and services," and represents the outcomes of tasks 1.1 and 1.2 focused on human-centric and grid-centric services and business models definition. This document provides the study and design of mapping existing and new energy and non-energy services and corresponding business use cases. It presents a conceptual work that will feed technological and regulatory improvements in the other Work Packages.

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This document presents the major work steps from October 2019 to June 2020 as tasks T1.1/T1.2. Following this introduction, chapter 2 details the design thinking methodological approach used since the beginning of the project. Chapter 3 presents the problem framing from the different pilots. Then chapter 4 grants the design of the solution aiming to conceive new service concepts. Chapter 5 stages the method to conceive a High-Level Use Case. Moreover finally, chapter 6 is the conclusion. The annexes exhibit all the major outcomes expected by the D1.1: service, business model, and high-level use cases.

The D1.1 is not a global functional requirements specification. Instead, these requirements will be described in D1.2 “mapping between use cases and large-scale pilots,” explaining the selected HLUC and D1.3: “system use cases for smart buildings and grids”, providing associated sequence diagrams.

2. METHODOLOGICAL APPROACH

2.1 INTRODUCING DESIGN THINKING

Scholars and practitioners acknowledge the central role of design as a driver of innovation and change. Far from being linked to the “form” of products, design thinking is accepted as a formal creative problem-solving method fostering innovation. However, several features distinguish design thinking from other innovative approaches: (1) helping to solve a wicked problem; (2) adopting the human-centred perspective in all steps; (3) integrating analytical thinking; (4) engagement-driven cognitive process.

The incredible opportunities that digital technologies provide allow us to access an unprecedented number of novel solutions. Idea management systems and crowdsourcing platforms significantly support creating and accessing innovative ideas. The design thinking paradigm suggests applying these creative dynamics (divergent + convergent) to develop the solution and define the problem. Indeed, by reframing the problem, new opportunities can surface.

2.2 DESIGN THINKING PROCESS IN INTERCONNECT

According to the design thinking approach previously described, divergent and convergent phases have been alternated to foster creativity and accelerate the decision-making processes. The design thinking process used on Interconnect is the following:

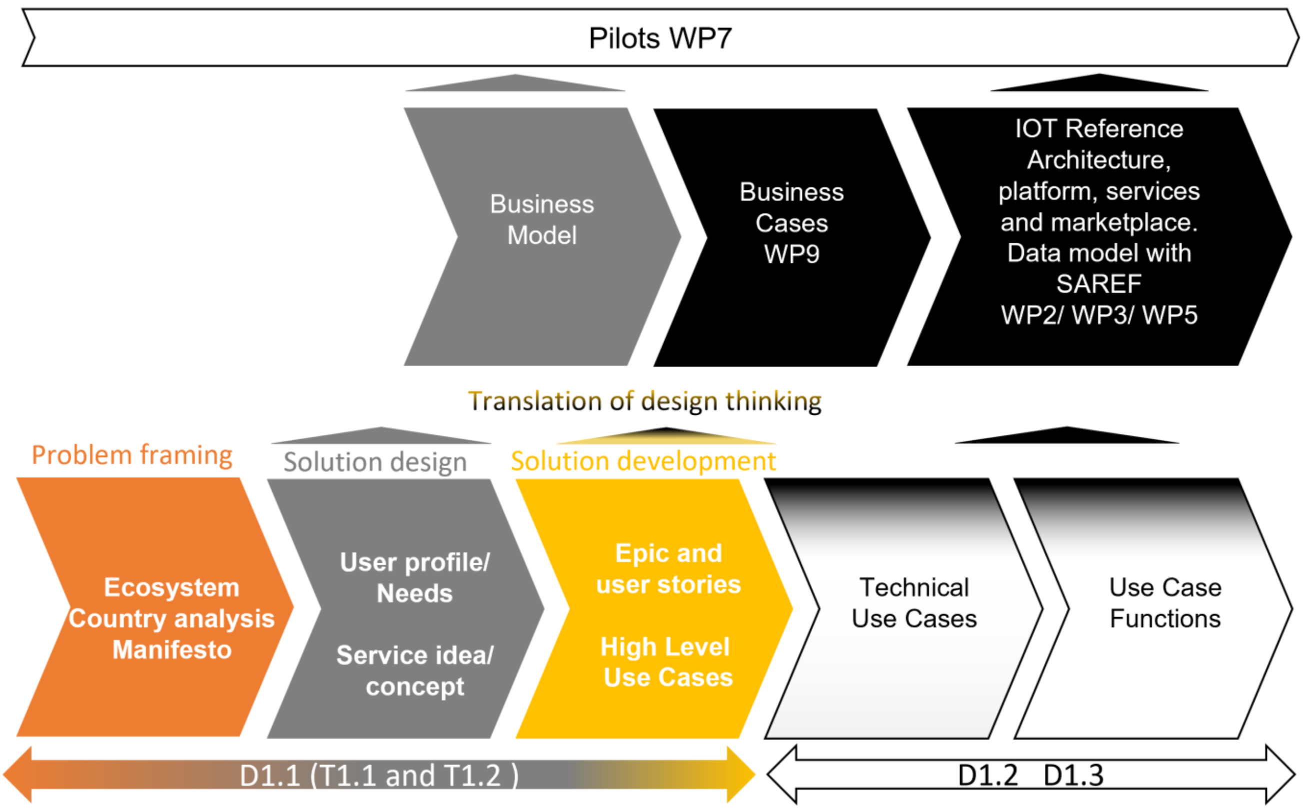

FIGURE 5: DESIGN THINKING PROCESS IN INTERCONNECT

The coloured process in the previous figure is based on three main phases:

- **Problem framing**: this phase aims at collecting relevant information that enables the conception of innovative solutions. The deliverables generated in this phase are manifestos, ecosystem maps and country analysis.
- **Solution design**: this phase is characterised by several divergent/convergent loops aiming to conceive new service concepts that can fulfil users' previously identified needs. The deliverables generated in this phase are detailed user-profiles and needs, service ideas to fulfil users' needs, service concepts highlighting the users' journey, and business models explaining the viability and feasibility of the conceived services.
- **Solution development**: this phase details the service concepts in epics and user stories. They represent the fundamental inputs to picture the high-level use cases. Therefore, the deliverables generated in this phase are epics and user stories, high-level use cases.

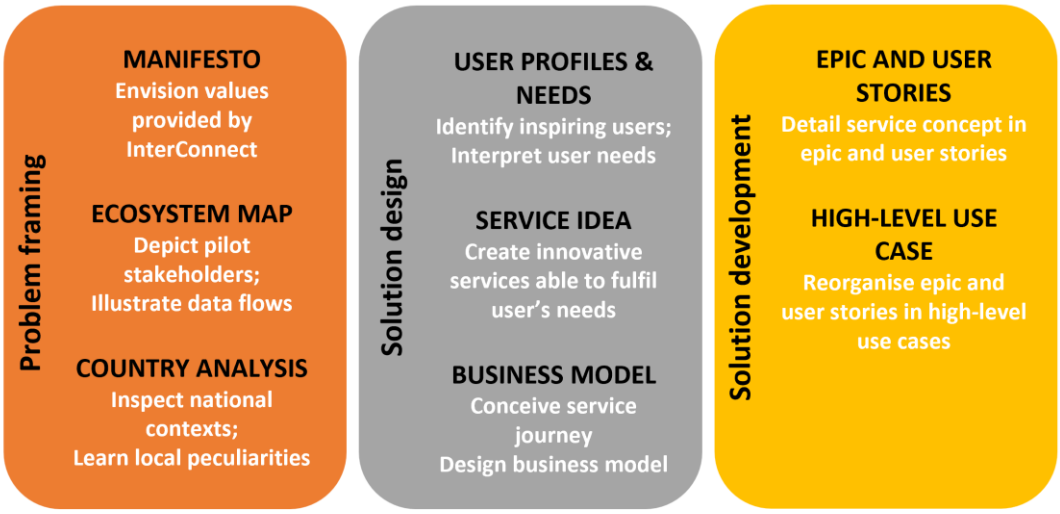

FIGURE 6: PROBLEM FRAMING, SOLUTION DESIGN, AND SOLUTION DEVELOPMENT

The following timeline presents the different milestones/iterations realised to produce the D1.1:

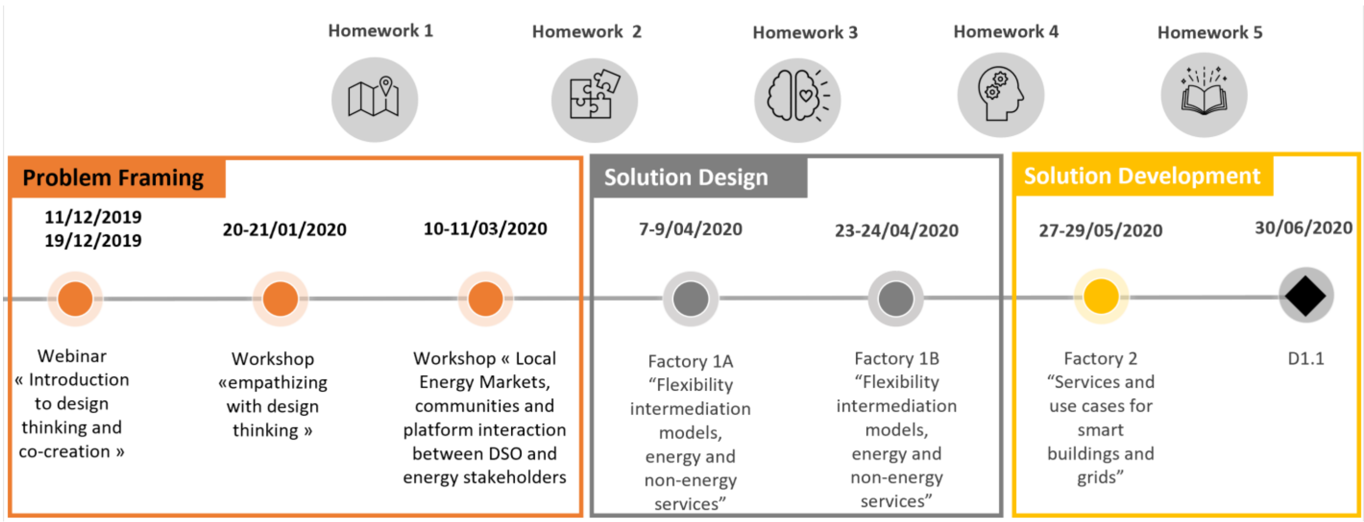

FIGURE 7: MILESTONES TO PRODUCE D1.1

More specifically, several activities have been organised to govern the entire process smoothly. Each activity will be detailed in chapters 3, 4, and 5, respectively.

3. PROBLEM FRAMING

3.1 WHY

This phase aims at collecting relevant information that enables the conception of innovative solutions. The problem framing phase aims at collecting information about the local market, technology, policy, and regulation that can influence the ecosystem architecture. In this phase, a draft vision desired by InterConnect and the pilot teams has been shaped.

3.2 METHODOLOGY

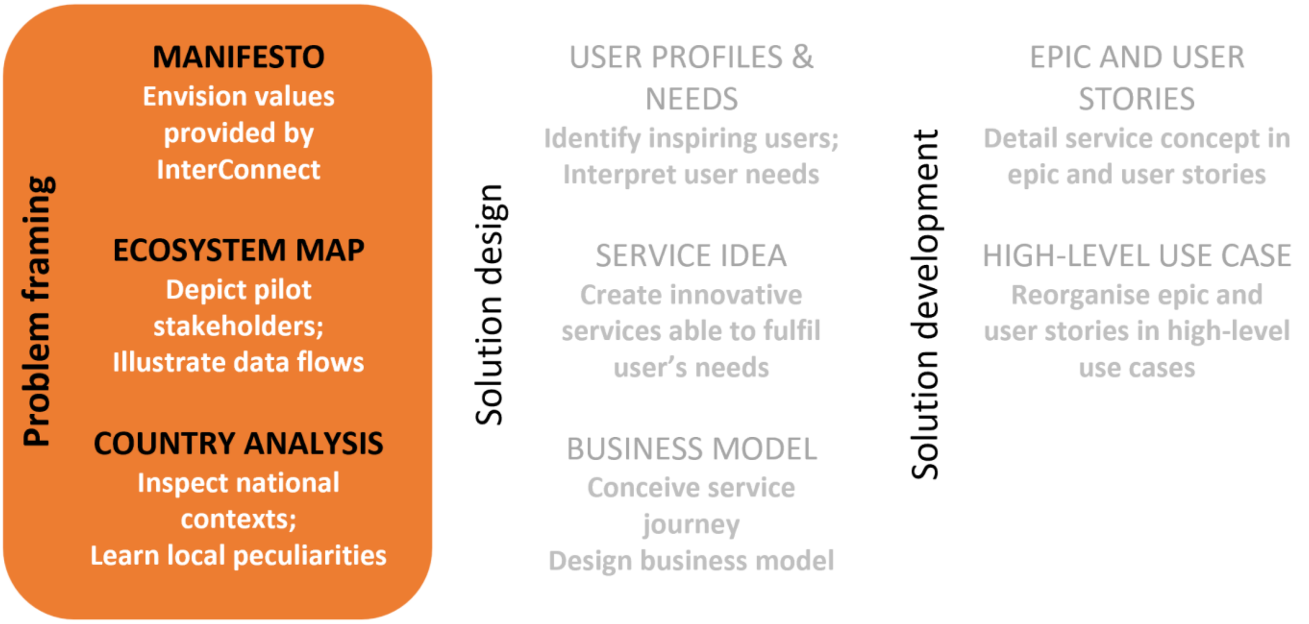

FIGURE 8: DESIGN THINKING PROBLEM FRAMING ACTIVITIES

Examining each country concerned by the demonstrators is necessary to frame the problem.

Thus, this phase shapes the overall vision of InterConnect, and more specifically, of each pilot. Moreover, it defines the boundaries of the projects with the ecosystem resulting from the collection of information about the local market, technology, policy, and regulation.

The following tools summarise the problem framing for each country in the following subchapters.

Ecosystem Map: the ecosystem describes the intermediation model adopted by each pilot to define the relationships between stakeholders. It defines the players involved in each pilot and sketches their relations (energy flow, money flow, and data flow) (see Figure below). Then, drawing on a questionnaire, each pilot identifies opportunities to maximise the value of demand flexibility through services and reliable, interoperable technologies.

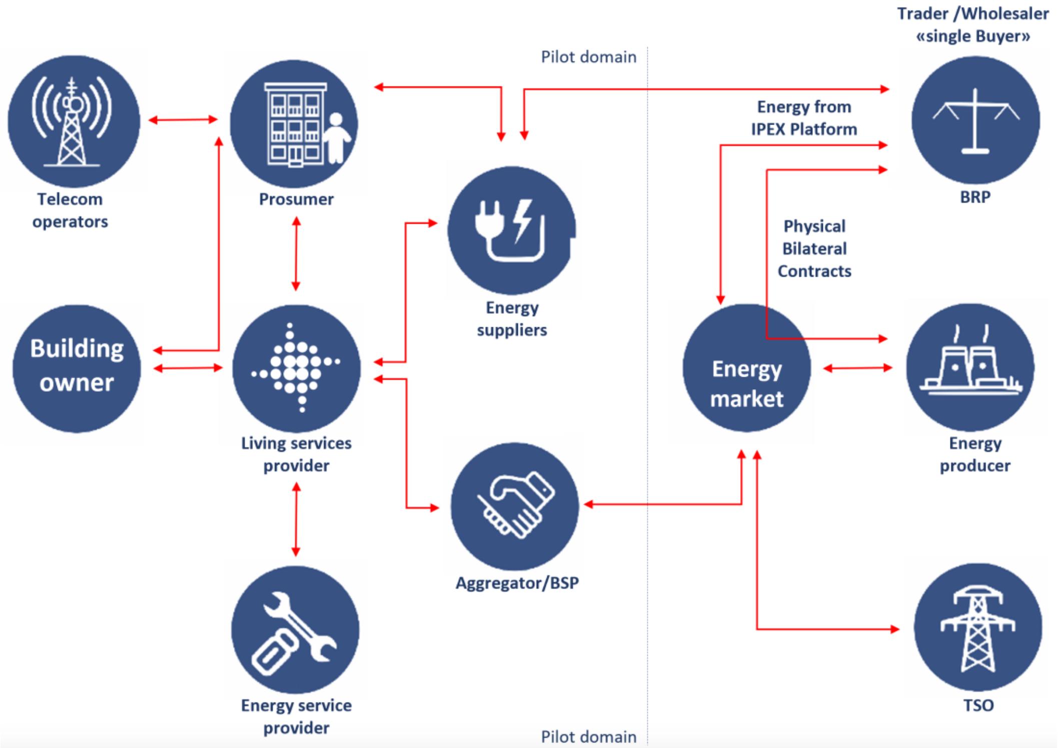

FIGURE 9: EXAMPLE FOR ECOSYSTEM MAP INTERCONNECT

Country analysis: the country analysis illustrates the country's peculiarities in local regulations and value chains. The main questions were asked on the seven following topics: the local flexibility and the self-community market, policy and regulation, end-user engagement, metering roll-out, feedback on past research projects, the constraint on the grid, and finally, the innovation awaited.

(1) Concerning the local flexibility market, it was necessary to understand the status of each country, how it is or how it will be organised, the different actors, and the incentive or impact for the Distributed System Operator or the retailer on this market. (2) The same question was studied for the energy community. (3) The policy and regulation were studied, the existing law or regulation on the flexibility market and self-consumption community, to understand the pricing schemes, technical requirements, storage requirements, time interval settlements, and national data protection regulation, and what is foreseen in the future. (4) The end-user engagement, the user awareness and the end-user profiles targeted by each pilot were introduced. (5) The smart metering roll-out, the country's penetration rate in the pilot, and what data are accessible. (6) For the research project anterior at InterConnect, the success and failures were studied as the different kinds of business models deployed. (7) The different impacts of the constraint on the grid, congestion cost, who pays for the grid's reinforcement, and the different roles of stakeholders for the grid provision. (8) Moreover, the new forms of organisation of production and consumption, the new control of assets, the products that will be traded and the new form of incentives.

Manifesto: the manifesto identifies the new values proposed to the users to declare the vision pursued by the Pilot team. Indeed, each pilot expresses the values, sets the vision, and outlines the expectations and intentions for InterConnect. This document publicly declares their program, advancing their ideas, opinions, or views while laying out a plan of action. To support the definition of the manifesto, each pilot employs a tool describing the change of meaning, the striking elements to be implemented, and the issues to be tackled

3.3 OUTCOMES

The activities related to the "problem framing" stage were shown in the timeline below in the form of webinars from December 2019 to April 2020.

During this period, we first organised two webinars on December 11 and 19, 2019, to present to all WP1 partners an introduction to design thinking and co-creation.

Then we realised the workshop "empathising with design thinking" in Milan on January 20 and 21 of 2020 to establish the pilot's personas, user profiles, and ecosystem map. The Wired Covers, personas, ecosystems map and country analysis were refined/realised by each pilot as homework.

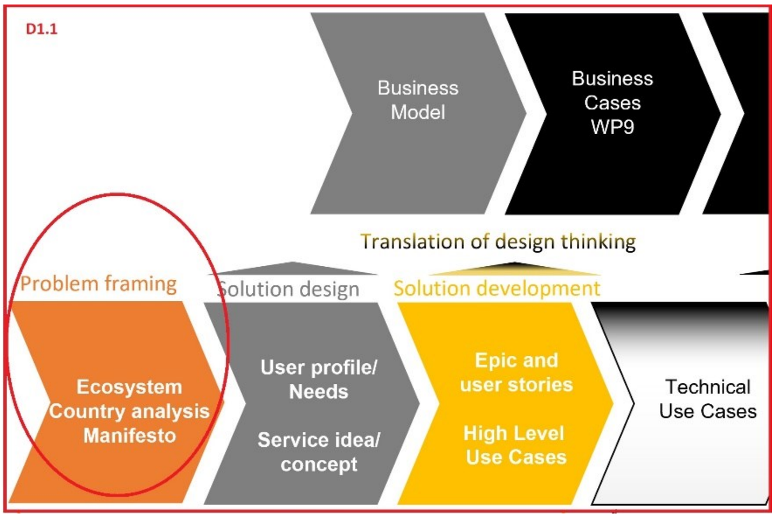

FIGURE 10. DESIGN THINKING PROCESS, PROBLEM FRAMING

On March 10 and 11, 2020, we held the last workshop on the problem framing stage in Lisbon. We shared with all the WP1 actors an overview of the use cases already produced on the European projects, exchanged examples of innovative services, and focused on the user needs and the wired covers. In addition, each pilot completed their country analysis and manifesto as a homework assignment following this workshop.

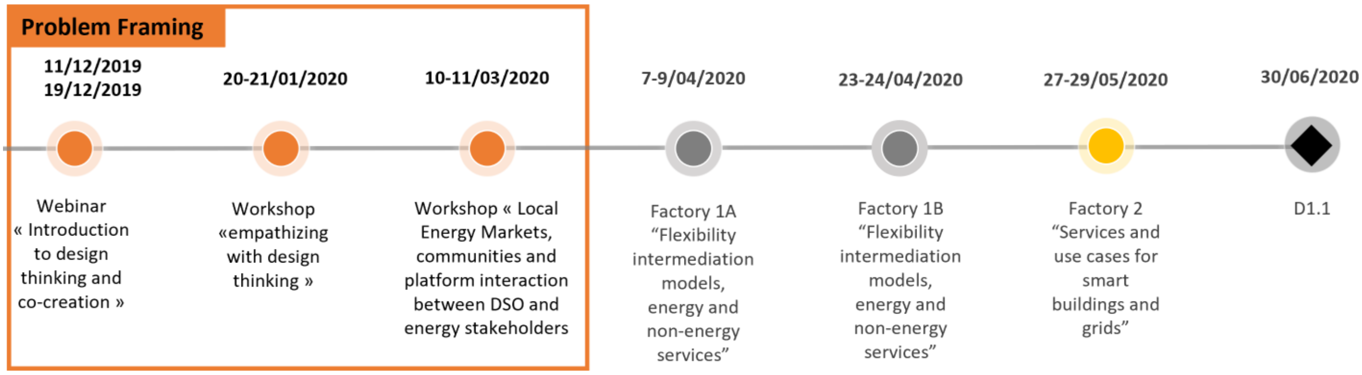

FIGURE 11: PROBLEM FRAMING TIMELINE

The following sub-chapters present the synthesis of the results obtained by each pilot.

3.3.1 PROBLEM FRAMING PT

Constraints

The electrical grid may suffer from several local constraints, namely grid congestion, due to the massive adoption of power demanding loads. Also, there are voltage levels in urban areas with a large RES concentration. Both commercial and residential buildings can better exploit their assets to provide services to the grid. Furthermore, there was no clear national regulation related to TSO and DSO at a local level. Local Energy Markets have experimented with some European projects like H2020 Dominoes without real-time trading (simulation only). Also, the business model for the Aggregator/Service Provider needed to be defined.

Motto

The value of the pilot is defined in the motto "Maximising the value of demand flexibility through services and reliable, interoperable technologies".

The different axis for action:

- technical: promote interoperability between smart homes, buildings, and grids to sustain and empower energy transition;
- business: explore advanced instruments for demand-side flexibility, market facilitation and consumer empowerment;
- environmental: interoperability as a technical leverage mechanism to increase renewable penetration.

Distinctive features:

- Advanced HEMS scheduling helps reduce bills, use consumer load forecasting, learn about consumer usage patterns, and adapt to comfort preferences.
- Fun recommendations on using loads for bill (and CO_2) reduction.
- Be sure to get investment back.
- Eco-EV charging, charging EV with carbon-free energy, and getting other values from the building (shopping).
- Choose among different appliances. Plug and play across ecosystems in a seamless way (simple, privacy-aware, interoperable) easily. Everything is working. Set it and forget it.
- No risk of appliances and devices and infrastructure not working together.
- Belonging to a community that cares about energy efficiency. Learning by a working example from peers. Energy for good: select to whom to give excess energy.
- Covering the entire value chain energy process, regarding provisioning flexibility and observability services, in an integrated manner, from the consumer to the grid operator.

3.3.2 PROBLEM FRAMING BE

Constraints

Currently, there is no local flexibility market in Belgium. Concerning the grid constraints, even if big constraints are not observed, DSOs are concerned about the progressive electrification of heating and the introduction of electric vehicles into the low voltage grid. High electrification scenarios are projected to lead to a lack of connection capacity at multiple voltage levels.

The TSO (Elia) considers LECs an LV/MV issue and thus the responsibility of DSOs. Both TSO and DSOs are concerned with the erosion of the cost base that energy cooperatives could create, i.e., the distribution of grid costs among fewer people. The DSOs are not open to other players operating the/a distribution grid. Parallel grids are not allowed, and also, the opt-out regime (choosing not to be part of the distribution grid) is a concern. The DSOs prefer actors managing assets (generation/load) to offer/deliver services. Authorities (mostly regional) are not eager to enable other actors (e.g., energy cooperatives) to take over DSO activities (e.g., grid management).

The CWaPE, the Walloon regulator, has been proactive concerning energy cooperatives regulations through a decree introducing the REC concept into Walloon law. The VREG, the Flemish regulator, is currently investigating relevant aspects concerning energy cooperatives (like tariff adaptation revised rule of electricity distribution). At the national level, there is no legal framework for energy communities. The Walloon government issued (in March 2019) a decree that fosters the development of "Renewable Energy Communities" at the regional level. The decision-making power is shared between a Federal and three regional governments (Flemish, Walloon, and Brussels-capital). Belgium is opting for an energy mix based on flexible capacity and renewable energy at the federal level. As national objectives, the federal government wants to "increase the flexibility of the national energy system to cope with limited or interrupted supply to improve resiliency in energy systems (national and regional)". Currently, regions are discussing the regulatory framework to help place storage (e.g., battery energy storage - behind the meter or collective use - at the neighbourhood level) and deliver demand management across the distribution grid. In the Flemish Energy Plan 2021-2030, flexibility is among the five pillars considered at the regional level. Proposals have been formulated to make energy infrastructure smarter and more flexible.

The rollout of smart meters is different between Flanders and Wallonia. **Flanders**: The digital meter rollout started in July 2019. The Flemish regulator expects every home to be equipped with a digital meter within 15 years. New projects for solar panel owners and customers with budget meters are prioritised when installing digital meters. **Wallonia**: According to the Decree of July 19th, 2018, for the electricity, smart meters shall be installed no later than 1 January 2023. The decree requires DSOs to achieve an 80% share of the following grid users: (1) users with annual consumption of 6,000 kWh; (2) users with a net electric power capability of 5 kW ; (3) charging points open to the public.

Motto

The motto of the Belgium pilot is that we provide borderless configuration of services from and to community members aiming to maximise the value of flexibility for society.

The different axis for action:

- technical: centralised control and monitoring, a combination of different services, manage flex resources to avoid peaks;

- business: reduce invoice, promote additional RES investments, add new sources of income (utilisation of spaces);
- environmental: CO_2 reduction/contribution to combating global warming, better forecasting of RES;
- ether (social, safety, privacy…): data used for community-related services and to respect values, respect GDPR.

Distinctive features:

- enables local trade facilitated by the LEC platform considering user preferences and values;
- uses distributed intelligence for user behavioural prediction and adaptation;
- enables the "smartifying" of devices.

3.3.3 PROBLEM FRAMING GE

Constraints

There were no regulations defined for Time interval settlements and pricing schemes. Additionally, the voltage measurement is not feasible on all streets and the MV/LV level. The measurement possibilities in the whole LV supply network were not existing. The deployment of Smart Meter Gateway as an intelligent measurement system will be started in 2021.

Motto

The motto of the Deutsch pilot is “Living as a Service”.

The different axis for action:

- technical: Interoperable connection via Smart Meter Gateways (BSI conform), fully autonomous local EMS operation, using a mobile app and automated devices to manage energy consumption, independent, environmentally friendly conveniently; House has an active role in the Network;
- business: manage over/underload scenarios driven by large scale volatile RES energy supply and transition in mobility and heating;
- environmental: less CO_2 emissions, efficient usage of renewable energy;
- other (social, safety, privacy…) transparency through the mobile app.

The distinctive features:

- current power consumption or forecast of the building;
- flexible tariffs enable local load management for the tariff-optimised operation of devices;
- power limitations within maximum power curve by DSO;
- indication to run devices manually if the price of energy is low;
- customer preferences define energy management target goals (prize, CO_2).

3.3.4 PROBLEM FRAMING NL

In the Netherlands, we see various smart devices in homes (smart white goods appliances, home automation). In parallel, electric sustainability in and near homes and offices is rising fast. PV panels, EVs and related charging spots appear near homes and offices. This last trend puts strain on the electricity system and grid, so PV energy integration (peak shaving) and smart charging of EVs (avoiding peak loads in, e.g., the evening) become important. Also, the energy flexibility of smart white goods appliances can contribute to the solution, and therefore information from the end-user and the appliances and sensors in the smart home can contribute to the solution. Further, at the beginning of the project, we also identified that smart homes, especially home automation, could contribute to healthy living and quality of life, and Covid-19 demands more focus on health and clean air in offices.

Therefore, we conclude that we need a multi-domain system and digital platform that can integrate and combine the information from these domains to cover all the use case areas. We want to provide consumer and commercial solutions on the following three domains: energy, healthy environment, and smart home and building services. More specifically: (1) smart comfort and control, smart homes; (2) consumer sustainable energy services; (3) healthy living, convenience, and health automation; (4) healthy work, healthy air in the office; (5) commercial building energy management; (6) smart mobility, green and smart charging.

These domains may seem separate, but the information of one domain is needed to execute (better) control in other domains. User involvement and information is required to perform energy services with white goods appliances. Commercial Building Energy Management requires seamless integration of EV charging of the EVs near and connected to the building grid. Much more combinations are envisioned. Therefore, a multi-domain system and digital platform where data can be easily shared in a secure and respected privacy manner is the foundation of the future InterConnect smart Service Ecosystem.

For the InterConnect Dutch pilot, we have an existing office building and a new being built 22 storey apartments complex available to pilot most of these services in different domains.

Constraints and opportunities

The grid constraint concerns mostly supply limitations (caused by RES integration from PV and wind); grid costs are divided over users of the demand, which is becoming more visible and causes discussion since some (EV) users cause the major congestions. It is the same for wind connectors at sea. There is also congestion at the demand side in some areas, sometimes caused by heat pumps or EV charging areas. So, from the grid perspective, a Local Energy Community can help but is not a complete solution.

DSOs are launching local flexibility markets and bilateral contracts. For example, GOPACS (https://gopacs.eu/) offers congestion management solutions by TSO and DSOs.

Motto

The pilot motto is “No hassle, no setup, plug and play and contribute to and enable a smart, sustainable, comfortable environment. I feel more comfortable at home or work quality, and at the same time, I support sustainability and innovative energy network automatically.”

The different axis for action:

- technical: an interconnected system (hardware and platform) that can connect in-house (smart) appliances (dishwasher, washing machine), devices (locks, lights) and systems (HEMS, HVAC) to external systems (power grid, energy markets, flexible tariffs), addressing Smart Comfort/Control and Smart Homes, and healthy living, convenience, and health automation needs;
- business: building owner will have a business case based on commercial Building Energy Management (BMS and EMS) and smart mobility, green and smart charging. This will realise more energy efficiency (power grid, energy markets, flexible tariffs, battery, EV chargers) and better conditions for higher work productivity by Smart Comfort, Healthy Work, Healthy Air and improved facility management;
- environmental: CO2 reduction by optimising external systems peak shaving leads to keeping the current power infrastructure, so no additional expansion is needed. Addressing Consumer Sustainable Energy Services and Smart Mobility, Green and Smart Charging;
- other (social, safety, privacy…) Also, Citizen Energy Communities and Energy poverty can be addressed by better energy system use, with privacy addressed by transparent and anonymised use of data.

The distinctive features

The distinctive feature is the creation of an Interoperable Smart Service Ecosystem that takes care of flexibility without hassle for or noticed by the end-user but can exploit flexibility on multiple energy markets simultaneously.

3.3.5 PROBLEM FRAMING IT

Constraints

Related to grid constraints - the electricity network in Italy is interested in some important issues:

- the frequency of extreme climate events (wet snow, floods, …) poses the risk of making the electricity grid vulnerable and increasing the risk of service outages;
- a shift in demand trends due to the large growth in electric mobility, both privately and publicly;
- for example, reducing energy generation from traditional fossil fuels is decommissioning coal-based thermal power stations;
- a rapid growth in production from renewable sources, particularly solar and wind sources, coming from small-scale plants spread throughout different parts of the territory and featuring a production output that is less predictable and manageable.

As described in Annual Report 2019 by ARERA, the average number of long and short outages by users due to all causes, including beyond the responsibility of Terna, including major incidents, slightly worsened nationwide concerning the values recorded in 2017 even if in some regions there were improvements (Turin, Florence, Rome, and Cagliari). Furthermore, the distribution service also worsened, both in terms of duration and number of outages, confirming the trend of 2017 and mainly due to the exceptional weather conditions. In detail, the duration of outages without notice for which the distribution companies were responsible stood at 45 minutes at the national level, while the number of long and short outages without notice (lasting between one and three minutes) for which distribution companies were responsible stood at 3.38 outages per low voltage user nationwide.

Concerning the Local Energy Market, the local Ancillary Services Market did not open in 2020. Therefore, the actors that will organise and operate each market need to be defined. Furthermore, in addition to the EU Directive 944/2019 “on common rules for the internal market for electricity and amending Directive 2012/27/EU”, in March 2020, the Italian government amended a decree to facilitate the transposition of the Renewable Energy Directive (RED II), which allows households, businesses, and public entities to produce and trade clean electricity in low-voltage grids. Concerning the penetration rate of the smart meter, 68% of the house are equipped with the older version, and 32% are equipped with the newer version of the smart meter.

Motto

The motto of the Italian pilot is “contributing to OUR future by acting (energy) smarter today, without compromising MY lifestyles”.

The different axis for action:

- technical: single and community can control energy consumption through an ecosystem of interoperable products;
- business: demonstrate, within the foreseen regulatory environment in Italy, that aggregation of residential users can have a positive business case;
- environmental: awareness about the CO2 emissions;
- social: understand mechanisms and stimuli that may induce users to change their behaviours to fulfil specific requests by grid actors.

The distinctive features:

- automation (ML empowered power management control);
- single AND community awareness;
- social impact.

3.3.6 PROBLEM FRAMING GR

Constraints

The following constraints related to the status of the energy market in Greece, the available technologies, policies, and regulations directly impact the design of the pilot’s ecosystem architecture. More specifically, Greece's concepts like Demand-Side Flexibility and power consumption monitoring/management are premature. While there are some DSM programs in place (e.g., ToU tariffs), there are no provisions for DR in general or for the straightforward operation of DR aggregators in the current market framework, which only recently has been partially aligned with the EU Target Model. The status of the energy market in Greece and the corresponding legislation foresees the role of aggregator, but not the existence of Flexible Tariffs. The operation of a DR aggregator is currently envisioned in the Greek regulatory framework. However, to be allowed to operate as one, the interested party should pass pre-qualification criteria, focusing on operation under Automatic Generation Control for the case of FRR or having the capability to provide symmetrical products for both FCR and FRR. Even as suggested by the term “Automatic Generation Control” derived from the “Terms and Conditions for Balancing Service Providers”, it becomes apparent that all measures regarding distributed load have been simply generalised based on the technical characteristics of centralised Generating Units acting as Balancing Service Providers, without capturing the operational and market complexities of dispatchable load portfolios offering Demand Response services.

Furthermore, the current Balancing Market Rulebook[3] foresees no interaction between TSO and DSO. Hence DR actions will not be available to the DSO for local congestion relief measures, given that flexibility cannot be appraised at the DSO level. On the other side, retailers cannot implement flexible tariffs given the lack of a clear legal and regulatory framework providing specific guidelines and the lack of DSO installed smart metering, which currently makes billing on an hourly basis impossible. As a result, due to the absence of DSO installed smart meters that would provide certified real-time consumption data, any implementation of flexible tariff schemes is currently deemed as not applicable, as it would be against a retailer’s interest to bill based on a user-owned smart meter that can be tampered without any legal complications. The enrolment of smart meters from the national DSO is starting gradually and will be finished by 2030.

In this context, the Greek pilot’s ecosystem architecture will provide a controlled environment acting as a regulation-less bubble, enabling consumers to familiarise themselves with new concepts that will challenge their preconceptions on electricity consumption and introduce them to the benefits of the digitalisation and democratisation of the grid. At the same time, it will prepare all the stakeholders (customers, SMEs, DSO, Retailers) for the upcoming transformation of the electricity sector.

Motto

The motto of the Greek pilot is "Play smart with energy, live better, save the environment and your pocket."

The vision, the expectations, and the new values that the Greek pilot envisions to accomplish are condensed in this single sentence of the motto provided in the manifesto. Breaking down the motto, we identify the following key concepts that form the implementation plan of the demonstrator. The word “play” stands for an interactive way of interfacing with the smart grid as two-way communication between the consumer and the grid, accompanied by engagement methods based on gamification techniques. “Smart” denotes the sophistication of today’s appliances, as well as home energy management systems (HEMS) that take advantage of IoT technology. “Energy” indicates that the concepts mentioned above will be linked to the way consumers behave and become more energy aware and efficient by changing their consuming habits. “Live better” stands for the two-fold objective of the pilot to offer services not only

4 https://www.admie.gr/sites/default/files/users/dda/KAE/Balancing%20Market%20Rulebook_v5.pdf

related to energy efficiency but also to home comfort and “peace of mind” for the consumers who want to take advantage of the latest technology developments in the sector of IoT, HEMS and smart-grids. The final part of the motto indicates that the objectives for the consumers will be related to economic benefits (electricity bill reduction), environmental benefits (carbon footprint reduction) or both. All these concepts will be implemented based on the following axes.

The different axis for action:

- technical:
  - smart homes equipped with IoT sensors (energy and non-energy ones) and custom gateways using open source frameworks; installed by the pilot;
  - collection of real-time measurements from the houses (a) power/energy-related using smart-meters (and smart plugs) and (b) non-energy related utilising a wide range of IoT sensors regarding temperature, humidity, pressure, presence/activity, door/window status, flood, smoke, ...;
  - interoperable mobile app for seamless participation of consumers from different providers and continuous personalised user engagement based on AI mechanisms and gamification;
  - demand response mechanisms based on smart appliances and IoT assisted energy management systems;
  - AI-enabled modelling and prediction of the end-users consumption behaviour and personalised recommendations for energy efficiency.
- business:
  - load shifting of users energy-costing consumption profiles from peak to off-peak hours;
  - demand response during off-peak hours where low market-clearing Prices are usually observed and when energy availability comes from renewable sources is higher;
  - demand-side flexibility with real-time energy management (remote control) based on users’ commitment/preferences.
- environmental & social:
  - active engagement of residential end-users for continuous validation of flexibility schemas and user acceptance;
  - learning which incentives (energy cost, social responsibility, carbon footprint, ...) are better accepted by the users.

The distinctive features

- IoT-assisted energy management through custom gateways and integration of sensors and devices from a plethora of different manufacturers:
- mobile app as a single and unified user interface for the three different HEMS in the pilot;
- demand-side flexibility based on dynamic user preferences provided through a mobile app;

- demand-side flexibility based on dynamic user preferences provided through a mobile app and considering different criteria: minimisation of the energy cost of the user, maximisation of the renewable energy consumption and minimisation of CO_2 emissions;
- engagement and incentives provision by using recommender systems and gamification techniques;
- personalised recommendations and prediction of end-users consumption behaviour using AI.

3.3.7 PROBLEM FRAMING FR

Constraints

With past research projects done before InterConnect, the lack of local assets for the aggregators was noted. Also, local monitoring data of the grid were not available. Another point was that the flexible charging tariffs (location, peaks) should be incorporated. Feed-in tariffs have supported renewable generation that does not encourage the management of these assets. To date, the main issue is to balance national supply/demand (430,000 producers and 65,000 individual self-consumption). Network evolution must also serve more local issues. Especially the actors of the territories would like to optimise the use of local production, from buildings, charging stations, self-consumption collectivities, an eco-district or territory with positive energy. Therefore, the network must manage peaks, anticipate anomalies, self-repair, and support the customer to manage their electricity consumption to limit their carbon footprint. Finally, it should be noted that possible tax exemptions cannot be guaranteed for re. Therefore, the profitability of a self-consumption project can hardly be based on them.

Motto

The motto of the French pilot is “Become an actor by contributing to efficient and eco-friendly energy management”.

The different axis for action:

- technical:
  - An interconnected system (hardware and platform) that can connect in-house (smart) appliances (dishwasher, washing machine, drying machine), devices (heater management, boiler management) and systems (HEM) to external systems (power grid, PV panels, EV charger).
  - A collection of real-time consumption/production information from residential setups.
  - Manage the different in-house appliances to maximise the energy efficiency from residential and self-consumption communities.
- business: creating new business models, which are integrating the diminution of the energy bill from the customer, and reducing carbon footprint based on:
  - the monetisation of the flexibility;
  - the development of new electricity subscription offers.

- environmental:
    - reduce the environmental impact, maximise the use of the RES;
- societal: validate the social and technological acceptance among different users.

The distinctive features:

- optimise the client's energy system by using flexibility;
- optimise the management of RE for maximising the locally collective self-consumption;
- cost-saving;
- automation of the solutions with power limitations.

3.3.8 PROBLEM FRAMING CROSS DEMO

Constraints

It is anticipated that there will be an increasing need for flexible services and management from the LV and MV grid levels. However, the absence of a common framework and standards inhibits the expansion of the flexible assets into the markets. This shuts-out new market participants and stakeholders at these grid levels, decreasing the ability to tap into cross-border sources of flexibility. Therefore, the resources available to these markets and ultimately the security of supply. Furthermore, compared with the traditional data exchange standards, there are a lack of technical details to enable more widespread, pan-European adoption of cross-border flexibility exchanges. Furthermore, a high level of technical challenges, low market values, and low returns on investment are presented when, e.g. a flexibility aggregator wishes to integrate with the balancing market. Standard data exchanges and frameworks, such as the interoperability framework in InterConnect, can help address these issues.

Motto

The motto of the cross-border pilot is: “Let everyone play the game!”

The different axis for action:

- technical: Seamless technical integration of energy assets;
- business:
    - providing additional, alternative aFRR and mFRR capacity to TSOs;
    - enabling small demand response and distributed generation to participate in the balancing markets and monetise their assets;
    - increasing liquidity of balancing markets.
- environmental: increase the use and need for flexible assets, increasing the overall efficiency of the grid;
- social: Democratizing aFRR and mFRR services by enabling the participation of distributed flexibility energy assets.

The distinctive features:

- cross-border flexibility data exchanges supported by a common interoperable framework;
- flexibility from energy assets on the LM and MV supporting (simulated) balancing services.

4. SOLUTION DESIGN

4.1 WHY

This phase is characterised by several divergent/convergent loops aiming to conceive new service concepts to fulfil users' previously identified needs. Creativity methods and techniques have been adopted to foster creativity, abductive reasoning, and out-of-the-box thinking.

4.2 METHODOLOGY

In this phase, a series of divergent/convergent loops that involve creativity methods define three deliverables:

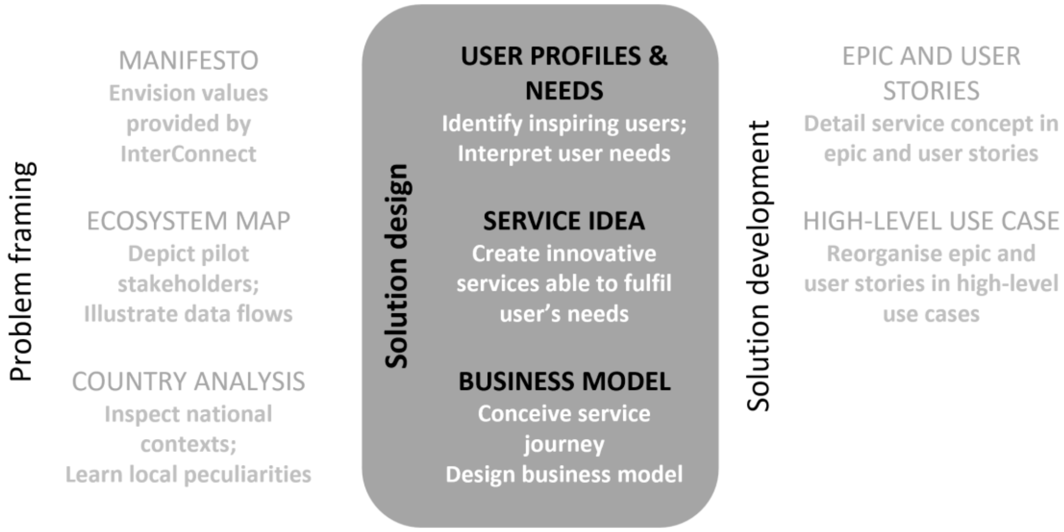

FIGURE 12: DESIGN THINKING PROCESS: SOLUTION DESIGN

4.2.1 USER PROFILES AND NEEDS

Each pilot identifies four user profiles to inspire emerging lifestyles and users' needs. User profiles are archetypes describing real audience data. They inform product development and services with information on the target users' backgrounds, needs, behaviours, and concerns, thus highlighting insights and points of attention to be considered during the solution design. Developing detailed user profiles uncovering ill-defined or latent needs and trends is critical to lay a sound ground for innovation. Embracing the diversity of users is central not only to the context of InterConnect large-scale experimentation but also to the ideation process. To account for this diversity, the definition of user profiles drew on iterations on user profiles that follow complementary strategies. The first encompasses a template to help to frame the user profiles of physical persons around specific points of interest for InterConnect. Second, it is proposed to build user profiles around already available characteristics ("Jocker cards"). Finally, the intention is to challenge hidden assumptions we may have about users, locking us in a comfortable belief about the high desirability of our product. In parallel, pilots are asked to define extreme user profiles.

Indeed, designers engage with users (people) to understand their needs and gain insights into their lives. They also draw inspiration from their workarounds and frameworks. When speaking with and observing extreme users, their needs are amplified, and their workarounds are often more notable. However, the needs uncovered through extreme users are often needs of a wider population. During a third iteration, an online survey is also made available to the pilots to elaborate on this and support the collection of initial background information about end-users. Finally, each pilot team refines the user profiles that will most likely populate the pilots and consequently derives the specific users' needs to be addressed. The pre-identified needs are related to comfort, convenience, environmental impact, and community/neighbourhood life. However, each team derives the specific users' needs that can be addressed in the pilot, e.g., as precise and observable needs, there are (1) awareness "supporting the individual responsibility in taking care of the environment"; (2) convenience "accessing all information and features through a single touch-point". As tacit/latent needs, there are (1) "knowing the impact is generating (individual and community levels) to be gratified"; (2) "willingness to contribute to the life of neighbours' children".

4.2.2 SERVICE IDEAS, SERVICE CONCEPT AND BUSINESS MODELS

SERVICE IDEAS

Each pilot member conceived at least three innovative (energy and non-energy) service ideas coherent with the manifesto, country analysis and ecosystem map previously described and able to fulfil users' needs previously identified. Members are asked to transform the needs into insights to support the idea generation using the «How Might We» format. Needs are human, physical, and emotional necessities. They capture the goals and the motivation. They are opportunities, not solutions (ladder vs to reach). Insight is the reason that led to that need. It interprets data, observations, users' needs to frame the solution space. The "How might we" question: every problem is an opportunity for design. By framing the challenge as a How Might We question, the ground is set for an innovative solution. The «How Might We» format suggests that a solution is possible. It opens to a variety of answers. An adequately framed «How Might We» question does not suggest a particular solution but gives the perfect frame for innovative thinking.

Then, each pilot recognised similar service ideas showing similar patterns to identify 5-10 clusters. Idea clustering is an essential practice of the service development process. Reviewing multiple ideas provides a means of communicating ideas developed by individual members and conceiving shared ideas developed by the team. They identify compelling, common, and inspiring ideas to highlight a few idea areas. Recognise patterns across ideas areas to identify key ideas areas. The more homogeneous and consistent, the better they are.

SERVICE CONCEPT & BUSINESS MODELS

The selected service ideas are further developed in service concepts and related business models. A service concept is a detailed description of what is to be done for the customer and how to achieve this [1]. The service concept is a "picture" or statement that encapsulates the nature of the service business and captures the value, form and function, experience, and outcomes of the service. It is different from an initial idea as the concept can be operationalised, while an idea cannot be implemented until its value, form, functions, and outcomes are defined.

The service concept plays a key role in service design and development. It defines the how and the what of service design and helps mediate between customer needs and the organisation's strategic intent. The service concept may be a communication construct among different groups (managers, employees, and customers). An articulated service concept may be used as a tool to align different corporate functions, employees, and customers [2].

The service concept describes its value proposition and offerings, including how the service works by describing its interaction with the user, each step of the service journey, and the actions performed by the service that react to allow the user's actions (see figure above):

- The value proposition is conventionally taken to mean the marketing offer or value promise formulated and communicated by a seller, with the intent that a buyer accepts it. However, an enterprise can initiate or develop value propositions as reciprocal promises of value, but beneficiaries will always determine value in their terms. If the value exists only when customers use the offering, companies can only offer "value propositions." Value propositions work as connectors and resource integrators within a service system [3];
- offering: "service as a set of advantages for clients, that can be described going over again the contact points of the service system with the client (moments of truth)." It identifies the users' needs and necessities to address through primary functionalities (core functionalities) and secondary ones (accessory services);
- customer journey: services need to be understood as a journey or a cycle – a series of critical encounters over time. They are a tool to design services, as they map the interactions and the touchpoints in an oriented graph, thus describing the journey of a user within the service.

Moreover, service concepts draw on the business models canvas, which, in turn, describes key partners, key resources, value proposition, customer segments, cost structure, and revenue streams. (See Annex I & II).

4.3 OUTCOMES

The activities related to the "solution design" stage took place as shown in the timeline below in the form of a factory "flexibility intermediation models, energy and non-energy services maximise the value of flexibility "split into two parts, the factory 1A (Microsoft Teams, 07th – 09th April 2020) and the factory 1B (Microsoft Teams, 23rd – 24th April 2020).

In factory 1A, the partners refined the wired covers, the manifesto, the ecosystem map from the "problem framing" homework, identified the user needs, and used all this data to develop innovative service ideas for each country that the partners then clustered. Concerning the factory 1A homework, the pilots had to develop/refine their innovative service ideas and select the most promising and innovative ones to implement on the pilots.

In factory 1B, the partners designed the innovative service concepts and their associated business models. Then they started to transform the innovative service concepts into user epics, user stories, and high-level uses cases. To prepare for the "solution development" stage at the end of factory 1B, each pilot team refined their service concepts and business models in homework and transformed them into epic/user stories and HLUC.

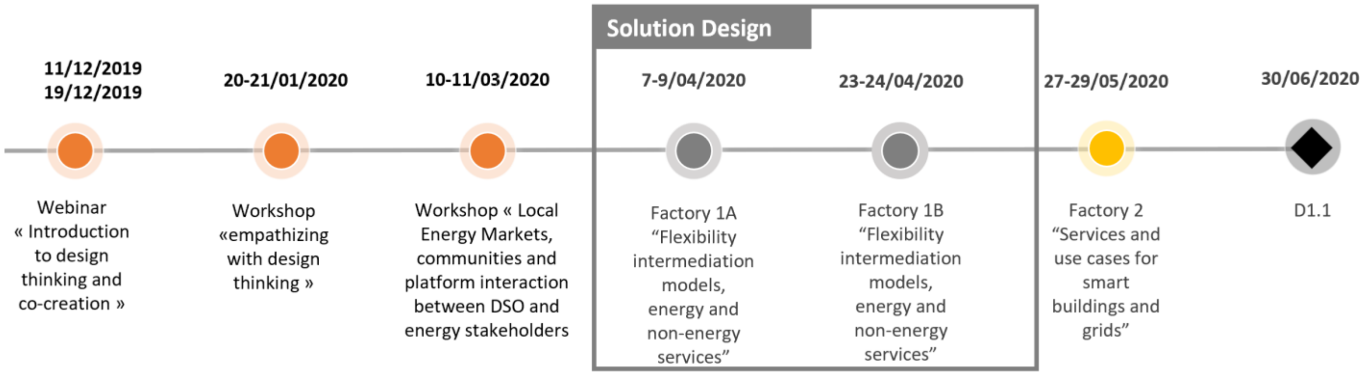

FIGURE 13. TIMELINE OUTCOME SOLUTION DESIGN

4.3.1 USER PROFILES, NEEDS, AND VALUES ON PILOTS

4.3.1.1 USER PROFILES

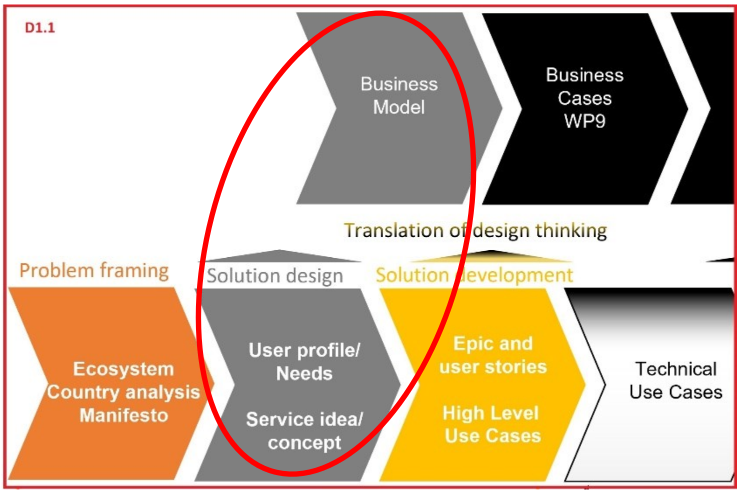

FIGURE 14. DESIGN THINKING PROCESS, SOLUTION DESIGN

Each pilot identified four user profiles to inspire emerging lifestyles and users' needs. User profiles are archetypes describing real audience data. They inform product development and services with information on the target users' backgrounds, needs, behaviours, and concerns, thus highlighting insights and points of attention to be considered during the solution design. It is critical to developing detailed user profiles uncovering ill-defined or latent needs and trends to lay a sound ground for innovation. Embracing the diversity of users is central not only to the context of InterConnect large-scale experimentation but also to the ideation process.

Each pilot identified four user profiles to inspire emerging lifestyles and users' needs. In the end, there were 34 "residential" user profiles created (i.e., profiles of users whose needs are related to their lifestyle and habits at home) and 10 "business" user profiles (i.e., users whose needs are related to the work environment). The user profiles include: (1) goal -> the single aspiration leading to their choice; (2) description->who is concerned with flexibility related energy services? (3) attitudes ->how do they behave? What are their energy consumption habits, beliefs, routines? What motivates them? (4) needs -> what problems do they need to solve? They can also be latent or implicit: (5) constraints -> what prevents them from choosing something and paradoxes, the difference between narrative and action.

4.3.1.2 USER NEEDS & VALUES

Following the methodological approach, during the Milano workshop on January 20 and 21, 2020, the consortium notably worked on the personas and the ecosystem map. Between the Milano workshop and the 1A factory, the pilots carried out homework on the ecosystem maps' personas. As a result, they have established users' main characteristics and needs while living in their ecosystem. The pre-identified needs were related to comfort, convenience, impact on the environment, and community/neighbourhood life. Still, each team determined the users' specific needs, met within the pilot project framework. Indeed, it is essential not to overlook the proper understanding of the needs and expectations as it can offer a reliable perspective on addressing the project objectives.

During factory 1A, each pilot team refined the user profiles likely to populate the pilots and, consequently, deduced from them the specific needs of the users to be treated. The following table resumes the list of user profiles. The user needs to be elaborated from M1 to M6 in the T1.1 and T1.2 based on explicit/observable and tacit/latent needs. The following table explains the following dimensions.

Latent needs	What people dream	What people make
Tacit needs	What people test	
Observable needs		What people do
Explicit needs		What people say

TABLE 1: EXPLICIT/OBSERVABLE NEEDS AND TACIT/LATENT NEEDS

To this end, starting from the aim of the InterConnect project to develop new ICT solutions for the energy domain, a detailed end-users elicitation plan has been defined to especially consider their needs (explicit/latent) from the very beginning of the project up to the release of the consolidated use cases.

Thanks to this iterative and participatory design thinking methodology including end-users, a first systematic formalisation of all relevant end-user needs and values on Pilot has been defined, leading to a set of relevant use cases and scenarios, and described in the following tables showing the map of user-profiles classified by technology aptitude and pre-identified needs.

The following diagram shows the distribution of the user profiles according to the dimensions:

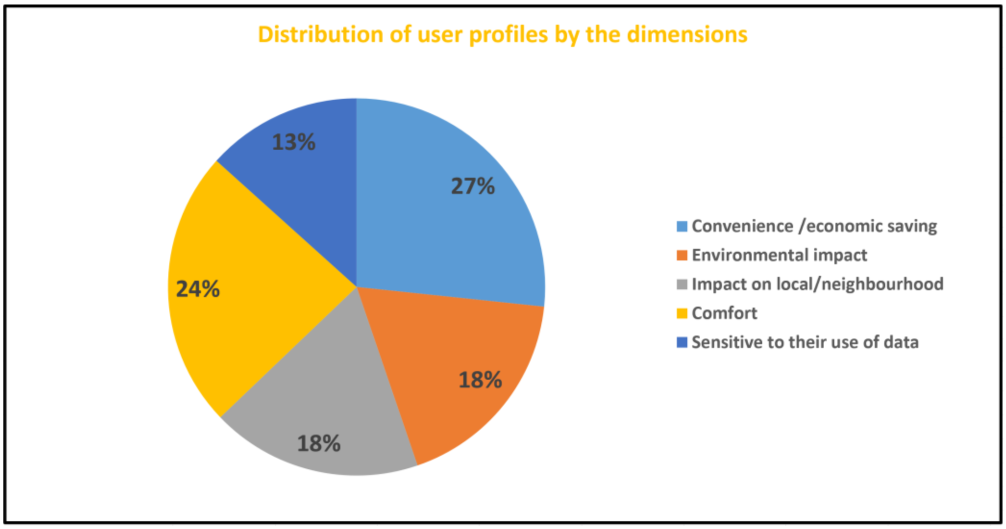

FIGURE 15: PERCENTAGE OF USER-PROFILES BY DIMENSION

Concerning the first needs of the user profile: convenience/economic saving; part of the need is economic saving, which is coming from the increase in the energy bill in most European countries for many years. Indeed, the average price of all the European countries was 16.8 cents/kWh (in 2009), an increase of 19% on average in 10 years up to 20.5 cents/kWh (2019). Also, the residential consumer prices are above the industrial prices.

Concerning the pilot country in InterConnect, the electricity cost rose (in 10 years): 43% in Belgium, 36% in Greece, 31% in France, 29% in Portugal, 27% in Germany, 20% in Italy, and 13% in the Netherlands [7]. The energy prices are different due to environmental protection costs, geopolitical location, network charges, and taxation. The impact of the cost of electricity on the country's income of the pilots: (1) for Netherland, Italy the energy bill represents 1% of the income; (2) for Belgium, France, Greece, Germany and Portugal, the energy bill represents 2% of the income. Furthermore, energy poverty is a significant concern in Europe, where 10% say they have difficulties paying their energy bill.

The second dimension is comfort. As the COVID-19 has reminded most of the worldwide population, we spend most of our lives indoors, and it takes a significant role in our psychological behaviour. Comfort also includes a higher temperature level (for the winter), which consumerism promotes as a cultural value [8]. Nevertheless, in the past few years, climate change's increase might impact the perception of comfort. Linking comfort to the carbon footprint will become a well-being comfort. Thus, the behavioural adjustments will be addressed through the new technology. Indeed, all the other infrastructures and new technologies in the smart home are helping and will be tested and implemented in InterConnect. Of course, the differentiation in outdoor temperature or elder's behaviours needs to take into account further in the project, helping to release the cognitive effort to change their habits and decoupling the effect that increasing comfort increases the energy consumption [9][10].

Additionally, concerning the environmental impact, most people are increasingly concerned about all the issues concerning climate change, as per air pollution and global warming effects. Indeed, one of the reasons is the worry to see a future reduction in their quality of life. Could the flow of laws and directives which are voted help solve these problems, help also change individual behaviour? The different motivations can be hedonistic (pleasure), gain (benefit-cost), normative goal frames (morality). Also, a sustainable environment requires an economy that improves the quality of life and is dissociated from resources [8].

The environmental impact can be linked to the local impact, so climate change will also be felt locally. Everyone is most aware of the perception of change in its local environment. The increase of willingness to act locally is due to the local media, the local weather, or local scientists. The local can be where the person chooses to identify itself and not necessarily close to where the person lives [11]. The benefits of local action will affect people's daily lives, improve collaboration, overcome challenges, and generate a global impact.

Lastly, this past context increases the need for security in our lives. With recent data leaks such as Cambridge Analytica and the increased damages caused by cybercriminals, citizens increased their awareness of data security and privacy. As a result, the European General Data Protection Regulation (GDPR) has been implemented since 25th May of 2018, and InterConnect will follow the GDPR's recommendations.

InterConnect will address all these needs helped by the new technologies markets design, and the technologies can be an intermediary, amplifying determiner, and promoter of environmentally effective solutions [11]

The elicitation and clustering activities of the user need to bring a clearer picture of the needs to be possibly addressed and are of vital importance for deepening the analysis to finally come to the definition of high-level use cases.

Most of the deployments and piloting activities will tackle the needs for flexible services in the energy distribution grid, enhanced by IoT and ICT technological advancements. However, from a non-technological aspect, the analysis pointed out the need to engage end-users massively. This challenge needs to be accomplished, perhaps leveraging the enhanced control and monitoring capability intended to generate benefits for residents in terms of comfort and economic savings, thus enrolling them as principal actors to reach effective stabilisation in the energy grid.

The following diagram shows the distribution of pilots' values.

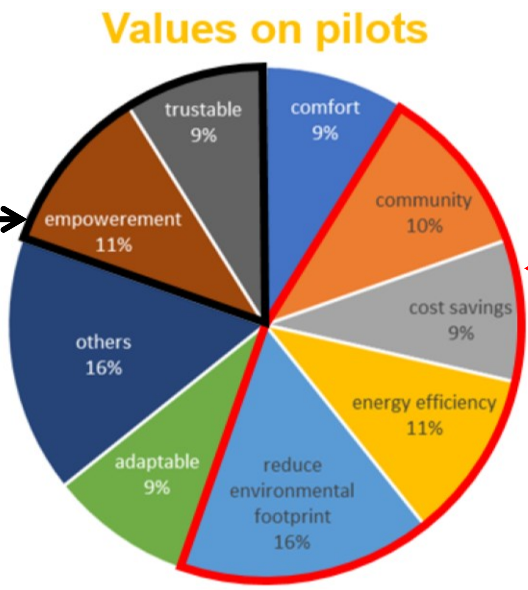

FIGURE 16: VALUE OF PILOTS

On the KPIs defined in the Grant Agreement of InterConnect, such as KPI5 [100], the red sector representing the values from the pilots answers the KPI5. The red sector represents 46% of the values (and 100% KPI5). Reduce environmental footprint's value includes, among others: the use of renewable energy, the increase of energy efficiency, and cost savings; it contributes to offering access to cheaper and sustainable energy for consumers (including the community). The black sector covers the KPI2.4 [100], with 20% of the included values. Indeed, the validation of end-user acceptance through empowerment and demonstration of viable concepts that ensure privacy, transparency, and liability are also represented through the trustability of the connected data spaces.

Not surprisingly, the design thinking approach emphasises the need for comfort in most pilots. Moreover, adaptability can be linked to interoperability, which is at the essence of the project of InterConnect. Moreover, finally, in the dimension "others," the most represented values are simplicity, flexibility, and innovation.

4.3.1.3 PERSONAS / USER PROFILE SEGMENTATION BY NEEDS AND ANALYSIS

Although not fully representative of the European population, the numerous user profiles for residential users represent the kind of users that will be part of the different pilots. The diversity will undoubtedly enrich the findings for each pilot and help understand how scalable they are at the national and European levels. We decided then to segment the residential consumers according to some demographic criteria to make some preliminary observations on the kind of users found in the pilots. The criteria for segmentation were inspired by some recent (Eurostat 2017) studies on the European population:

- gender;
- age (less than 35 years old - between 35 and 55 years old - over 55 years old);
- household size (singles - couples - couples with kids - single parents);
- gross annual income level for the entire household (below 30 k€ - between 30 k€ and 60 k€ - over 60 k€);
- homeowners versus tenants;
- type of homes (single homes - apartment in small condominiums - apartment in large condominium - communities);
- living in big cities versus small towns and villages.

Then the users were mapped according to the level of priority of the expressed needs. The following charts show the results of the cross-linking of the segmentation criteria with the level of needs. The data cannot be considered statistically relevant due to the limited number of personas in each needs cluster. However, the charts below allowed us to make some observations that should be validated during the pilots to transform them into valuable insights on user behaviours.

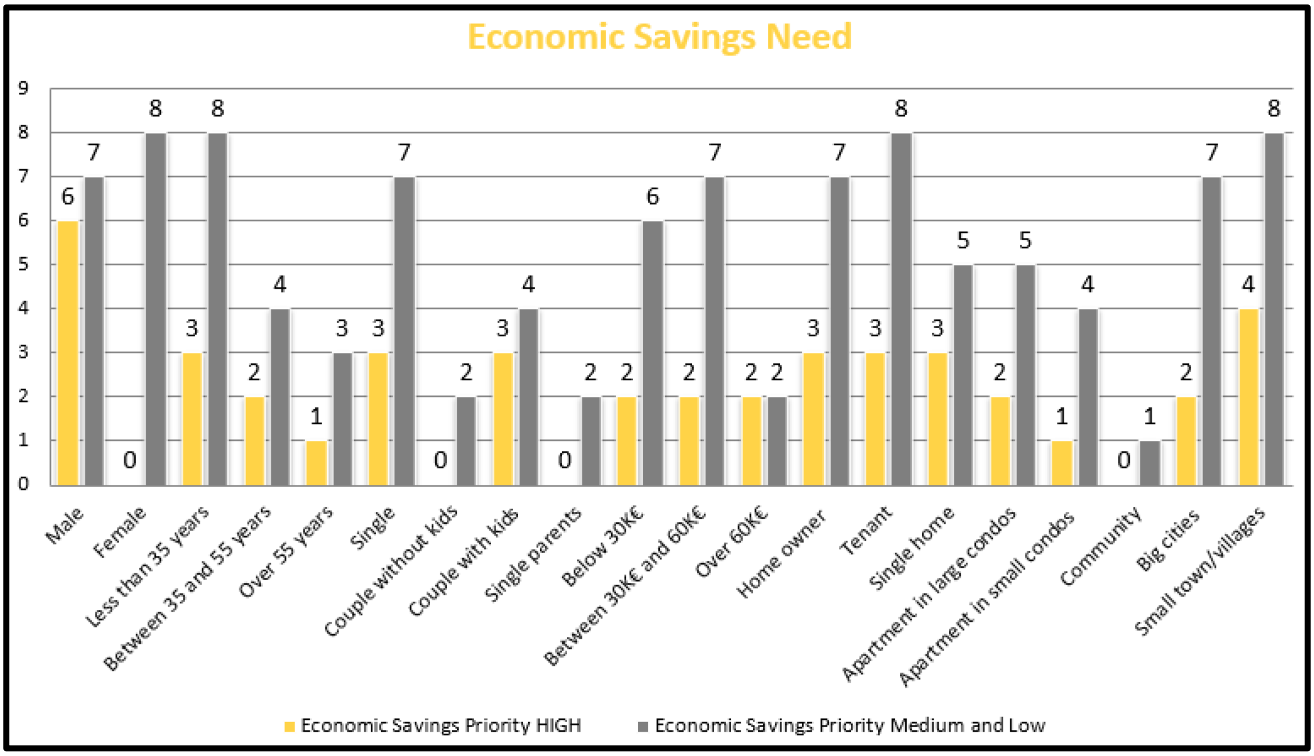

FIGURE 17: ECONOMIC SAVINGS NEED

As it could be expected, this need is more frequently mentioned by users in the two-lower income level but is a high priority only for a few of them, at least when dealing with energy solutions. No differences could be seen between homeowners versus tenants on this need. The vast majority of 'singles' user personas mention the need for saving.

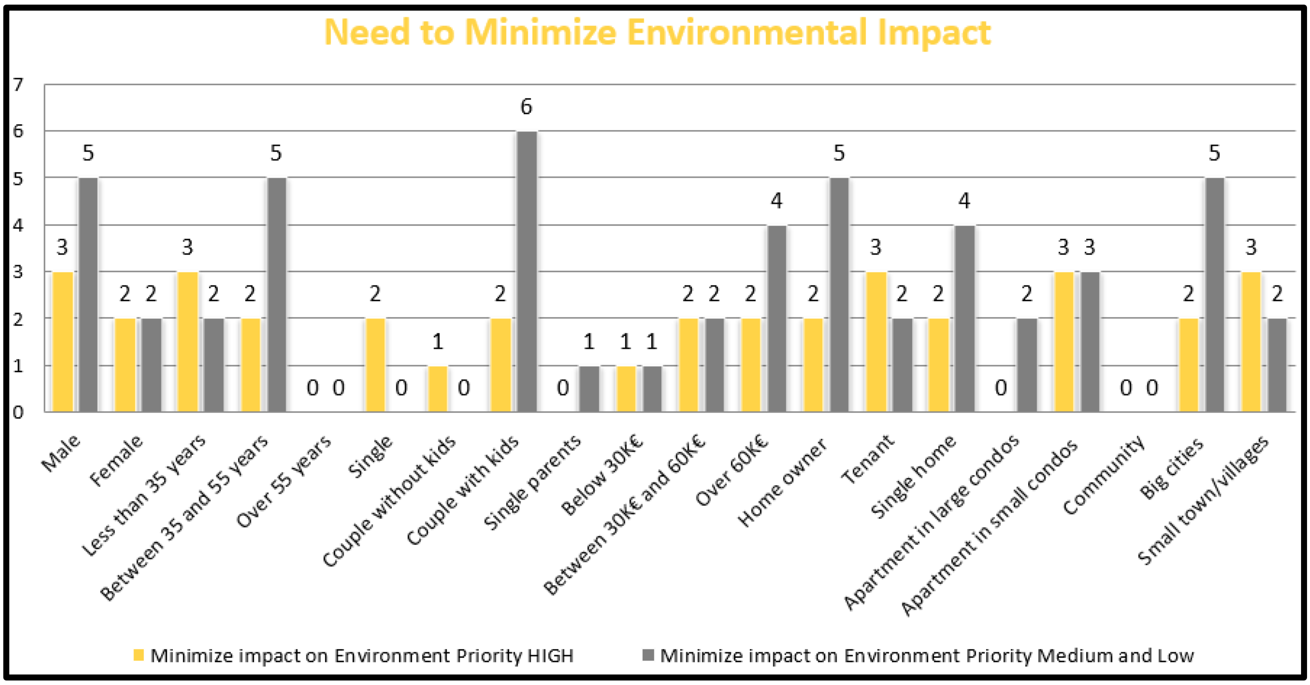

FIGURE 18: NEED TO MINIMIZE ENVIRONMENTAL IMPACT

Couples with kids have recognised this as a priority and are way more than other household types on the need to minimise environmental impact. There is not much different sensitivity between residents in big or small cities. It is singular that no user profile over 55 years old mentioned this as a need (neither high nor medium/low).

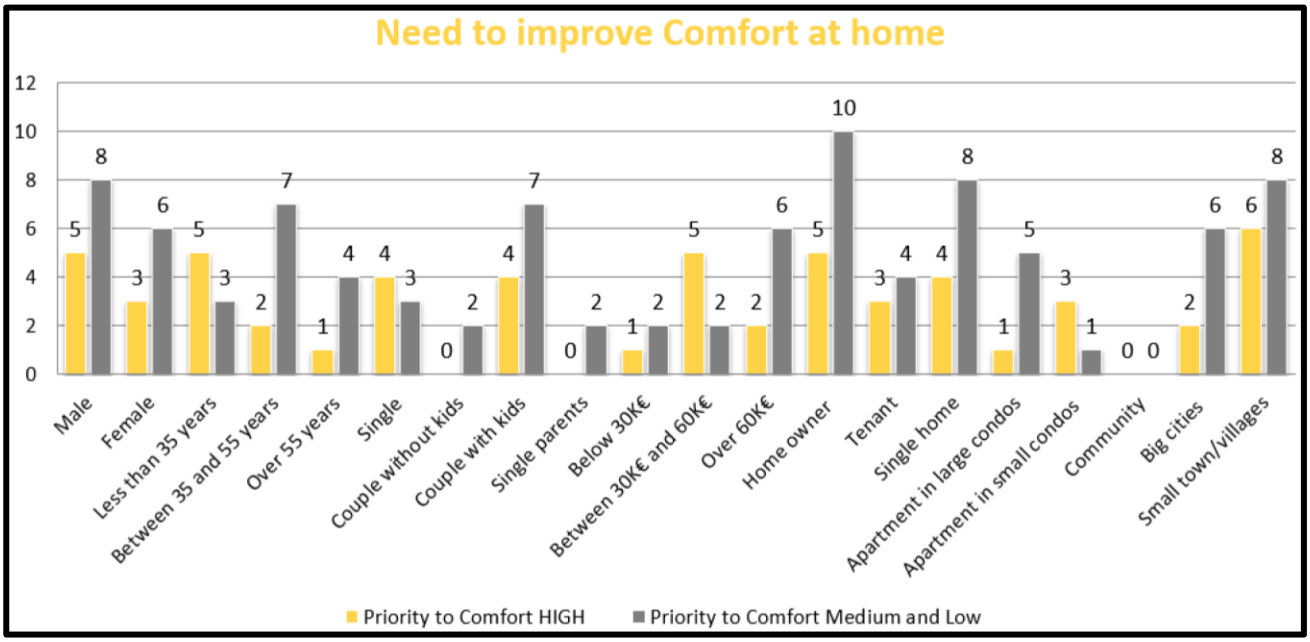

FIGURE 19: NEED TO IMPROVE COMFORT AT HOME

Improving comfort is one of the highest needs rated: small towns seem to be more interested in comfort than big cities. However, only one out of five people over 55 years old rated comfort as a high need compared to users under 35 years old, where 5 out of 8 rated comforts as a high priority. The question worth exploring is if young generations are used to more comfort or wellbeing. So, they strive to increase their comfort level versus older generations or if they could not afford yet to achieve a satisfactory level of comfort at home.

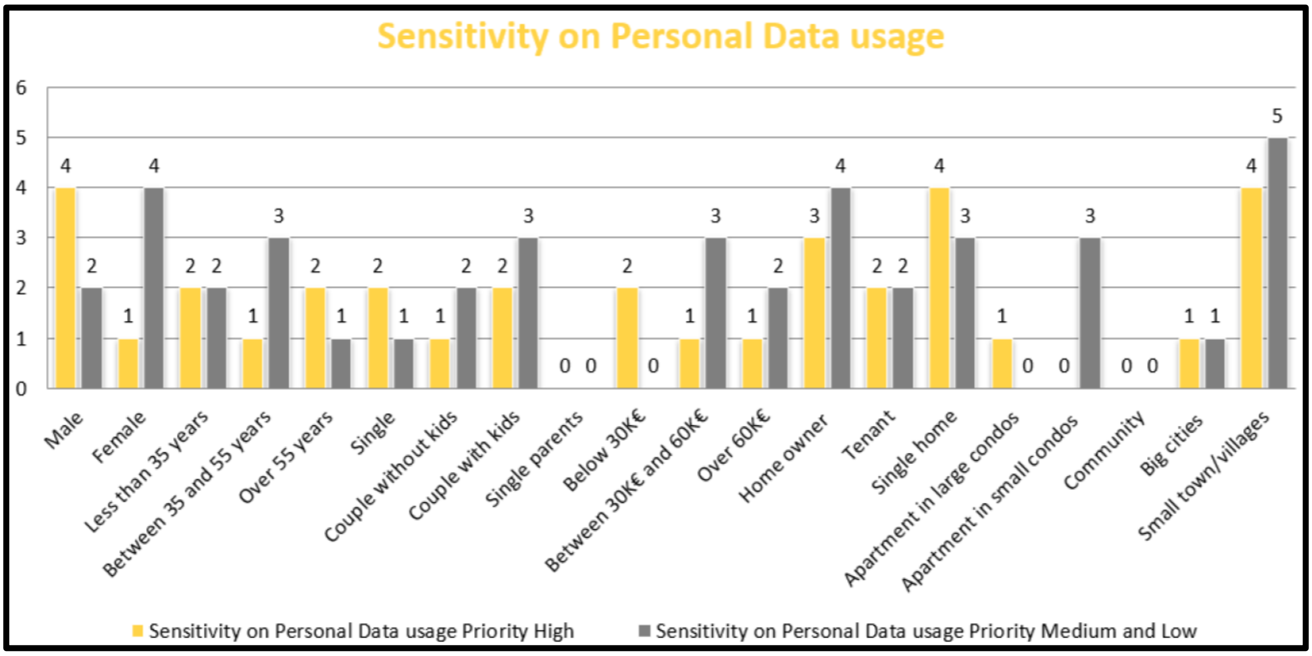

FIGURE 20: SENSITIVITY ON PERSONAL DATA USAGE

On sensitivity to the use of personal data by third parties, people in small cities seem to be more concerned about data privacy and how data are used. Unfortunately, no specificities could have been observed in all other categories. What strikes instead is that the total number of personas that have rated this as a concern at any level is relatively small (only 11 / 32).

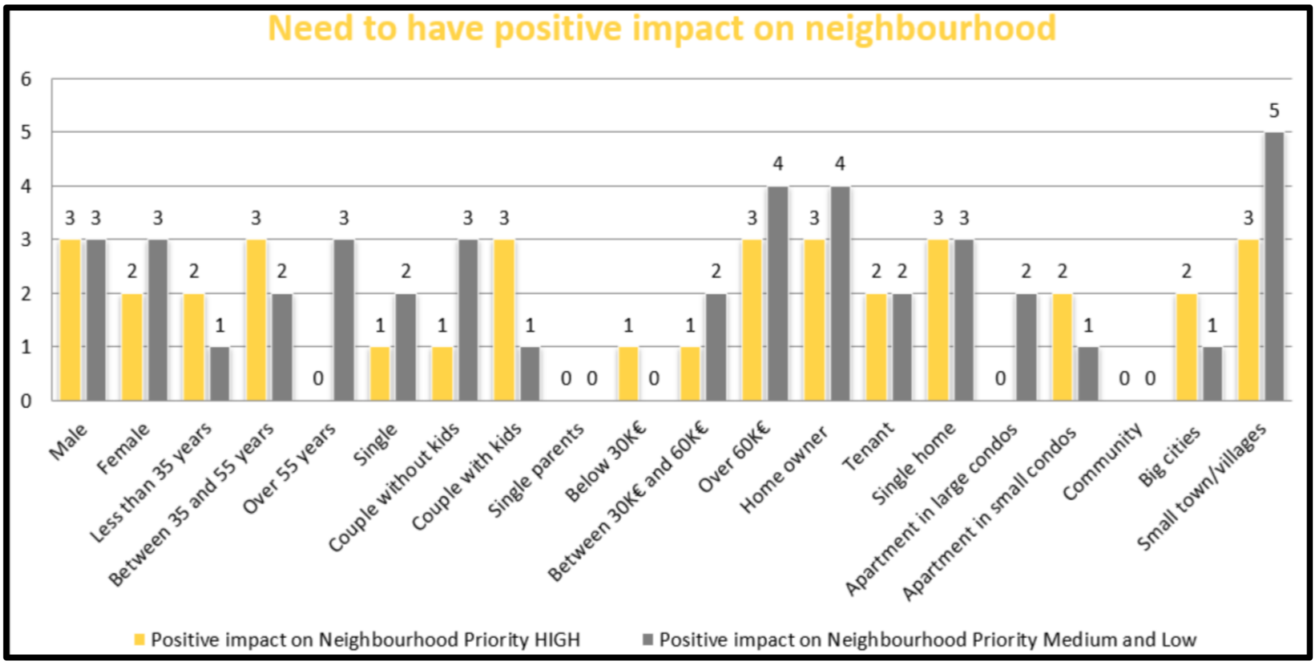

FIGURE 21: NEED TO HAVE POSITIVE IMPACT ON NEIGHBORHOOD

On the need to positively impact the neighbourhood or local community, it appears (and is probably no surprise) that those living in small towns and villages care more about this. We can also observe that the higher the income, the more they positively impact the neighbourhood. However, unfortunately, not so many people rated it as a need.

4.3.2 DESCRIPTION OF SERVICES

Then each pilot member conceived at least three innovative (energy and non-energy) service ideas (see annex I) (coherent with the manifesto) and an ecosystem map. These service ideas meet the users' needs previously identified. The user profiles also fundamentally assessed the service ideas clustered in groups; more specifically, each pilot team assessed the service clusters according to selection criteria: desirability for the user, technical and regulatory feasibility (e.g., compliance with GDPR), and viability.

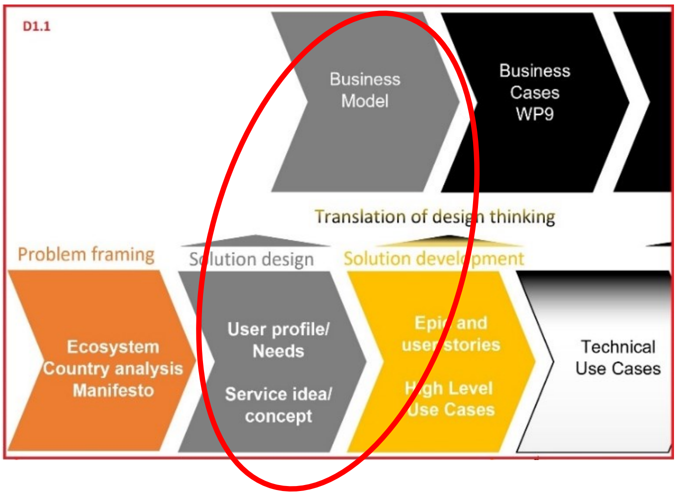

FIGURE 22. DESIGN THINKING PROCESS, SOLUTION DESIGN

4.3.2.1 LIST OF THE SERVICES CONCEPTS

Leveraging on the contents pointed out in the manifestos conceived by each pilot team, with close regard to the user's needs, the ecosystem map, the country analysis, service ideas were proposed, and plenary discussed during factory 1A workshop by all the pilot member teams.

The discussion finally led to the definition of at least four service ideas per pilot that were further refined, fostering across the pilot exchange to have a broader vision expressed at the project level and reach a high-level conceptual perspective. During factory 1B workshop, each pilot member clustered their service ideas and developed them into service concepts, a detailed description of what is to be done for the customer (what needs and wishes are to be satisfied) and how this can be achieved [1].

The service concept is a "picture" or statement that encapsulates the nature of the service business and captures the value, form and function, experience, and outcomes of the service. The associated value propositions were then explored and elaborated into the detailed description of business models. The following table resumes the concept services elaborated from M1 to M8 in the T1.1 and T1.2 of InterConnect. In addition, all these 36 services concepts are detailed and reported explicitly in annex I. Service concepts were then grouped with close regards to the human-centric or grid-centric purpose of the services. However, accordingly reported, some of the service concepts conceived offer the dual nature of both the human and grid value. It is worth depicting how the service concepts are distributed according to their orientation (grid, human or both), underlying that most service concepts are human-oriented. This can be interpreted as a broader business to customer market that can be approached but with a broad reflection on the grid that urges to be addressed and can rely on a variegated set of service enablers. The InterConnect services are distributed according to 53% of human-centric service, 14% of grid centric service and 33% of services that are both grid and human-centric related.

4.3.2.2 ANALYSIS AND DESCRIPTION OF INNOVATION IN SERVICES

4.3.2.2.1 DESCRIPTION OF THE INNOVATION PATH IN THE SERVICES

Each of the 36 candidate services and innovations was described in a single template. The idea of this description was to create a single repository of innovations, described in a standard way, which could be used for assessment and analysis, as described below.

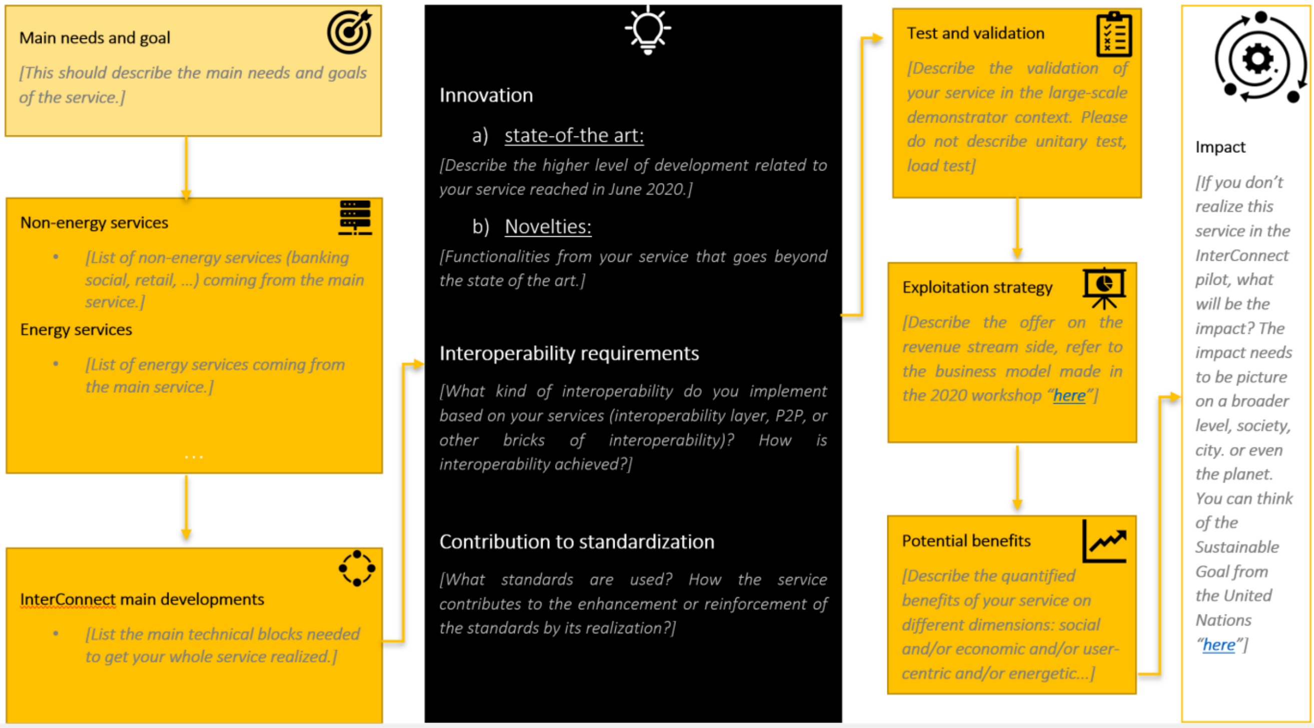

FIGURE 23: INNOVATION PATH TEMPLATE FOR INTERCONNECT SERVICES

This preliminary assessment creates a tank of innovative candidate services, which is at the entrance to the innovation funnel of our project. This template describes the innovation path from discovering the customer need to exploiting the concept. It follows the methodology of our entire project and offers the possibility to describe:

- its user-centred design (left column);
- its relationship with state of the art (middle column);
- its commercial exploitation, from testing to marketing (right column).

Once described in this normalised template, each service can be compared and assessed as described below. As such, D1.1 is a crucial entry for Tasks 1.3 and 1.4 of WP1 in charge of "D1.2 - Mapping between use cases and large-scale pilots" and "D1.3 - System use cases for smart buildings and grids" and for WP7 (large-scale demonstration).

4.3.2.2.2 WHAT IS REAL INNOVATION?

Innovation implies creating and implementing new methods, algorithms, services, or business models. Still, it can be developed in two directions: (1) novelties in technologies and (2) novelties in the use field. Therefore, these two directions of innovation can be used as two axes to build an **innovation matrix**, as described by Verganti (*Design-Driven Innovation, 2009*):

New use	Sustained innovation	Disruptive Innovation
Current use	Incremental Innovation	Radical breakthrough
	Current Technologies	New Technologies

TABLE 2: TECHNOLOGICAL INNOVATION MATRIX

This matrix can specify any innovation and place it in a 'map' of innovation intensity. For example, in this map, we could define four distinct zones:

- **Sustained innovation** is mainly based on implementing a brand-new use case and existing and emerging technologies. For example, some companies have been recently using virtual reality helmets (emerging technology) to provide neurological training for people with disabilities (new uses).
- **Incremental innovation** adds technical features to enhance an existing use. The incremental innovation happens when we move from one software version to another with additional functionalities/features.
- **Radical innovation**: new technology is successfully introduced into an existing and well-established market, with regular uses. For example, the introduction of LED bulbs was a radical technological breakthrough in the lighting market but did not change the way the lighting of homes or buildings is managed.
- **Disruptive innovation**: describes the most intensive type of innovation, where pilot technologies are implemented to create disruptive uses. Disruptive innovations often create new markets and opportunities. For example, Netflix has often been considered a disruptive innovation.

To use this matrix, an innovation needs to be qualified on the two axes of the matrix. To do this, two measurement scales have been created that can be applied to any proposal. The construction of the evaluation scales is based on state-of-the-art in human and social sciences.

The created technological innovation intensity scale is a direct adaptation of the TRL (the Technology Readiness Level) recalled below:

FIGURE 24: TECHNOLOGY READINESS LEVEL (TRL)

To simplify our assessment process, a six levels scale has been created as described below:

The technological innovation intensity scale	
Level	**Label**
0	This technology has been used for a long time (TRL 9)
1	On the shelf Technology (TRL 8)
2	First tests carried out on experimental grounds (TRL 7 & 8)
3	Some prototypes exist (TRL 5 & 4)
4	It is a technological promise (TRL 3 & 2)
5	At the primary research stage (TRL1)

TABLE 3: TECHNOLOGICAL INNOVATION INTENSITY SCALE

The innovation intensity scale is based on two existing models: the TALC and the HYPE described below.

The first is the TALC (Technology Adoption Life Cycle), a model describing a technological trend's adoption process. This model is interesting for understanding which parts of a population are ready to adopt new tools to create new uses. Over the past 30 years, most innovation adoption processes have followed the same patterns, which are represented as follows (adapted from Geoffrey Moore in *Crossing the Chasm* (1991)):

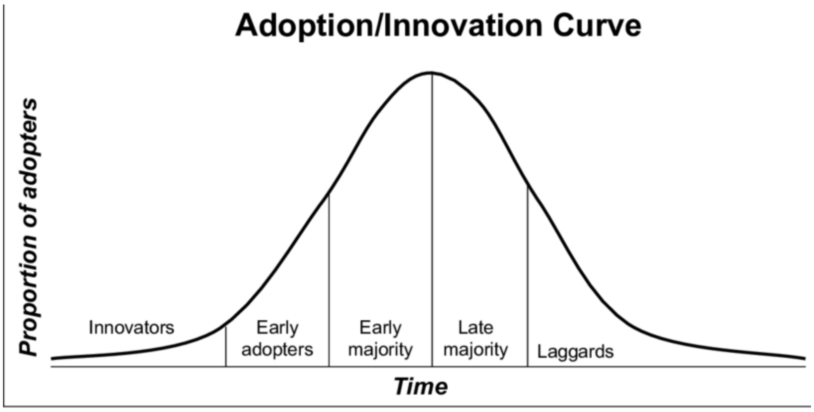

FIGURE 25: ADOPTION/INNOVATION CURVE

The interest of this representation is that it focuses on the social aspect of the technologies: who uses them? What part of the general population is affected by this innovation? When a new technology emerges, it generally follows the same adoption pattern described below:

- At first, the technology is used by rare innovators eager to experiment with novelties to explore new uses. After that, innovators often build their bricolages for personal uses. At this stage, adoption is shallow.
- Then, some early adopters may apply these technologies in their domains and silos, creating more stable and concrete usage scenarios.
- The early majority is responsible for mass adoption, accompanied by industrialisation.
- The late majority *follows the herd*, benefiting from massive industrialisation, low prices, new stable generations of technology.
- The Laggards are the last to adopt a technological trend when there is finally no other choice.

The pitfall of this model is the lack of precision at the beginning of the curve when innovation is still at the early stages of development. However, InterConnect is an innovation action that departs from TRL 6, so we are designing uses at the beginning of the model. Therefore, we also used the HYPE model, which the Gartner Group created to evaluate the promise and potential of every emerging technology. The HYPE model is shown here next.

The HYPE model focuses on the visibility of emerging technologies. The Hype is based on an extended and profound analysis of the Internet (scientific databases, websites of high-tech companies, ….) and is renewed every year. Existing and emerging technologies are plotted over a curve with their common uses cases and applications depending on their popularity.

At the very beginning of the curve, in the "Technology Trigger" part of the representation, we explore weak signals in the technological trends and promises. This is the place where we find brand-new technological trends.

Then comes the "Peak of Inflated Expectations," which corresponds with the technologies having the higher "hype," the most promising ones.

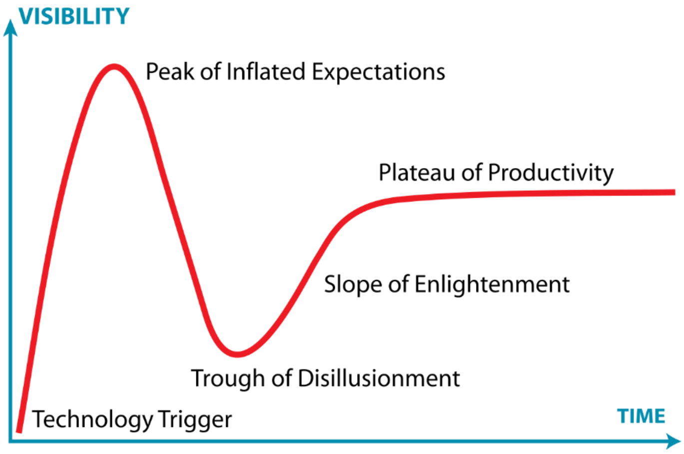

FIGURE 26. HYPE CYCLE

There is a well-documented overlap of these two models (HYPE/TALC), which gives us the following representation: The "Hype Cycle" (HC) and the "Technology Adoption Lifecycle" (TALC) models plotted together[4].

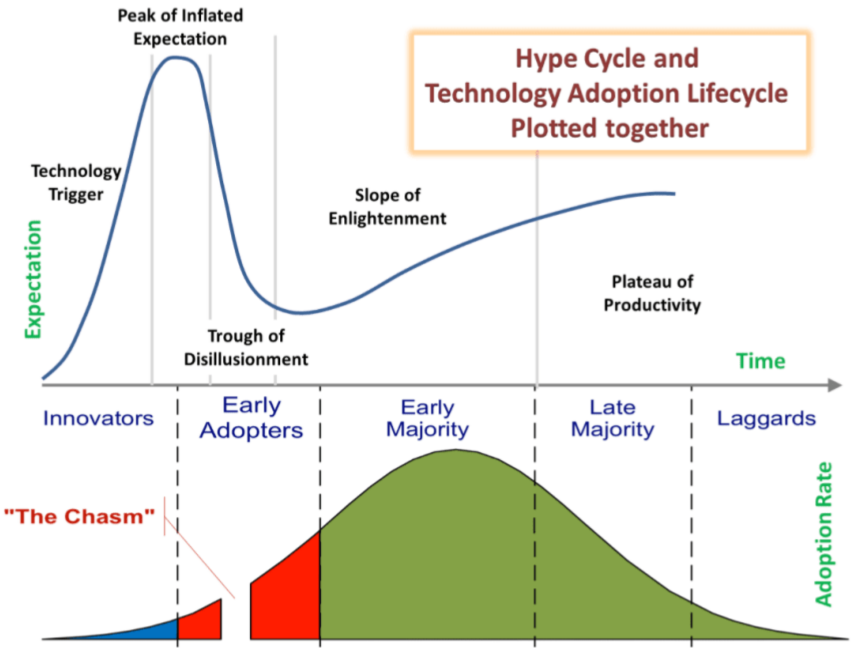

FIGURE 27: REPRESENTATION OF HYPE CYCLE AND TALC

[4] from: http://setandbma.wordpress.com/2012/05/28/technology-adoption-shift/

Based on this literature review, an evaluation scale has been created to assess the novelty of the uses introduced by the services developed during InterConnect. This created scale is as follows:

Use innovation intensity scale		
Level	**Label**	**Description**
0	Old and traditional use (Late Majority and Laggard of the TALC)	Very traditional use, based on past technologies. (Go to work by horse)
1	Current use for the majority (Late Majority of the TALC)	What most of the people do (go to work by car or public transport)
2	Emerging use (Early Majority of the Talc)	New Use, based on emerging technologies (mixture of telework and electric vehicles to work)
3	Use for early adopters (Early Majority of the TALC)	Use created and already implemented by rare people willing to test something new (nomad worker with a mobile autonomous office)
4	Use that has been designed but not implemented yet (Innovators of the TALC and Peak in the HYPE)	Use imagined by designers, lead users, engineers, which only exists in a use case. (Working in a mixed reality environment using VR helmets and haptic sensors)
5	Dreamed and prospective use (Technology Trigger of the HYPE)	Use imagined in literacy, movies, fiction, and prospective studies (working using a neurosensorial helmet)

TABLE 4: USE INNOVATION INTENSITY SCALE

In this report, this analysis grid will then be applied to all the innovations and services developed and demonstrated during our project. This will allow us to map the intensity of innovation during the project.

4.3.2.2.3 INNOVATION ANALYSIS

Each of the 36 innovations has been assessed by seven experts issued from the InterConnect consortium. The evaluation has followed a two-stage process described below:

- A blinded individual evaluation has been conducted for each service in the first step. Then, the individual results were collected in an Excel file. The standard deviation of the experts' assessments can be seen from this file.
- The second stage was a meeting of the evaluation committee, where we discussed our most apparent discrepancies. The idea here was to understand the origins of our divergences to have a deeper understanding of the innovation material created during InterConnect.

This two-step assessment process allowed us to better understand, for example, that some uses that are rare in one country (level 3 or 4) may be common in another (level 1 in our scale).

The committee also had the opportunity to state that when one of the proposed services was “SAREFized,” it should be evaluated, onto the technological scale, at 3. This reflects one of the expected primary outcomes of InterConnect, namely, to provide interoperability possibilities to existing technologies by developing their compatibility with the SAREF ontology. Then, using these results, the matrix below was created to provide a graphical representation of this dataset. In the diagram below, the size of each dot represents the number of occurrences for a notation.

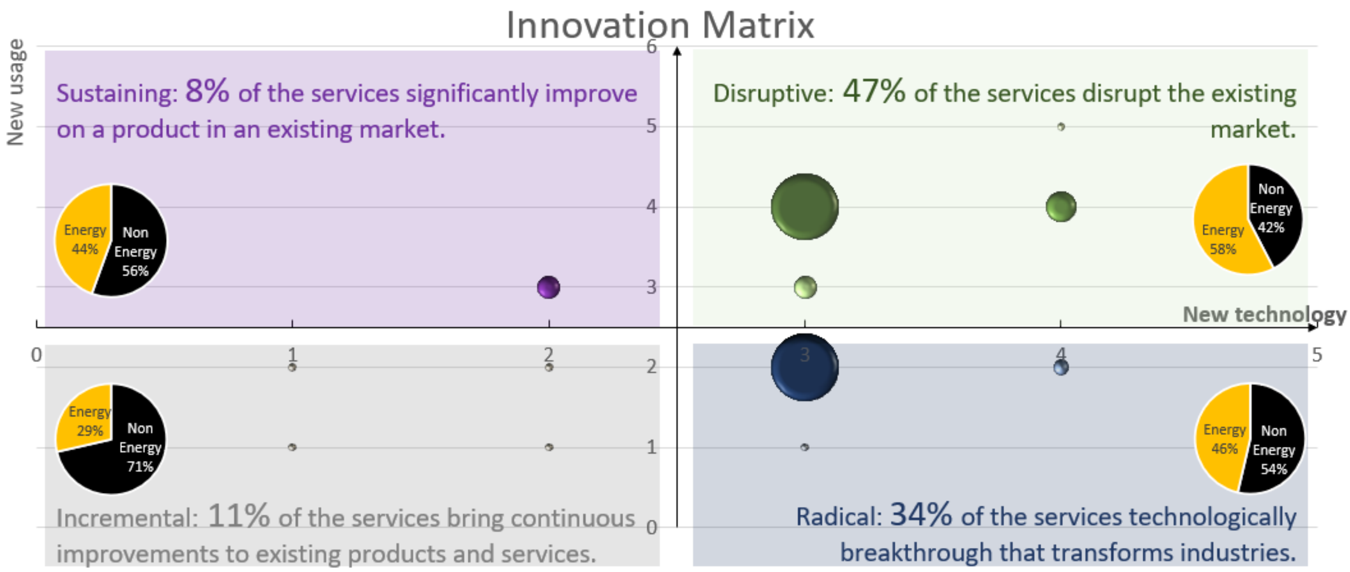

FIGURE 28: INNOVATION MATRIX

Most of the innovation dots are in the northern part of the map. This means that most of the services developed during the project will allow new uses in demand-side flexibility and electrical energy sharing. In addition, InterConnect facilitates (via augmented interoperability) many user stories specific to what many innovators have imagined those past few years and sometimes tested in limited experimental fields, such as the gamification to improve user engagement, cross-sector services (e.g., EV charging and supermarkets) or the use of a green progress bar to visualise the consumption behaviour.

One of the reasons why 81% of the points are located on the right side of the graph is that most of the services are designed to be compatible with the SAREF ontology, which can be seen as an essential component to bring more innovation in terms of smart home and smart grid connectivity. By enriching SAREF ontology, InterConnect solves a crucial technological barrier. In addition, it will enable the recruitment of a wide range of devices involved in the smart grid and its services. Moreover, the services enable the large-scale implementation of components/results that have barely been through the stage of prototypes or small-scale demonstrators or have connectivity issues that prevent the implementation of new business models. Thus, they may potentially disrupt the current *status quo* in the European energy market by democratising advanced use cases.

At the crossroad of these two scales, we can see that many services can be qualified as Disruptive Innovations on the Northeast of the map because they were evaluated with a high score in novelty both in technologies and uses. This result is somewhat promising, as it shows that many services developed during InterConnect **may pave the way for the rising for new markets,** with new uses, emerging technologies, innovative processes, and business models. For instance, in this category, the services are found below:

- smart and convenient EV charging;
- asset and energy sharing services for energy communities (sharing economy models);
- data marketplaces and crowd-sourcing mechanisms for energy efficiency and DSF;

- interoperable platforms with user interface, monitoring and controlling intelligent IoT devices, sensors, and appliances in B2C and B2B (buildings, supermarkets, ...) sectors.

4.3.2.2.4 MAIN INNOVATION BY PILOT

Departing from semantic interoperability (*the ability of digital systems to exchange data with unambiguous, shared, and agreed meaning*), the InterConnect pilots bring the following innovations in digital services:

Portugal. Integration of SAREF-compliant DSF and behind-the-meter data (i.e., exchange of interoperable collective data) from B2C and B2B (supermarkets) customers into the operation of distribution grids using a standardised DSO interface (WP4). A cross-sector business model with supermarkets offering EV charging as a service to their customers and integrating DSF from EV and refrigeration systems in distribution grid management (WP3/5). Regarding the HEMS component and services, the main innovations from InterConnect are as below (WP3/5); more details can be found at Annex I (PT pilot):

- implement a microservice architecture to create a fully digital cloud version of the HEMS and modular energy services (*"Energy as a service"*);
- the use of SAREF to exchange flexibility information (availability and activation) between prosumer, aggregator/retailer, and DSOs, and include aspects such as data ownership and GDPR compliance in flexibility modelling and communication in a privacy-by-design approach (service: *"Energy as a service"*);
- in addition to flexibility, SAREF will also enable new data-driven services, valorising consumers' data (e.g., connectivity, sub-metering data, electric measurements) for improving grid observability and aggregators' analytics capabilities;
- the enhancement of a human-machine interface for energy monitoring and control (e.g., smart EV charging using ISO 15118), service: *"Monitoring energy consumption".*

Belgium. The flexibility of retrofitted thermal loads, accompanied by other flexible devices (heat pumps, PV, EV), via the interoperability framework and the services' SAREFization, is a significant barrier to integrating behind-the-meter heterogeneous devices and systems. Cross-sector and multi-utility business rule engine for integrating many interlinked assets, including a cost-driven heat vs electricity optimisation and tracking environmental benefits (water saved, avoided CO_2 emissions). Combination of several energy management systems engaging in a SAREF-based peer-to-peer market.

BE describes the first set of services. *E-Mobility Services for Energy Communities*, *BE. Building level services: Peak shaving* and *Building level services: RES self-consumption* in D1.1. The main innovations for these services focused on interoperable asset integrations are below; more details can be found at Annex I (BE pilot):

- use of innovative flex trading interaction scheme that leverages DSF beyond traditional demand response;
- interConnect semantic interoperability interfaces to develop SAREF compliant forecasting services (WP3) for local solar energy production, electricity demand, and heat demand accessible to third parties;

- use a cross-sector and multi-utility business rule engine to integrate many interlinked assets, including a cost-driven heat vs electricity energy optimisation and tracking environmental benefits (water saved, CO_2 emissions avoided);
- application of new business models to valorise waste energy in a nearby industry, including energy and clean water exchange;
- use district and private unit data to inspire behavioural change. For example, visualised measured data can be the starting point for consumers to become more aware and active in their energy use;
- provision of flexibility by the pilot to DSOs through aggregating district-level assets and intelligent private appliances.

BE describes the second set of services. *Energy flexibility service with thermal loads for individuals* focuses on retrofitting (thermal) assets in energy communities. The main innovations are as below:

- Integration of end-users comfort feedback (main bottleneck in terms of flexibility potential) with energy efficiency objectives and DSF monetisation via reduced consumption, self-consumption, and peak shaving optimisation for every customer individually.
- The flexibility of retrofitted thermal loads can be complemented with other flexible devices (e.g., heat pumps, PV, or EV charging points) through the interoperability framework (WP5) and the SAREFization of the service (WP3), which is a significant barrier for the integration of behind-the-meter heterogeneous devices and systems.

Germany. The demonstration of the entire chain of bidirectional end-to-end communication from the DSO to interoperable devices in residential and commercial environments via BSI-certified (Federal Office for Information Security) smart meter gateway infrastructure, considering a fully interoperable negotiation of energy consumption plans with devices that have their intelligence (EVs or heat pumps) to avoid loss of comfort, inefficiency, or conflicts with internal processes. The main innovations from InterConnect are as below; more details can be found at Annex I (DE pilot):

- 'flexible tariff service,' 'power monitoring at grid connection point'; 'power limitation at grid connection service. 'full chain standard-based bidirectional end-to-end communication from the DSO to interoperable devices in residential and commercial environments via BSI-certified SMGW infrastructure;
- 'power monitoring at grid connection point'; '*fuse* protection service': Identification of consumption hotspots by DSO through standardised SMGW solution. SMGW meter data up to 1-second metering interval is provided via interoperable EEBUS or SAREFized service (on change, exceeded the limit, ...);
- '*power* monitoring at grid connection point'¸ 'Power limitation at grid connection service': Dynamic grid support by power limitation on building or device level, with the real-time reaction by the DSOs to power curtail consumption or local production to avoid overload scenario the grid via interoperable EEBUS or SAREFized service. Especially devices such as EVSEs/EVs or heat pumps are considered power curtailed as grid support;
- '*flexible* tariff service': Grid support by flexible tariffs to use energy-relevant device's flexibility via EEBUS or SAREFized service. Adapt power consumption to the availability

of RES production through price offers. The flexible tariff service is supposed to work within the power constraints received from the DSO (innovation item c). (See Annex I Germany pilot);

- incentive-based energy management: Negotiate energy consumption plans with devices with intelligence (EVs or heat pumps) to avoid loss of comfort, inefficiency, or conflicts with internal processes;
- dynamic AI-based power management of buildings to avoid overload and underload by grid quality status. Grid bottlenecks or capacity requirements are calculated by Fraunhofer beeDIP platform.

The Netherlands. Living-as-a-service interoperable platform (Ekco) for multi-domain heterogeneous services where users can easily connect all types of devices autonomously powered by FIWARE standards, including a data marketplace where data users/suppliers have wallets to hold loyalty tokens for transfer of data-value using InterConnect interoperable framework. REFLEX platform used by aggregators to maximise the value of flexible energy assets across multiple energy markets, merging S2 flexibility standard (EN50491-12-2) with SPINE flexibility concepts in SAREF. The most impactful innovations from InterConnect for the Dutch Pilot are as below; more details can be found at Annex I (NE pilot):

- Automation functionality (convenience), automation functionality (health) and platform function, user interface, and dissemination - monitor and control. Ekco is the IoT technology platform behind these services, which process the data in the Dutch pilot. To extend the Dutch pilot with services, we will implement a single Ekco platform enabling heterogeneous services for energy and non-energy use-cases in the building's domain, enabling the 'living-as-a-service'' business model. This also means households are paying a recurring monthly amount for the services platform.
- Platform function, user interface, and dissemination - monitor and control. The data marketplace behind these services is also a blockchain setup that can record trace data sharing activities of parties, transfer loyalty, verify approval for service-to-service providers, and record this.
- Energy recommendation and automation – intelligent Building Management System (iBMS) - monitoring and controlling and mobility - green/smart is charging for mobility. The technology behind these services is REFLEX. This technology enables value stacking across multiple energy markets (congestion management, dynamic tariffs, imbalance prices) with energy flexibility assets in the VideoLab and Next buildings, such as the innovative charge lounge for EV's. (See below for a detailed description). This service will also use the novel Relational Graph Machine Learning methods for forecasting and error detection (Task 3.4). These will make learning over SAREF knowledge graphs that include various types and modalities (sensors, geo-data, ...).
- Platform function, user interface, and dissemination - monitor and control and mobility - green/smart are charging for mobility. The innovation behind these services is graph pattern technology (developed in WP3/5) in combination interoperable layer for producing and consuming SAREFIZED data. In addition, the Ekco platform has been extended to facilitate dynamic ontology-based SAREFized data mapping for any data originated or generated by the platform.

- Platform function, user interface, and dissemination - monitor and control. Related to the innovation identified in point a), the Ekco platform will enable complete but straightforward control for users over their homes. Furthermore, the service will connect to the novel Relational Graph Machine Learning methods (Task 3.4).

The main innovations from InterConnect for the Ekco platform and features are as below:

- The platform has been extended to facilitate dynamic ontology-based SAREFized data mapping for any data originated or generated by the platform.
- The platform can transform NGSI and NGSI-LD based Smart data models from the FIWARE stack into SAREFized graph patterns.
- The data lake is a managed FIWARE Orion context broker; this adds another layer of interoperability between highly innovative cities in this project. By having a scalable infrastructure also after this EU project.

REFLEX combines the following innovations to tap into the built environment's flexibility potential are described below:

- the S2 flexibility standard (prEN50491-12-2) provides a uniform and generic way to describe the flexibility of a wide range of assets found in the built environment, such as PV, HVAC systems, EV, stationary batteries, ...
- the merging of S2 flexibility concepts with SPINE/EEBUS flexibility concepts in the SAREF(4ENERGY) ontology;
- graph patterns combine with the Interoperability layer and the ontology to exchange flexible information between REFLEX (aggregator platform) and platforms directly connected to assets such as the Ekco platform described above;
- planning algorithms that user-value stacking to maximise the value of flexible assets. These planning algorithms combine flexible information from the assets with input from multiple markets/energy services such as congestion management, day-ahead trading, intra-day trading, and imbalance prices. The planning algorithm provides detailed insights into how flexibility can best be exploited across the different energy markets.

Italy. The interoperable architecture of a monitoring and control IoT platform that covers the specific case of residential social housing and digitalisation of energy behaviours at the community level introduces and tests the role of a social aggregator to capitalise on inclusion and capability in accessing the emerging market of flexibility services, considering only white goods (e.g., washing machine) as a source of flexibility. The main innovations from InterConnect's Italian pilot for the proposed services are below; more details can be found at Annex I (IT pilot):

- Implement modular architecture with a centralised energy management system to enhance optimal grid operations. The algorithm proposed will be empowered with ML techniques to profile the prosumers digitally at the district level, promoting a predictive optimisation of energy capability. In terms of innovation, the service will target a digitalisation of energy behaviours at the district level (community-wise), introducing and testing the role of a social aggregator to capitalise on inclusion and capability in accessing the energy flexibility market.

- Use of SAREF to exchange flexible information (availability and activation) between devices and the aggregator permitting a seamless data exchange independently from the infield devices, thus scaling up seamlessly the energy capacity reachable for the flexibility services.
- Raise the sense of belonging of residents in the neighbourhood and their feeling of contributing to a common goal as a community. This is key to transforming simple energy consumption into energy welfare with a relevant social impact. The community will be deeply engaged by the community managers throughout the Planet App to structure and leverage the app's practical energy flexibility feature. Guidelines for sustainable behaviours (energy-related, among others) will be made available to ensure a common understanding of the hot topic. Promotional awards will be accorded at the community level to reinforce the sense of belongings and subsidiarity in reaching common goals. Rewarding will nudge behavioural changes in making use of energy.

Greece. Design and implement an end-to-end architecture (based on InterConnect reference architecture) combining the SAREF-ized services with existing open-source home automation systems (e.g., OpenHAB, home assistant) offering interoperability across a wide range of commercial energy/ non-energy sensors from different vendors and including consumer feedback. This architecture will leverage information from providing non-energy services (e.g., home comfort, physical security) to residential users for energy efficiency purposes. Moreover, innovative DSF services, based on machine learning algorithms, will be implemented to exploit high-temporal resolution measurements and crowdsourcing mechanisms (e.g., incentivise users to submit their predictions).

The different services of the Greek pilot are: (S1) “Energy Efficiency” including use cases that enable consumers and grid operators to be more energy efficient; (S2) “User Engagement” including those use cases that aim to familiarise the citizens with novel technologies to their own and the social benefit while harnessing the power of the crowd; (S3) “Non-Energy Services” including use cases that indirectly relate to energy, aiming at offering home comfort and “peace of mind”; (S4) “Data Analytics Services” including use cases such as modelling and prediction of the end-users consumption behaviour and recommendations for energy efficiency.

The main innovation areas of the services developed in the Greek pilot are the following (see Annex I (GR pilot) for more details):

- Design and implement innovative DSF services based on ML algorithms (including deep learning techniques). By exploiting historical energy consumption datasets of a household, a service can forecast the consumption within the next 24 hours for the different appliances or equipment. Suppose this predicted consumption (from a single household) is aggregated to others from the same area (e.g., district). In that case, the “flexibility requester” can be informed about the peaks that will occur the day after in a particular area. With this knowledge, the “flexibility requester” can decide: 1) how to avoid specific peaks and hence request the users to change their behaviour; 2) the type of incentive that should provide. One important novelty is that the forecast is generated for each appliance and equipment in the household, considering that the consumption is significant, regardless of the manufacturer. (S1, S2, S4).

- Novel developments in currently existing services that offer personalised recommendations, crucial insights, and educational material to the consumers, based on behavioural analysis of their consumption patterns and characteristics, energy profiling, time-series, and non-time series data clustering, and novel deep learning methods to individually forecast their behaviour with a single global model that learns to distinguish the different consumption patterns and characteristics of different types of consumers.
- Leveraging crowdsourcing mechanisms through offering attractive incentives to the consumers, the more significant impact for the demand response actions and energy savings, in general, can be expected. More specifically, in addition to the novel consumer-level demand forecasting models, the system will also incentivise users to submit their plans/forecasts for their household's energy consumption, with multiple benefits, such as an increase in the individual consumer forecasting accuracy, less erratic energy consumption by the users (since they will be awarded to do so) (S1, S2, S4).
- Leveraging information from providing non-energy services (e.g., home comfort, physical security) to residential users for energy efficiency purposes, utilising information gathered from non-energy sensors without compromising the services themselves. (S1, S2, S3).
- Data analytics services for consumption practices recommendation based on demand forecasting through ML algorithms. The service uses data from various sources as input. It provides an analysis of energy consumption either for the home as a whole or for specific devices (depending on the object that is being monitored and analysed). Innovative algorithms based on Recurrent Neural Networks are utilised for providing short or long-term forecasts. (S1, S2, S4).
- Design and implementation of an end-to-end architecture (based on the InterConnect reference architecture) combining the developed SAREF-ized services with existing open-source home automation systems (e.g., OpenHAB, home assistant) offering interoperability across a wide range of commercial sensors (energy and non-energy ones) from different vendors, supporting various access technologies. (S1, S2, S3).

To realise the pilot's objectives, partners will interconnect their IoT infrastructures with the services built in the context of the project for implementing the individual use cases and forming the ground for technical, business, and social innovation is driven by the points below:

- A complex IoT infrastructure comprises 270 households equipped with smart meters, custom IoT gateways, sensors, and smart appliances with rich features for monitoring, remote control, and automation capabilities. This consists of a diverse environment with a set of heterogeneous devices from different vendors (Aeotec, Fibaro, Blitzwolf, ...) and technologies (Wi-Fi, z-wave, Zigbee, BLE, ...), and back-end services (storage, fast data retrieval through open APIs, ...), by three different partners (COSMOTE, GRIDNET, and HERON) who integrate their IoT households and services rendering them SAREF compliant.
- An advanced DR environment (DR-solution by INETUM) where system operators can proactively shift the consumers’ appliances load based on consumption forecasts and their offered flexibility, while at the same time reactively responding to unforeseen events

in real-time by disabling appliances through the responsible device manager to avoid blackouts.

- Continuous engagement and involvement of consumers in the decision-making process through a mobile app developed by AUEB transforming the Grid-Consumer relation from a linear one-way communication to two-way communication where consumers interact and respond to Grid needs, either manually by following alerts and push notifications or automatically by providing their flexibility preferences and their consumption forecasts in a crowdsourcing manner to improve Grid forecasts. The consumer feedback will be incorporated into the deep learning and recommender system models, continuously re-trained throughout the pilot to provide a more personalised experience to the users and increase the acceptance potential of the proposed energy-saving recommendations.
- Extensive data analysis to process high granularity data from many households, along with a novel behaviour modelling and forecasting approach based on consumer profiling, time-series & non-time-series clustering, and a generalised deep learning architecture (HLUC 7, PUC13) trained on the whole customer base, capable of conducting accurate demand forecasts even for new households with few data available. This approach will enable a novel demonstration where the energy consumption behaviour of many consumers will be modelled and forecasted using a single AI model that is more replicable compared to a setup with a separate model for each household, while also being scalable for large-scale utility customers and can provide accurate predictions even for new consumers.

France. The design and implementation of a Smart Orchestrator, in a dynamic tariff context, allowing the intelligent and remote control in the same household of different energy management microservices from various service providers and considering aggregated flexibility from other sources (space and water heaters, EV, white goods) in real-world conditions. Furthermore, implementing a blockchain-based platform to reward PV surplus with green coins, enabling exchanges within the community, e.g., the baker could exchange his products with his customers by using green coins. The main innovations of InterConnect for control and devices in the dynamic tariff context are as below; more details can be found at Annex I (FR pilot):

- An interoperable framework implements the SAREF ontology to exchange flexibility information, tariff information, and real-time information issue from the customer (instantaneous consumption, power subscriber, max power subscriber reached, …). SAREF will also enable new data-driven services (e.g., connectivity, soft real-time electric measurements, metering data, comfort data), valorising consumers' data for improving grid observability and aggregators analytics capabilities.
- The design and implementation of a Smart Orchestrator (Inetum and YNCREA) allowing the intelligent and remote control in the same household of different Energy Management Systems (EMSs) provided by various service providers; e.g., the Smart Orchestrator intelligently controls by AI and according to user recommendations from both the Engie/ThermoVault EMS controlling the water heater and the heating and optimises the start-up of whites-goods provided by Whirlpool/Miele/Bosch and the charging of the EV managed by Trialog.
- Creation of a power limitation service to prevent the smart meter from tripping (and cutting off the electricity supply) because of different appliances being started by

different independent EMSs. Power limitation is an interoperable microservice using cloud and edge computing to stop intelligent devices when the electricity consumption exceeds the maximum power.
- The intelligent orchestrator schedules computation, an interoperable microservice that provides an electrical consumption schedule at the household level to advise all household EMSs for starting/stopping their smart appliances. The schedule is a function of the user habits analysed by IA and the DSF service provider commitments.

The main innovations of InterConnect to maximise the use of local RES in soft real-time are as below:

- Using an interoperable framework implementing the SAREF ontology to exchange soft real-time information and issues from the customer (smart meter identifier, instantaneous power, smart appliance control).
- The Smart Orchestrator advises each EMS to consume local RES when available in an interoperable manner. This makes it possible to use/value local production that is not consumed.
- The end-user is rewarded by “green coins” (local money) proportionally to the level of his investment in the energy community. The key innovation is the monetisation of the local energy community through blockchain, which is used as a trusted mediator in the payment process.
- The repartition key for the energy distribution is established when the customer signed in the energy community, leading to ownership and management of energy-related assets. This model allows sharing costs and enables the participants to own assets with lower investment amounts. This effectively encourages people to unite and act on energy and other socio-economic challenges locally to their community. This is a crucial innovation for community-ownership models.

Finally, a **cross-border demonstration** will be promoted in InterConnect to **highlight the technological and economic advantages of cross-border interoperability**, and the use case consists in aggregating flexibility resources (e.g., loads, RES, DSF, and storage) from the country-level pilots to a simulated TSO for the provision of ancillary services. The main innovations include: (See Annex I Services WP7.8):

- implementing a SAREF-ized flexibility aggregation platform facilitates **cross-border flexibility data exchanges**, creating a *grid-centric* service for TSOs;
- leveraging the interoperability framework further expands the flexibility markets to new participants and stakeholders at the LV and MV levels (e.g., residential prosumers, local aggregators). This allows different types of flexibility and aggregation platforms across Europe to use SAREF and enables **interoperability between digital platforms by utilising the Interconnect framework**. However, compared with the traditional data exchange standards, they lack the technical details enabling pan-European adoption;
- finally, this demonstration has a solid potential to be **replicated** throughout EU members states and the broader European energy markets, given the establishment of a typical data exchange (i.e., SAREF.).

4.3.2.3 CLUSTERING OF SERVICE CONCEPTS

During Factory 2, service concepts (see Annex I) were clustered according to a particular set of critical dimensions for the project: flexibility service, grid stabilisation service, monitoring service, comfort services, self-consumption, others services.

The choice of these clustering dimensions for the services was a joint result with WP2's partners (architecture) and moved from iterative elicitations of the specific architectural extension needed. Therefore, the dimensions agreed may ensure a consistent transition to WP2 and were conceived to accelerate the definition of innovative energy and non-energy services benefiting both the prosumers and the energy transition. The following diagram shows the distribution of InterConnect's services according to the chosen dimensions; their analysis will be found in the next subchapters.

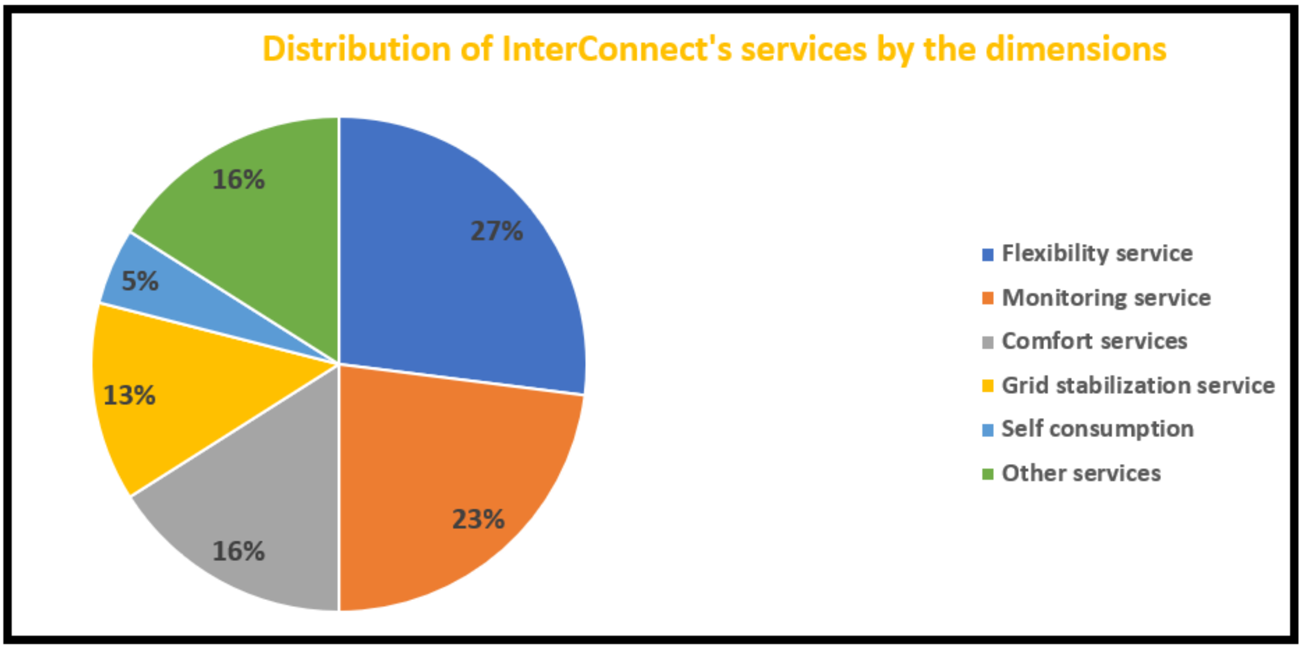

FIGURE 29: PERCENTAGE OF SERVICES BY DIMENSION

4.3.2.3.1 CLUSTERING BY THE "FLEXIBILITY" DIMENSION

27% of InterConnect's services are classified in the dimension "flexibility service," representing the overall need for grid operators to rely on third-party resources (for example, household, buildings, EVs, ...) as tertiary power reserve for grid support. Such a service concept may functionally use AI schemes in pattern detection for user behaviour, device operation, and flexibility modelling. The main characteristics that have been pointed out during the sparring sessions of Factory2 are the following:

- automatic piloting according to time slots of the appliances;
- user' response to flexibility requests from the DSO or aggregator;
- provide consumption and production predictions;
- keep the energy consumption of a building or house below a certain level;
- planning energy to promote flexibility the user to directly provide flexibility;

- provide dynamic tariffs based on business criteria/constraints;
- maximise the use of RES;
- modulate/adapt the charge of the battery of the EV according to the user's needs;
- provide EV charging mechanisms despite a significant network congestion/capacity.

The means imagined in these services to act on flexibility are non-exhaustive:

- retain/reward users in exchange for flexibility;
- automate the optimisation of the energy consumption provided by the network, PV, local communities with intelligent algorithms;
- automate appliance management using EMS;
- offer time slots with adapted prices;
- provide interfaces (mobile application, tablet, ...) allowing the end-user to participate in flexibility;
- perform data analytics (user, forecasts, ...) to advise the user for better behaviour;
- set up real-time data collection to optimise user charges/consumption;
- use EV, stationary batteries;
- allow collective self-consumption.

4.3.2.3.2 CLUSTERING BY THE "GRID STABILIZATION" DIMENSION

13% of InterConnect's services are classified in the dimension "Grid stabilisation service. " These services participate in the grid stabilisation because they depict the need to implement such kind of functionalities:

- The network operators can analyse data to detect and optimise their customers' energy consumption.
- The grid operators can send DSF requests to users (who can react remotely if necessary).
- Customers are encouraged to contribute to the grid stabilisation actively.
- The grid operators can limit the power used by customers.
- The grid operators can tackle grid constraints such as congestion management or voltage control by performing peak shaving and benefiting from the optimised self-consumption.
- The grid operators can manage directly or indirectly to use the potential of the customers' EV batteries and PV to respond to grid flexibility needs. The aggregator can activate flexibility capabilities on behalf of DSO or TSO. With this, TSO and DSO can activate balancing capabilities (it provides adequate and relevant balancing power according to the imbalance issue).
- Increase flexibility to loads associated with EV charging. Its impact on grid congestion and voltage control can be directly managed and measured by establishing market and bilateral contract flexibility instruments and mechanisms.

4.3.2.3.3 CLUSTERING BY THE "MONITORING" DIMENSION

As the counterpart of the flexibility cluster concepts, 23% of InterConnect's services are classified in the dimension "Monitoring service," well representing the need to provide monitoring and control capabilities to end-users as a critical enabling factor to enhance active consumer participation and achieve broader and transversal market participation in the provision of flexibility services for grid support. Among the functionalities pointed out, here are recalled the followings:

- real-time consumption and ecological impacts monitoring;
- power and energy flow monitor/control;
- effective scheduling of energy usage;
- self-consumption optimisation;
- usage and effectiveness checking routines regarding devices performance and connected home appliances.

These services mainly use applications developed on mobiles, tablets, and vehicles. These applications will implement the functions previously produced and thus make interactions between EMS, intelligent meters, service providers, end-users; ... In addition, these applications will potentially operate in push mode to inform, advise, and propose improved actions to end customers.

4.3.2.3.4 CLUSTERING BY THE "COMFORT" DIMENSION

16% of InterConnect services are classified in the "Comfort Service" dimension. These services are intended to contribute to the achievement of a digital-driven grid, being conceived to self-manage or optimise the energy usage of connected devices by:

- automating tasks for end-users;
- enhancing digital control capabilities of equipment;
- managing the reliability and maintenance of the system;
- providing machine learning-driven tailored services.

4.3.2.3.5 CLUSTERING BY THE "OTHER" DIMENSION

Moreover, some other services clustered could be noted under "others services," representing some overarching issues (i.e., normative compliance with EU directives or national legislation) and needs to be addressed, such as commercial agreements. The "others services" cluster dimension represents 16% of the overall InterConnect services list.

These services implement some transversal functionalities around energy, such as commercial agreements; security and privacy issues; diagnostic capabilities; health, insurance enhanced capabilities.

4.3.3 MAP OF BUSINESS MODELS

4.3.3.1 CLUSTERING OF BUSINESS MODELS

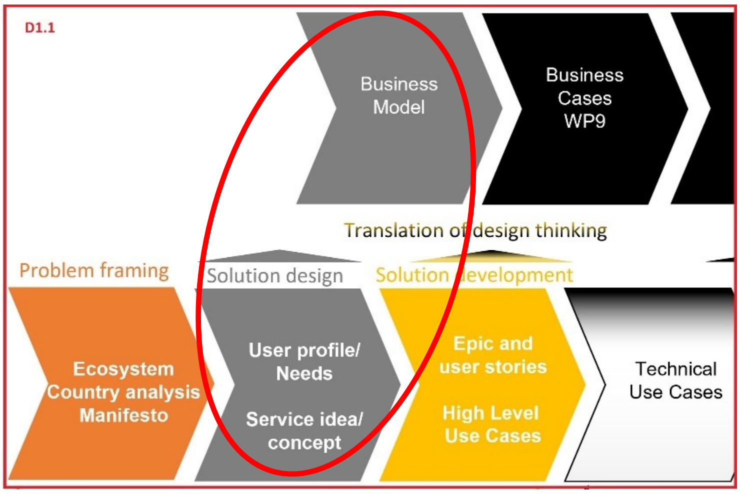

FIGURE 30 DESIGN THINKING PROCESS, BUSINESS MODEL

Based on the service concepts developed and discussed under Factory 1B workshop, each pilot team identified the business models using BM Canvas. The main trigger for identifying a business model is the value proposition, which is the service concept in our methodology. Hence, each pilot created a canvas for each service identified in the previous methodology step, placing the service's value proposition in the centre. The next item to be filled in the canvas is the customer segment. This needs to identify the type of customer (a segment) for which the value proposition will relieve a need, considering that not all the segment members might currently have the optimal conditions to the provision of the value proposition.

The homework from Factory 1B resulted in 51 business models. As there is a significant number of them, we proceeded to cluster them to understand better the main items that will make them successful. The clustering categories defined are as below.

- Innovation (from a customer perspective): classified from 1 to 5, 1 the lowest, and five the highest level of innovation compared to market SoA.
- The cost estimation was split into the two subcategories below.
  - Financial:
    - value propositions provision that will cost less than 1 M€ per year;
    - value propositions provision that will cost between 1 M€ and 10M€ per year;
    - value propositions provision that will cost more than 10 M€ per year.
  - Primary cost type, considering two main types:
    - provision of the technology related to the value proposition, including software development, integration, and deployment, hosting, and hardware;
    - marketing and promotional costs, related to making the customer segment's value proposition and increasing its market penetration.
- Revenue stream. The categorisation exercise identified three main types of revenues: 1) recurrent fees (monthly/yearly) paid by the end-user; 2) revenues from a reward/penalty schema based on end-user behaviour. This includes Energy Performance Contracts RoI schemas; 3) fees by third parties that obtain direct/indirect benefit from the end user's usage of the value proposition (e.g., DSO).

The results of the business models categorisation are detailed in Annex II (List of Business models).

4.3.3.2 BUSINESS MODELS ANALYSIS

At first, creative ideas for new service concepts need to be developed, but we know that "technology push" alone will not be enough for our service concepts to impact the real world. We need to consider the underlying business rationale, why organisations will work together to achieve the innovations, and how finance and other forms of value will flow through the ecosystems. The success of service concepts is closely tied to the value that they create. That is why the value proposition lies at the heart of the Business Model canvas. Even at this early stage, we must understand how each service concept translates into value for each actor in the ecosystem. What type of value is that? How is that value captured or integrated into the actors' other activities? Will each actor consider that the value they capture is worth the investment they will need to make in terms of finance, time, expertise, data, market position, or other considerations? The strength of the business model is that it brings creative new ideas and the practical realities of the natural world together. A viable business model is one where all actors involved in realising the innovation experience a positive value case. That means that every actor who plays a role needs to weigh up the value capture versus the costs and decide that it is worth their collaboration. The reason for starting to understand the business model at an early stage in the project, rather than wait until the services are ready to test the market, is that as the business model develops, changes, and becomes refined, it necessarily requires changes to the service concept itself and the organisational ecosystem that is expected to realise its implementation.

INNOVATION

The average innovation of business models is 3.8, meaning that most business models are considered to have medium to high innovation. Fourteen business models are considered disruptive (classified with 5), considering the ICT technologies involved, namely the platforms enabling the implementation of innovative energy and non-energy services. Also, artificial intelligence and data-driven techniques in implementing some services will offer unique functionalities and value to end-users.

Twenty business models are considered highly innovative (classified with 4), the majority related to the implementation of EV, community, and home/building energy management systems. These business models enable small to medium-scale loads in the grid support services through improved monitoring and energy management. Also, engagement strategies based on gamification are considered. These business models are cross-sector.

Eleven are considered to have medium innovation. This is because the remaining business models are built upon existing services and concepts that will be implemented for the energy domain (as in the case of the Italian pilot). Finally, six were considered low innovation (classified with 1 and 2) since these business models are already in place. However, they are relevant for the InterConnect pilot ecosystems to ensure compliance with GDPR or the implementation of power limitation energy services.

COST ESTIMATES

Overall, the estimates for development costs required after the end of the project are relatively low, with many service concepts showing estimates in the range of one million euros. On the other hand, the estimated deployment costs required, including developing market share and other operational expenditures, are relatively high. Finally, we may note that these estimates are made by groups predominantly including technology developers with faith in the quality of their work in the project but with little experience scaling up pilot services in competitive market settings.

In some groups, there are indications that 10,000s to 100,000s of end-users will be required to cover initial launch costs, meaning there will have to be significant attention for scaling up to this level from the start to ensure market viability. In other groups, participants mentioned that making valid cost estimates would require a suitable methodology (task 9.2) to be made available to improve the quality of this part of their business models.

Regarding the cost, about 45.2% of the business models have a cost estimation below 1M€, 17,6% below 10M€, and 7,8% are considered costs above 10M€. For 29,4% of business models, it was not possible to estimate financial costs, considering the early stage of the business model definition. Regarding the main cost types, 50 business models identified IT costs as the main cost. Some (11) consider that marketing costs will be high. They offer a solution that is unknown to the customer segment.

REVENUE STREAMS

On the positive side, many other revenues stream ideas were generated, and many different actors were named as sources of revenue. These include end-users, e.g., paying a monthly fee for service subscription, much as they do now for their standard network connectivity, third parties, for access to data and users, and aggregators, passing on savings that they make in the energy market, enabled by the service flexibility gains. Insight from one of the groups was specifying alternative revenue flows. So, instead of only identifying the revenue source, this idea is to specify the chain of actors through which revenue exchange takes place. In this concept, an older tenant with limited abilities is provided with automated help to allow them to enjoy their independence for longer. The ideas for possible revenue flows are (1) health insurers and government -> application service provider (fee); (2) end-users (pay a subscription for assisted living) -> building managers -> application service provider (fee); (3) application service provider (kickback fee) and healthcare platform providers (pay for data) -> healthcare providers. Also, different concepts envisage new forms of collaboration between actors, such as between various third parties and energy firms or between healthcare providers and building managers. What is needed to orchestrate successful collaborations? The validation of many of these revenue streams is non-trivial but vital to ensure the success of the service concepts.

Related to the revenue streams, they are mainly based on monthly fees (42.1%), followed by reward schemes (35.5%) for end-users and third-party fees (22.4%). The reward schemes are mainly considered to incentivise the end-user to participate in grid or community-related services or even provide data. The business model focused on monitoring, reporting, and energy management services will be reimbursed mainly through monthly fees. Third-party fees are mainly related to business models targeting mobility companies, aggregators, retailers, and platform providers. It is essential to notice that the total revenue stream is usually composed of more than one of these schemes.

The main take-away message at the end of the business modelling session of Factory 2 is this: the value case for each actor in the ecosystem needs to be worked through and validated as planned in the grant agreement through Work Package 9. The work on business models started in task WP1 task 1.1 / 1.2 will be continued in WP9.

5. SOLUTION DEVELOPMENT

5.1 WHY

This phase aims at detailing the service concepts in epics and user stories. They represent the fundamental inputs to picture the high-level use cases.

5.2 METHODOLOGY

The design solution is then developed in the third phase of the design thinking process. This phase generates two main deliverables: epics/user stories and high-level use cases (see figure below).

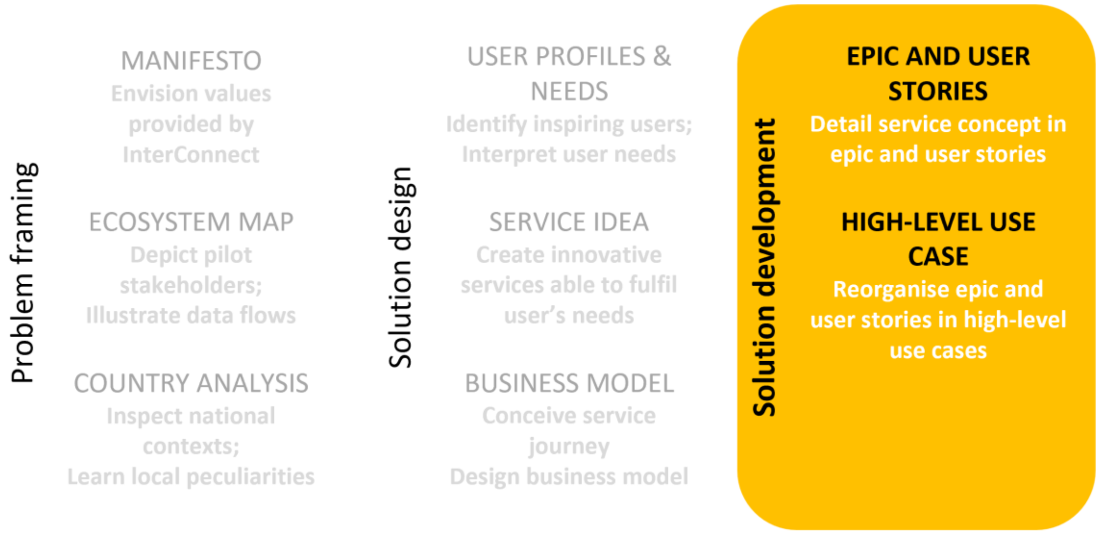

FIGURE 31: DESIGN THINKING PROCESS: SOLUTION DEVELOPMENT

The work on the service concept and the business model informs the definition of the super epics. A super EPIC is composed of EPICS. EPICs and user stories: drawing on the service concepts and business models, pilots generate EPICs, user stories, and high-level use cases. (See figure below)

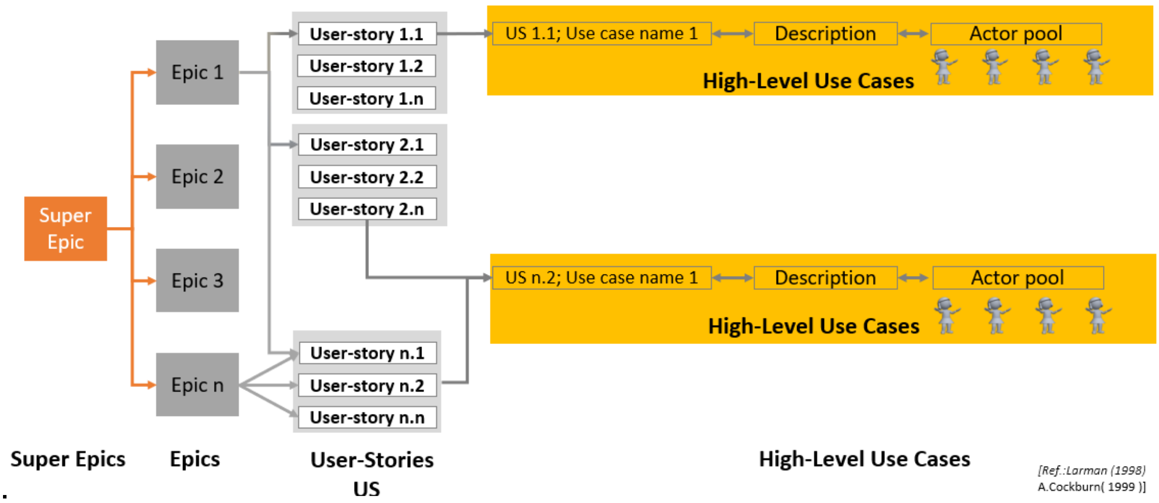

FIGURE 32. METHOD FROM SUPER EPIC TO HIGH-LEVEL USE CASES

5.2.1 FROM SUPER EPICS TO HIGH-LEVEL USE CASES

SUPER EPICS

Super EPIC uses the service concept and business model as an entry. The common themes are grouped and associated with a persona. Indeed, super EPIC is considered a group of EPIC stories fulfilling common themes. Thus, the super EPIC is extracted from the service concept, the customer segment, and the value proposition.

EPICS

One EPIC contains the where and the what. The what will explain the user needs and the where will explain the directions we want to go. Based on different key partners, for example, in the related business model, the EPIC is observed from different points of view.

Then, a user story is created based on this EPIC's selected point of view to deliver a high-level use case. E.g., the super EPIC “maximise self-consumption” with the personas “Pano & Soler,” upon the previous sequenced achieved. Its legacy starts in the service offer, coupled with the business model, large enough to be qualified as a super EPIC.

Its corresponding EPIC could be EPIC 1 photovoltaic, battery storage, bioenergy; EPIC 2 controllable devices, heat pump boiler, white goods. “Like whom, I want what so that why.” If we take the example of “Pano & Soler” “I want to run PV systems on my roof (what) so that I can get cheap PV energy and charge my battery system during the day and use the PV energy at night (why). The different points of view from the different actors are considered and create a different epic.

EPICs: to arrive at the user stories, we need to position ourselves on the point of view of different user-profiles and actors. An EPIC consists of multiple user stories.

USER STORIES

User stories: they have selected points of view of an EPIC, consisting of multiple user stories. We have chosen the engineering point of view to create the user story in the vein of the epic “as who, I want what, so that is why. It helps us to leverage the High-level use cases eventually. In our example, “Pano & Solar,” user stories on the controllable devices could be: “Pano & Solar” want to get smart white goods so that they can use them when the energy is cheapest. “Pano & Solar” want to store my energy produced so that they can benefit from the cheapest energy offer.

HIGH-LEVEL-USE-CASES

High-level use case: a title defines it; a goal, stretched by the actors, will allow a description explained in a few principles and sentences. The description is based on the actor and the purpose of the use case to describe a single solution with a list of functions. It is needed to go to a high level of granularity. We can identify the use case name from the example used before: increase self-consumption to save money and reduce CO_2 emission.

Actors	
Primary business actors PV leasing company, energy supplier	Secondary business actors (external) PV manufacturer
Initiator actor(buyer) Pano & solar (citizen passionate by solar panel)	External service actors (technical actors) PV System/ battery system energy manager house owner/app

TABLE 5: SELF CONSUMPTION EXAMPLE

This use case describes how to increase self-consumption as a house owner. Through a PV installation (leasing or investment), own PV energy will be produced. This is the first step to reduce the energy bill – all loads will be served with PV energy once it is available. The availability of the PV energy by temporary storage in a battery system is increased. The system will provide KPIs such as PV energy produced, € and CO_2, savings, and others to the end-user by Smartphone App.

5.2.2 TECHNICAL USE CASE AND USE CASE FUNCTIONS

TECHNICAL USE CASE

Technical use case: from the HLUC, the technical use case is derived. A technical use case describes the specific machine-to-machine information exchange to enable one of the solutions from the HLUC. The technical use case is specified through (1) actor description; (2) scenario overview, which shows the functionalities of the use cases; (3) scenario flow diagram to describe the relationship of the scenarios; (4) scenario's specification to detail the functionality; (5) sequence diagrams show the exchanged information. The technical use case will structure the requirements for IoT reference architecture. The technical use-cases will be generated and detailed in D1.2.

FIGURE 33. TECHNICAL USE CASE PROCESS

USE CASE FUNCTION

Use Case Functions (UCF): the technical use case description will be transformed to UCFs. A UCF is the smallest functional piece that may be reused in another use case. The UCF contains all relevant information to build the described functionality. Thus, UCF will help to have a lean product implementation. In our process, the technical use case will also be detailed in D1.2.

5.3 OUTCOMES

The activities related to the "Solution development" stage took place as shown in the timeline below in the form of factory 2 ", Services and use cases for smart buildings and grids "(Microsoft Teams, 27th – 29th May 2020).

During factory 2, we finalised the process and methodological approach to produce innovative HLUC and business cases for InterConnect project. We transformed all design thinking results as input of the D1.1 deliverable. We constituted the transition to D1.2 through the aggregation Service concept aggregation and the clustering of the Business Model and HLUC.

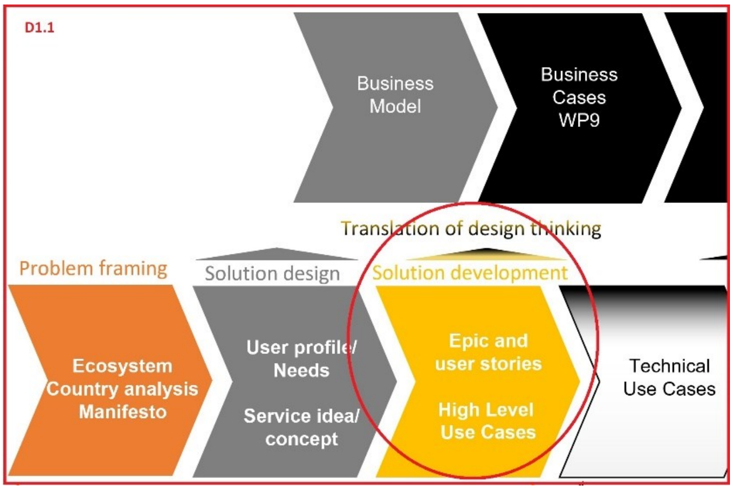

FIGURE 34. DESIGN THINKING PROCESS, SOLUTION DEVELOPMENT

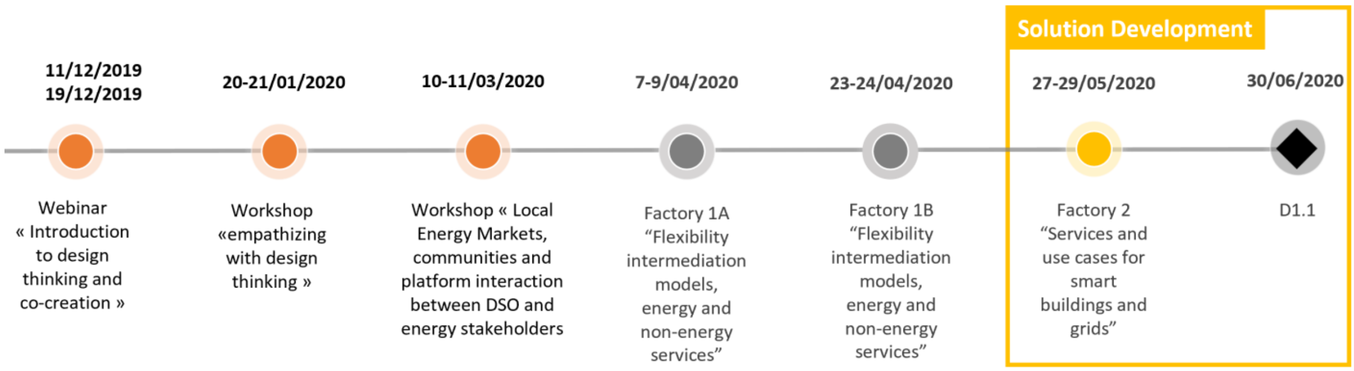

FIGURE 35: TIMELINE SOLUTION DEVELOPMENT

High-Level Use Case (HLUC) are value-added functionalities to address specific consumers' needs. They may be composed of several basic features (i.e., an elementary capability or action) that together form a whole more significant than the sum of its parts. There are many functionalities and features among the High-Level Use Cases, so they are not equal. The list of HLUCs created on Interconnect is detailed in Annex III.

5.3.1 HIGH-LEVEL USE CASES CLUSTERISATION

Annex III reports all the HLUC created by the different groups in which the participants of the Work Package were divided. The criteria for forming the groups were to have each team representing a pilot as much as possible. This helped the group focus on the personas they expected to find in the demonstration phase and the specificity of the pilot itself.

The combined work of six teams has created almost one hundred HLUC. We have analysed the results and mapped the different use cases according to two different sets of criteria. It is worth mentioning that a single HLUC can score against multiple dimensions in each of the two sets of criteria: solution-centric and social-centric dimensions.

SOLUTION CENTRIC DIMENSION

The first set has been named 'Solution Centric.' It includes different dimensions representing the kind of solution the HLUC would deliver to the key stakeholders (user, energy service provider, grid, ...) to address a specific need(s). The graph below shows the distribution of the HLUC according to these dimensions:

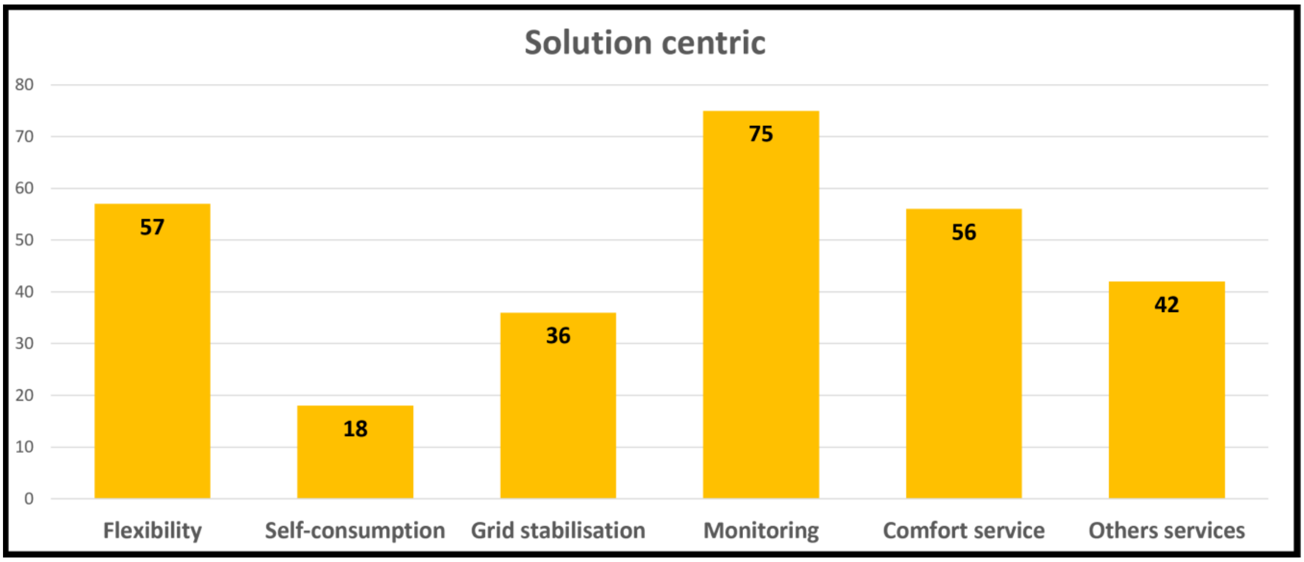

FIGURE 36: DISTRIBUTION OF THE HLUC ACCORDING TO THE SOLUTION CENTRIC DIMENSIONS

Even though each HLUC has its own goal and corresponding benefits, the following HLUC has been selected to be "the most representative" for the Solution centric – Monitoring criteria. The following key points can be extracted from the IT #4 HLUC to highlight how it deals with these criteria. (1) It provides full chain considerations for building energy production and consumption; (2) It provides a high-level and straightforward Key Performance Indicator understandable by everyone; (3) It includes individual daily behaviours and choices and the resulting impact on the environment; (4) it encourages behaviour improvements in a challenging way relevant to EU citizens' engagement towards energy decarbonisation.

SOCIAL CENTRIC DIMENSION

The other set of criteria has been named 'Social Centric' since it classifies the HLUC from a positive impact on society, environment, or business innovation. Here is the graph reporting the distribution of the HLUC according to these dimensions:

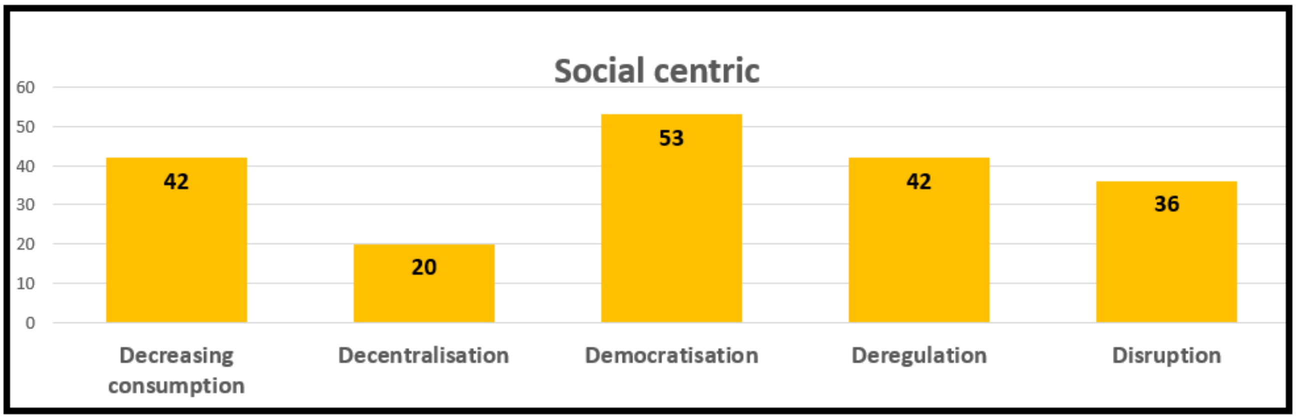

FIGURE 37: DISTRIBUTION OF THE HLUC ACCORDING TO THE SOCIAL CENTRIC DIMENSIONS

The following HLUC has been selected as “the most representative” for the social-centric – democratisation criteria. The following key points can be extracted from the NL #7 HLUC to highlight how it deals with these criteria: (1) it provides energy bill reduction by controlling own consumption, which is fully democratic; (2) it provides an accessible way to point out the higher energy consuming device/appliance and postpone or cancel its usage; (3) it provides an individual behaviour improvement to reduce consumption and energy resource sharing.

Every pilot has a similar HLUC. The “core” of the energy management control is to be developed for interoperability.

5.3.2 HIGH-LEVEL USE-CASES SWOT

We have also holistically analysed the different use cases, trying to understand the opportunities and the areas of strength that the totality of the use cases is showing, and the weaknesses and the areas where we should pay attention. A traditional SWOT analysis was then performed, and the primary outcomes are reported here:

AREAS OF STRENGTH

- Many relevant HLUC to support energy flexibility at the residential level can be familiar to most pilots.
- Different ideas for monitoring and providing aggregated dashboards to users to have everything under control.
- Strong focus on integrating renewable energy (including self-produced) to minimise cost and optimise grid operations.

Comments: all pilots have some key elements and features in common, like providing solutions for energy flexibility to residential users and engagingly, which is excellent since this is a crucial way to show the benefits of interoperability of devices. Understanding the most effective dashboards to show to consumers and the most meaningful information to be reported there will occupy a central role in the design of the solution, which can be applied in all pilots. The richness of the feedback we can gather will help refine this part to what we hope could become the ‘industry standard.’

AREAS OF OPPORTUNITIES

- Other pilots could leverage HLUC on engagement and wellbeing since they do not require specific equipment.
- Explore different User Experience and User Interface solutions for user interfaces (link to dashboards) to identify the most effective/easy-to-understand solution.
- The way to integrate EV in the home ecosystem.

Comments: because of the importance of engaging consumers, all our best efforts will converge to find a common approach for User Experience and User Interface to be considered best in class. Electric vehicles may not be familiar to all pilots, and their presence may be just a few. Nonetheless, much learning can be done even with a few devices, and they can be integrated within the results of the other pilots to understand their impact.

AREAS OF WEAKNESSES

- Significantly, few EVs will be involved in pilots, making integrating that device more theoretical.
- Grid stabilisation HLUC is 'the standard,' with no uniqueness.
- HLUC on building management may require substantial effort and probably be pilot-specific.

Comments: as mentioned above, real EVs will be few in the test, so although valuable learnings can still be achieved, we may only simulate the impact of large fleets of those vehicles.

Use cases related to building management have to be carefully considered not to fall into the trap of designing something too specific for a single case that cannot be easily replicated or scaled up.

AREAS OF THREATS

- HLUC related to health or heat management can be costly to implement; we may miss specific competencies and are specific for one pilot.
- Intensive use of "gamification" techniques but skills and competencies for implementation and continuous support to be assessed.
- We may have to study the imbalance issues created on the primary and local grid when specific solutions are scaled up from pilot level to mass market.

Comments: even though use cases related to remote health care or heat management in the building may be of interest to many, we need to consider that those use cases are not quite aligned with the project objectives and that the competencies required for the development of that HLUC may not be present among the 50 companies in the consortium.

Many HLUC referred to gamification techniques to engage consumers. This is sure well, but we must be mindful that specific skills are required to create engaging games, as demonstrated in other European projects. In addition, they have a short life and need to be constantly updated or expanded to avoid losing the users' interest.

HLUC CONCLUSIONS:

Through a collective and creative process, the Work Package 1 team has created a broad and rich set of HLUCs that can cover the needs of InterConnect. Of course, not all these HLUCs will be produced as part of the project. Instead, similar HLUC will be aggregated and consolidated first. Those that will be eventually implemented will be selected, refined, adjusted later in task 1.3 based on the work on HLUC started in task WP1 task 1.1 / 1.2.

6. CONCLUSION

This document presents the main results of Tasks 1.1 and 1.2. The following objectives set in the Grant Agreement were achieved:

- To map the existing and new energy and non-energy sub-services and the corresponding formal business use cases, which could significantly benefit from an innovative decentralised ICT architecture leveraging semantic interoperability, like the one designed in WP2 based on SAREF ontology.
- To design new human-centric and grid-centric services with their associated business model.

Indeed, through a design thinking methodology extended by an exploitation phase of these exploration results, all the WP1 and WP7 partners have carried out cross-country ecosystems' studies, the study of their context, the study of user-profiles and their needs to transform this information into services and business models to deduce the HLUCs. Therefore, in this document, we have focused on the presentation of innovation in our services as of the 30th of June 2020.

This document is not a global functional requirements specification. These requirements are described in D1.2 (mapping between use cases and large-scale pilots) and D1.3 (system use cases for smart buildings and grids) documents. The D1.2 provides the selected HLUC, and the D1.3 presents the system use cases (SUC) definition and their sequence diagrams associated. The societal impact will be further explored during Task 9.3 in the WP9 based on D1.1. Further analysis will be run on economic, social, environmental with a quantitative and qualitative approach. Also, the condition for social acceptance and trust will be studied.

D1.1 provides a collection of services, business models, and HLUC designed around the concept of interoperability and flexibility to make the most of this new decentralised architecture. A subset of these collections, refined/selected from the work described in documents D1.2 and D1.3, will be implemented in InterConnect based on the results produced by D1.1. In addition, the work on business models started in WP1 Tasks 1.1 and 1.2 will serve as a basis for WP9 to further define them.

Overall, InterConnect will (1) contribute to a single market for energy and data; (2) encourage the citizens to trust data-driven services, accept new technologies, and exercise their rights effectively in a digitalised energy market. Moreover, InterConnect allows for creating a trustworthy technology, putting people first, and enabling citizens, prosumers, and energy communities to play an active role in the energy markets, and (3) also expand the energy sector to other actors like IT.

InterConnect also aligns with the Green Deal objectives, making accessible and interoperable data at the heart of the project.

Concerning the strategy data European policy, the InterConnect rejoins its policy regarding data interoperability and quality, facilitating cross border data use. Within SAREF, the need for sectoral authorities is considered specifically for each sector, which will help to work towards a harmonised description and overview of datasets, data objects and identifiers, as the ontology SAREF is at the heart of the data interoperability; A sole ground for innovation has been built for cross-sector business models. The InterConnect project will ensure that its research data will be made findable, accessible, interoperable, and reusable (FAIR) when possible.

In conclusion, this first deliverable from the InterConnect project highlights the following InterConnect relevant contributions aligned with the “Action Plan on the Digitalisation of the Energy Sector”:

- **Developing a European data-sharing infrastructure.** The Pilots in the Netherlands, Portugal, France, and Greece will demonstrate a blockchain setup that can trace data sharing activities of parties, transfer loyalty, verify approval for service-to-service providers, and record this.

- **Empowering citizens**. All InterConnect pilots leverage demand-side flexibility and energy/non-energy digital platforms to empower citizens and local communities. Consumer-centric services are dominant in the InterConnect project. Services such as monitoring, energy management functions, user preferences, energy optimisation or forecast are essential building blocks of all the InterConnect pilots. To access devices or services through the interoperability layer, common adapter ontologies need to be developed in WPs 2-5 and is a building block for this overarching goal.

- **Enhancing the uptake of digital technologies.** The demonstration activities of InterConnect use cases/services with customers from different segments (domestic, tertiary buildings, social housing, ….) will generate relevant lessons to future regulatory and legal frameworks, and the cross-sector and multi-utility dimension of the pilots also enables the demonstration of additional benefits to end-users and digital service providers. Moreover, multiple digital systems/platforms from comfort to energy management are available that cannot be networked into one single system and limit end-customers to the specific vendor portfolio. Through this, vendors exclude the competition from their system to set high price points, creating digital technologies and services barriers. InterConnect semantic interoperability will solve the incompatibility issue and is considered a high-value innovation to maximise the uptake of digital technologies.

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INTERCONNECT DOCUMENTS

[100] InterConnect Grant Agreement number 857237

ANNEXES

Annex I. SERVICES AND INNOVATION

LIST OF ALL SERVICES

Country	Service Concept name & description	Human-Centric (HC) and Grid-Centric (GC)
PT	**Monitoring energy consumption: t**_hroughout technological solutions, such as the Energy Management System (EMS), it allows users to: - have immediate access to the data generated from all their appliances to: - monitor their consumptions of energy; - customise some parameter related to energy consumption; - have notifications about improvements of their consumption behaviour; - have control based on the informed decision (scheduled actions/ autopilot mode); - increase energy cost savings (having best tariffs); - can provide flexibility (e.g., by allowing shift usage in exchange for best tariffs)._	HC
PT	**Energy as a Service**: _This Service describes how the end-user can have the ability to select which (sets/modules) services to subscribe to (ex. Load optimisation for EVs; PV forecasting; Recommendation System) through technological solutions, such as the Energy Management System (EMS) - the concept of the "Energy as a Service." This service will consist of three main modules, independent of each other and optional to the user, but which together work in an orchestrated way, using SAFEF for data exchange: 1) Forecasting; 2) Scheduler; 3) Recommendation._ _One important feature is the "Auto-configurator" for device detection and association to an EMS. It allows the device to be associated to the HEMS with a structured exposition of data based on SAREF - Important characteristics: this Service is Multicriteria - the user can make multiple options; the Privacy is guaranteed, according to the user's options/permissions._	HC
PT	**Energy Efficiency as a Service – Commercial:** _integrated Energy Management System (iEMS) at tertiary buildings, EE enabler, and flexibility aggregation:_ _- Awareness @ store / building / portfolio level through access to data / monitoring / dashboards / KPI's_ _- Integration of diverse technology for optimal energy management/maximisation of RES penetration/cost reduction_ _- Active and remote control over stores/buildings to enable flexibility exploitation (through aggregator - mitigation of portfolio imbalance and provision of DSF to TSO/DSO)_	HC&GC
PT	**Convenient Smart EV charging:** _small impact in daily routine, significant benefits. Take advantage of the ecosystem interoperability to enable smart EV charging (optimisation of time slots/maximisation of PV generated energy use / competitive energy cost/demand-side flexibility needs...). Commercial store/building customers can conveniently charge their EV's with minimum impact in their daily routine while shopping in the store/building._	HC
PT	**Profiling-based user data sharing:** _Enabling consumer data and metadata share via consumer profiling and ingesting consumer data by matching target profiles enables advanced third-party analytic services. Consumer data and metadata are made available by consumer proactivity. Consumer profiles are established. Consumer allows or restricts data granularity or quality. Differential privacy technique is employed to reflect consumer preferences. Third-parties or data consumers choose data providers (consumers) based on profiling. Reward may apply_	HC
BE	**E-Mobility Services for energy Communities:** _Companies at the site (or industrial/commercial/private entities) that form an energy community demand efficiency, demand-side management, and flexibility. E-Mobility solutions are an option to provide energy efficiency, demand-side management, and flexibility but also offer sustainable transportation within the community and its members. The service entails investigating which e-mobility package is the most appropriate for the community, installation of infrastructure, and provision of assets, maintenance, and an intelligent interface through a mobile (online) application._	HC
BE	**Building level services: Peak shaving:** _Modulate power demand of the building by direct and dynamic management of grid capacity utilisation, avoiding penalties for brief incursions of power demand above the contracted network capacity. The service controls building loads (heating/cooling system, EV chargers, HP, ….) in a coordinated manner considering the optimisation of local RES self-consumption._	HC
BE	**Building level services: RES self-consumption:** _Maximize consumption of local RES generation (e.g., from PV panels) at hours of high production to reduce electricity supply costs. Collaborative consumption considers the strategies set by the peak-shaving service._	HC
BE	**Data 'freedom of choice 'service:** _This service offers end-users of pilots the possibility to opt-in or opt-out for specific energy and non-energy services that require their data. In addition, it provides an easy application where the user can select which data they want to share with different parties. This can be anonymous (aggregated) data required for optimising algorithms or personal data._	HC
BE	**Green progress bar service:** _This service allows users of a pilot to see the commitment and progression of the building or entire site towards specific ecological KPIs. For example, by installing displays throughout the site, the users_	HC

	can be informed of what is the percentage of RES at the moment, what is the estimated amount of CO_2 saved this month, what is the air quality … We can even imagine including gamification into the display where we need all users of the pilot to modify their behaviour to reach specific goals.	
BE	**Energy flexibility service with thermal loads for individuals:** *Control water heaters and heat pumps using IoT devices to reduce consumption during high consumption peaks or increase consumption during local generation installation surplus periods.*	HC
BE	**Peak-shaving and self-consumption for local energy communities:** *Once the individual control of water heaters and heat pumps is implemented and interoperates with other systems, this service aggregates individuals in local energy communities, reduces their community peak cost, and increases the self-consumption rate.*	HC
DE	**Flexible tariff service:** *The flexible tariff service reacts to the energy market or DSO needs. It helps through incentives to shift electricity consumption in underload scenarios enforced by energy from renewable power generation or underload scenarios with too much consumption.*	GC
DE	**Power monitoring at the grid connection point:** *The monitoring of power consumption service helps the DSO to save grid expanding costs and to identify hot spots*	GC&HC
DE	**Power limitation at grid connection service:** *The power limitation at grid connection service reacts to the DSO needs and helps to distress the grid in case of an overload scenario to prevent backouts*	GC
DE	**Fuse protection service:** *The fuse protection service helps avoid local overload scenarios. The local fuse will not be activated by monitoring and comparing the individual phases towards the configured electrical power capacity. This service must be implemented in the HEMS/BEMS, requiring controllable devices.*	HC
DE	**Manual power shifting service:** *The manual power shifting service reacts to the DSO needs, e.g., in case of an overload scenario with too much renewable power generation by customers intervention to force power consumption*	GC&HC
DE	**EV Fleet charging service:** *The mobility turn will challenge the grid. Especially commercial buildings or hotels need to handle multiple charging demands and departure times while considering grid constrains*	GC
NL	**Automation functionality (convenience):** *Value proposition: freeing up time for the user, reducing the cognitive load, having the option for remote control/status-view* *Offer: collecting user (also building level) behaviour data and predicting future needs/preferences to adjust the settings and automate (basic) actions involving thi[rd] parties. The user shares data, limited interaction (feedback). Necessary: interoperable devices and platform. Set of sensors. System learning/adaptation period or use existing databases.*	HC
NL	**Automation functionality (health):** *Value proposition: having remote control/status-view, maintaining the quality of life for older or less able people to allow them to live independently (longer)* *Offer: The service manages appliances and routines for less able people living alone. It does this through appliance data analysis, AI pattern recognition, and interaction with the end-user. People interact with the service via a web interface. For the service to work, it is necessary to connect many appliances (doors, electrical devices, ….) and have information about the needs and limitations of the end-user. Actors involved include the end-user, family members, home care personnel, GPS, service providers, network operators.*	HC
NL	**Energy recommendation and automation – Intelligent Building Management System (iBMS):** *Value proposition: saving operational cost (maintenance & energy) and increasing the functionality of the building* *Offer: remote control of the building systems by the integrated system with customised control strategies. Real-time insight in building performance and building status. Predictive maintenance due to data collection and analysis. Adaptive configuration by machine learning.*	HC
NL	**Mobility - Green/Smart charging for mobility:** *This service should charge the EV according to –1- user mobility needs (next trip, time of departure, …) and –2- user objectives (green-charging, cheap charging, autarchic, comfortable driving, fast...)*	GC&HC
NL	**Platform function, user interface, and Dissemination - Monitor and control:** *The principal value this service offers are that the user has complete but straightforward control over his home. It is easy because the user interface is accessible from most of his devices. Smart appliances and sensors are needed to collect the data. A system aggregates the data and steers all devices, and an app visualises the data and provides monitor and control options.*	HC
IT	**Digital Platform for End-User Control and Awareness:** *The digital platform for awareness satisfies users' needs (economic saving, energy efficiency). The user chooses a flexible service or selects a smart tariff offered by different service providers in real-time. The App also includes a gamification approach to attract interest to environmental and energy efficiency issues at the community level. To this end, game tournaments between different neighbourhoods can be developed.*	GC
IT	**Unlock Perks with Use:** *Keeping users engaged in making DSF with residential consumers sustainable over time is fundamental. One of the possibilities to keep users using the Energy Manager and associated services is to unlock additional features or perks with the continuous use of the App to offer their flexibility. Some examples: the incentives provided to users that offer flexibility may increase the more they offer it. The best tariff during the day could have an extra discount for the users who often shift their loads into the cheapest tariffs. There could be several features to unlock, like providing cost for each appliance cycle or even discount on accessories and consumables for the appliances.*	HC
IT	**Interoperability and availability of solutions:** *The service aims at ensuring a seamless and easy check of integration effectiveness of different home devices, offering to the end-users the perception of the reliability of the playground to make use of smart appliances. The diagnostic routine will enhance the contribution capabilities to a Flexibility Program. A cloud-based platform will integrate into a distributed architecture the connected devices through REST calls (Pub/Sub Broker), gathering information exposing them through an App, offering control capabilities to end-users and an overarching system diagnostic to Aggregators to manage DR mechanisms properly.*	GC&HC

IT	**Energy & Environmental Performance App:** *An App reflects the user's energy behaviour and consumption pattern. The app shows his ecological footprint related to energy (such as CO_2 emissions steaming from energy consumed). In this app, the user is reimbursed for exemplary performance in the form of points. Once the user performance significantly worsens than before, he receives a notification. If agreed to, the user can participate in a competition among community members to see who is performing best over time.*	HC
IT	**Playing with technologies:** *The main scope of the service is to allow users to create their functions to realise tasks that are not present in the default configuration of the system. It requires a cloud-based platform to interact with all the connected devices and detailed documentation describing how to perform this interaction (API description or an SDK). The most valued "mod" could be integrated into the platform, improving it. The user who provided the "mod" obtains rewards, such as a more convenient tariff schema discount on products/services….*	HC
GR	**Energy Efficiency:** *Enable users to monitor their energy consumption, receive feedback on CO_2 emissions reduction and increase their awareness about energy efficiency. Users need to have installed a smart meter, an IoT GW paired with sensors and devices, and a corresponding mobile app acting as the user interface. The actors involved are consumers/prosumers, technology providers (IoT, smart meters, app developers), energy suppliers, grid operators, and aggregators.*	HC&GC
GR	**User engagement:** *This service aims at engaging the users through incentives like loyalty program awards and gamification techniques. Users respond to DSF requests and incentives through gamification techniques and earn rewards in gamification points, reduced tariffs, and loyalty program benefits. Users need to have installed a smart meter, an IoT GW, and a set of sensors to enable the service. The actors involved are consumers/prosumers, technology providers (IoT, smart meters), energy suppliers, grid operators, and aggregators.*	HC&GC
GR	**Smart Home Energy Management System:** *Provide a service about integrating various devices and appliances in a single framework. Users will be able to monitor and control their assets/devices remotely. They will receive notifications regarding events in their house or DSF requests from the GRID. In addition, they will be able to respond to these requests when out of their house through remote control. Interactions are based on a mobile app or a web interface. The main actors involved are end-users, technology providers, and GRID operators.*	HC&GC
GR	**Data Analytics:** *Predictive analytics service for energy demand predictions and recommendations/optimisations. Analysed data and predictions based on usage patterns can be used to show the potential impact of a user's action on their overall energy footprint and energy bills. End-users/consumers will have the opportunity to check their usage behaviour and decide if it is more efficient to shift the usage of power-hungry appliances to off-peak hours. Analysed data and predictions based on usage patterns of customers can be used to provide valuable insights into demand and schedule supply accordingly. The main actors involved are end-users, energy producers/operators, and service providers.*	HC
FR	**Dynamic Tariff & usage management:** *Dynamic tariff and use management (offer a dynamic tariff that allows users to benefit from lower electricity tariff by acting on their usage to reduce their costs and know their usage and impact, including service management). Using dynamic information from suppliers offers to adapt the energy consumption to the tariff on-going to reduce bill and carbon footprint. The flexibility is also used for the TSO as ancillary services and is monetised on the energy and capacity markets. Direct Actors involve Energy supplier, service provider, end-user, Indirect actors: DSO, BRP, equipment provider, settlers/ maintenance provider.*	HC&GC
FR	**Maximise use of RES:** *Manage the different customer uses by maximising renewable energy consumption via smart meter consumption and production data. This service synchronises consumption with RES production at the local level. Moreover, this service uses local storage in the house based on a recycled EV battery. Thus, the customer stores the energy produced by his PV in his absence, and he uses this energy when he needs it.*	HC&GC
FR	**Consumption optimisation assistance service:** *service that turns off devices in standby mode when the consumer leaves home and facilitates energy savings (a touch screen integrated into the house allows the consumer to manage his energy context with simple modes that can be activated with one click (sleep mode, evening mode, out of home ...)*	HC
FR	**EV charging, flex & balancing grid contribution within LEC (Local Energy Community):** *When an EV is plugged into the system for charging, make double usage within a community:1. EV as a source/storage of flexibility for the community consumers/prosumers, 2. EV as a source of ancillary services to keep the community well balanced and potentially self-sufficient*	HC&GC

TABLE 6: LIST OF SERVICE CONCEPTS

SERVICES WP7.1 - PT

Portuguese services innovation

The Portuguese pilot is focused on integrating DSF from B2C and B2B (i.e., supermarkets) customers into the operation of distribution grids and demonstrating a set of data-centric energy and non-energy services for prosumers and communities. Moreover, the pilot shows cross-sector business models and platforms by having supermarkets offering EV charging as-a-service to their customers and integrating DSF from EV and refrigeration systems in distribution grid management (using the DSO interface for flexibility from DER).

The first set of services was defined for the home energy management system (HEMS) in domestic prosumers, driven to enhance the solution developed in the H2020 InteGrid project (2017-2020) by INESC TEC (at TRL 7 at the beginning of InterConnect), which was a combination of hardware (energy gateway) and software (forecasting and optimisation algorithms for load management). The main innovations from InterConnect for the HEMS component are:

a. the implementation of a microservice architecture to create a fully digital cloud version of the HEMS and modular energy services (*"Energy as a service"*);
b. the use of SAREF to exchange flexibility information (availability and activation) between prosumer, aggregator/retailer, and DSOs, and include aspects such as data ownership and GDPR compliance in flexibility modelling and communication in a privacy-by-design approach (service: *"Energy as a service"*);
c. in addition to flexibility, the enablement of new data-driven services thanks to SAREF, valorising consumers' data (e.g., connectivity, sub-metering data, electric measurements) for improving grid observability and aggregators' analytics capabilities;
d. the enhancement of the human-machine interface for energy monitoring and control (e.g., smart EV charging using ISO 15118), service: *"Monitoring energy consumption".*

For DSF in the B2B sector, InterConnect will demonstrate an interoperable architecture of digital monitoring and control IoT platforms (from Schneider and Sensinov corresponding to the use case: *"iEMS – Integrated Energy Management System"*) acts as an enabler of digital data-driven services such as the exploitation of flexibility from the refrigeration system and EV charging at the supermarket premises (service: *"Energy Efficiency as a Service – Commercial"*), which will be aggregated by a retailing company (Sonae/Elergone) for participation in the wholesale electricity market (i.e., peak prices shaving) and provision of system services to the DSO (E-REDES). The innovation path is depicted in Figure 1. The use of flexibility from supermarket refrigeration systems was only explored at the academic level[5] and not demonstrated in real-world conditions. However, upward and downward regulation capacity is well-known and relevant for the market.

Sensinov's platform will be deployed and constitute the endpoint demonstrating efficient Hardware/BMS integration (i.e., possibility to interconnect any device / any sub-system behind EMS). In terms of innovation, this solution will offer users full situational awareness for buildings in heterogeneous environments via functionalities such as Digital Twin or Hypervisor. Additionally, one key innovation for this project can combine data collection, analysis (and monitoring), as well as actuation based on external signals (e.g., DSOs), allowing for flexibility exploitation and activation (with a particular focus on optimisation strategies for achieving the latter). As mentioned in the document, the use of flexibility from refrigeration systems in supermarkets has been studied in literature and deemed relevant but has yet to be demonstrated in real-world conditions.

Another goal is to demonstrate cross-sector use cases benefiting from the combination of electric mobility and PV generation using commercial charging incentives in supermarkets (i.e., opportunistic charging to take advantage of PV surplus while shopping), service *"Convenient Smart EV charging,"* which innovation path is depicted in Figure 2. Other scenarios where benefits resulting from flexibility needs (that may lead to charging rate constraints) will be shared with the EV user in the form of rebates through the loyalty card program. It is important to note that cross-sector business models and sharing energy data with non-energy sectors have been explored in a minimal scope in Europe, as showed by a review from JRC of 217 digital platforms running energy-related activities[6]. This review only identified three cross-sector services: crowdfunding (green loans), managing fuel consumption and vessels; provide EV users with smart navigations during their journeys. Therefore, this InterConnect service will promote EV-centric cross-sector business models to attract new customers (EV users), contribute to the reinforcement of the EV charging infrastructure, and improve return-over-investment in RES technologies.

[5] O'Connell, N., Madsen, H., Pinson, P., O'Malley, M., Green, T. (2014, October). Regulating power from supermarket refrigeration. In IEEE PES Innovative Smart Grid Technologies, Europe (pp. 1-6). IEEE.

[6] Duch-Brown, N., Rossetti, F. (2020). Digital platforms across the European regional energy markets. Energy Policy, 144, 111612.

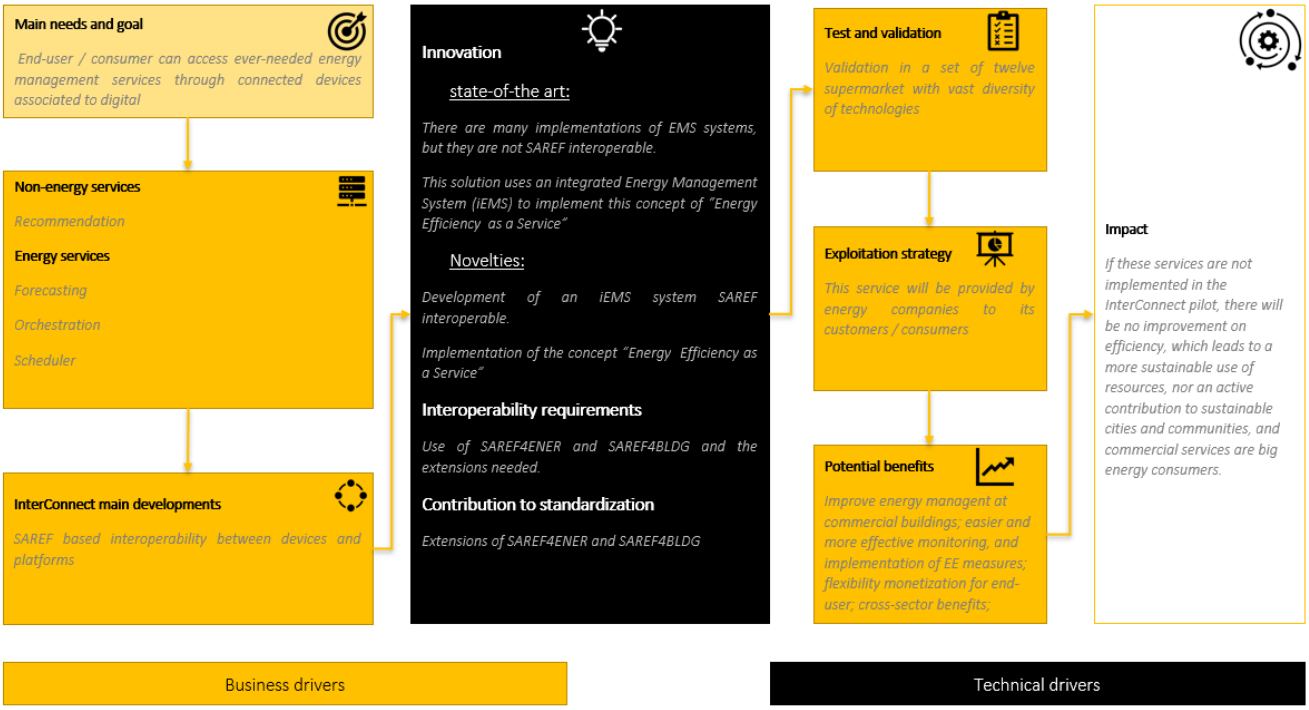


FIGURE 1 – INNOVATION PATH OF THE SERVICE "ENERGY EFFICIENCY AS A SERVICE – COMMERCIAL."

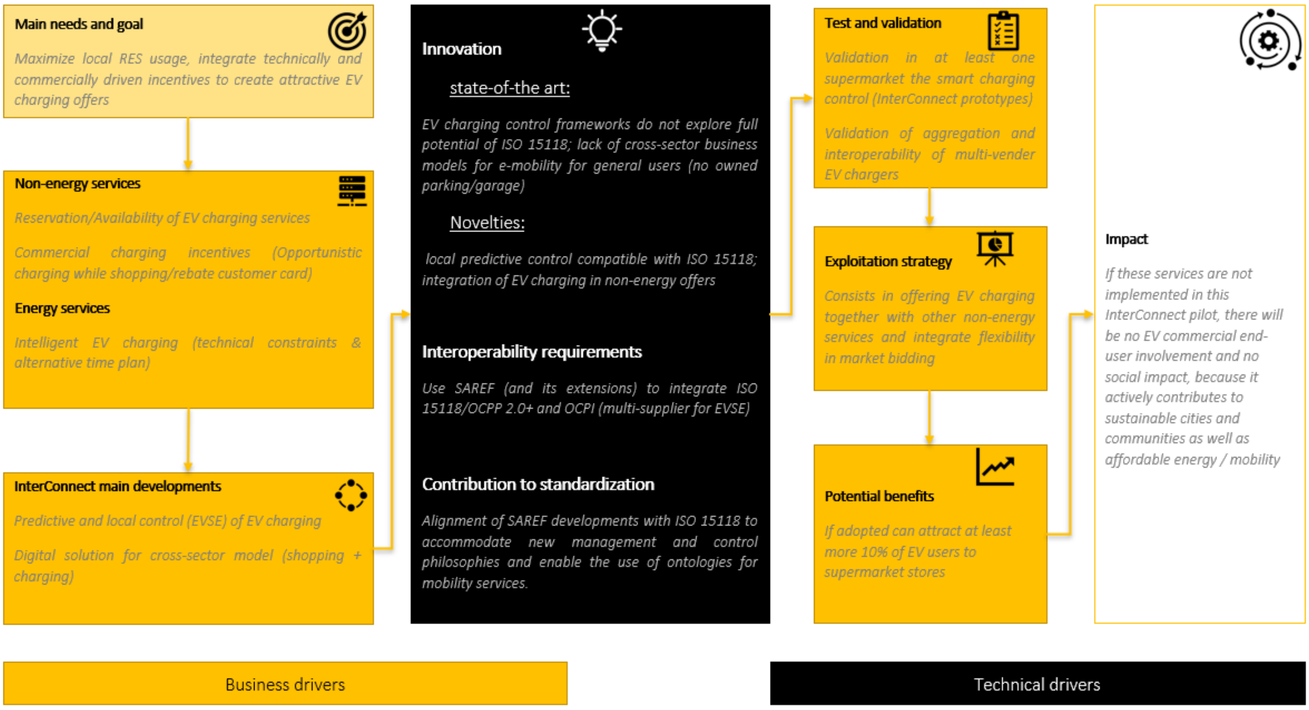


FIGURE 2 – INNOVATION PATH OF THE SERVICE "CONVENIENT SMART EV CHARGING. "

The whole interoperable ecosystem is expected to set the basis for further developments to be built on top of those achieved during InterConnect. They bring value to various players, from supermarkets operators, energy retailers, aggregators, and digital services providers.

Extraction of value from the user is shared data (service *"Profiling based user data sharing"*) is also at the core of this pilot. In addition, Interconnect intends to implement interoperable barter exchange schemes (HLUC, *"Enabling community services via P2P and Blockchain enablers for SAREF services"*) where data owners can trade their data either by digital services offered by third parties or offer their data directly to regulated entities

(DSO) in exchange for a better quality of service, or share “assets” such as PV generation surplus at the local community level.

A core component for these services is the Hyperledger Fabric from VizLore, which will unlock collective use of data in renewable energy communities (RECs), together with consumer data sharing for non-energy services, including data tracing when prosumers data is shared with third-party service providers. Data management and sharing in the energy sector have been mainly promoted by data management platforms (primarily for smart meter data) operated by DSOs and TSOs[7]. InterConnect establishes a P2P exchange of interoperable collective data within RECs and explores cases where stakeholders (namely DSOs) receive data from prosumers, which innovation path is depicted in Figure 3. Exploiting data value for predictive capabilities is also present in:

(a) HLUC011 – PUC1 in D1.3, *“Using HEMS/BEMS data to support distribution network fault location”*) were data shared by HEMS or BEMS is used by DSO to identify network works with interruption of electricity supply.
(b) HLUC011 – PUC02 in D1.3, *“Quantification of customers load elasticity,”* where data shared by the HEMS customers can be used by third parties to assess their consumption elasticity when intervention signals are provided (prices or control signals).
(c) HLUC011 – PUC03 in D1.3, *“Assessing LV network operation status and the impact of load types,”* where data from smart appliances and shared via HEMS is used to assess the impact of loads (EV, heat pumps, amongst others) and their flexibility in low voltage grid operating conditions.

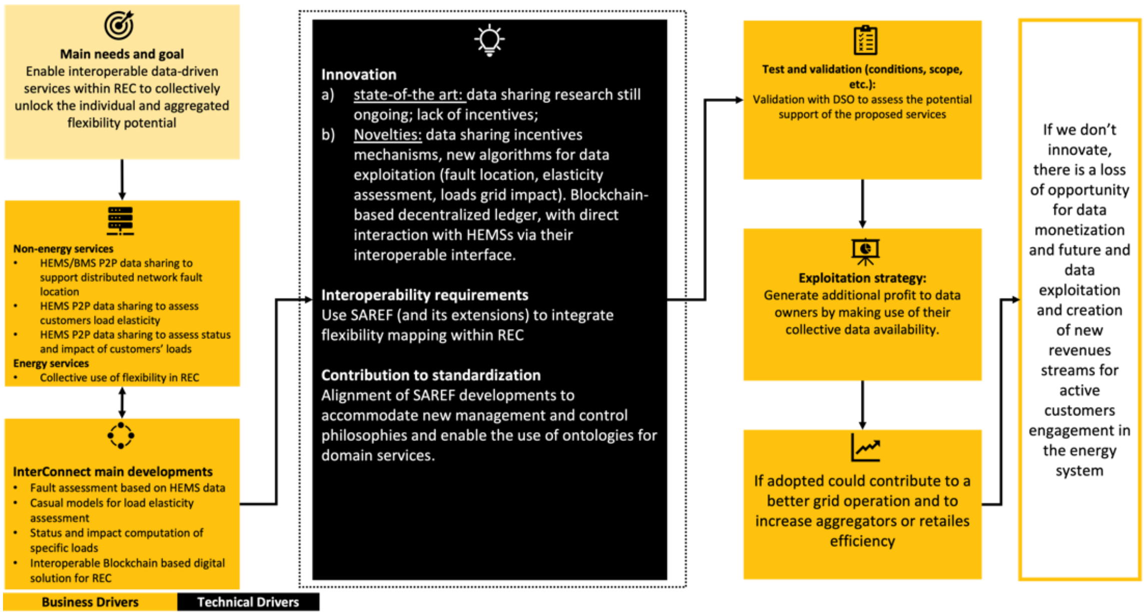


FIGURE 3 – INNOVATION PATH OF THE SERVICE "ENABLING COMMUNITY SERVICES VIA P2P AND BLOCKCHAIN ENABLERS FOR SAREF SERVICES"

DLT (Hyperledger Fabric) is also envisioned for REC management service (HLUC09, *“Enabling P2P flexibility sharing within renewable energy community via Blockchain enablers for SAREF services”*), conceived to engage customers into resources sharing (i.e., RES surplus and DSF). Flexibility based on shiftable loads and batteries is modelled with the novel concept of virtual battery that allows smooth integration into optimisation algorithms. In the first step. Two-level optimisation provides an initial flexibility schedule for individual benefit. The second step is the final schedule for the additional benefits from sharing unused resources at the community level. Finally, benefits are assessed according to different regulatory options, from those currently available (still too limiting) to more suited regulatory proposals. Moreover, the identified services will be supported by several partners representing different actors in the value chain, starting from the end-user device to the DSO. In most cases, these partners will integrate their platforms and applications with interoperable solutions instead of point-to-point solutions. Some play similar roles to other pilots and take advantage of the developed interoperable solutions.

[7] Prettico, G., Marinopoulos, A., Vitiello, S. (2021). Distribution system operator observatory 2020. JRC123249.

SERVICES WP7.2 - BE

Belgian Pilot innovation

The Belgian pilot is focused on bringing interoperable energy services towards existing and newly formed local energy communities (LEC). The demonstration took place on 8 locations (sub-pilots) in Flanders, each with its target audience, organisational structure, and implemented services. The distributed locations show the essential aspect of the InterConnect project. The services can be replicated on different demonstration sites, each using its energy management system. In that sense, the sub-pilots provide an ideal testbed to show the interoperability of the developed technologies between (student) flats, social housing, and tertiary buildings (e.g., day-care centres, retail). Although each sub-pilot has its own goals, the implemented services can be grouped into three sets of services:

1. Interoperable assets (e.g., white goods, EV charging infrastructure, (district) heating infrastructure, PV, and (neighbourhood) batteries) integrated on a district level in the context of a LEC.
2. We retrofitted (thermal) assets to provide flexible services to DSO and TSO.
3. We enable a P2P energy trading market within a residential LEC.

The services provided within the pilot are aimed both towards the end-users within the community and towards the grid operator (DSO) where relevant (e.g., flexibility services). In the different sub-pilots, the LEC takes on another form. For example, the Nieuwe Dokken sub-pilot sets up a cooperative to manage the community, while in the Antwerp sub-pilot, the community is built around students. Both examples require a different strategy for integrating assets in the community.

BE describes the first set of services. *E-Mobility Services for Energy Communities*, *BE. Building level services: Peak shaving* and *BE (figure 1) and Building level services: RES self-consumption* in D1.1. The main innovations for these services focused on interoperable asset integrations are:

- Use of innovative flex trading interaction scheme that leverages DSF beyond traditional demand response.
- InterConnect semantic Interoperability interfaces to develop SAREF compliant forecasting services (WP3) for local solar energy production, electricity demand, and heat demand accessible to third parties.
- Use a cross-sector and multi-utility business rule engine to integrate many interlinked assets, including a cost-driven heat vs electricity energy optimisation and tracking environmental benefits (water saved, CO_2 emissions avoided).
- Application of new business models to valorise waste energy in a nearby industry, including energy and clean water exchange.
- Use district and private unit data to inspire behavioural change. For example, visualised measured data can be the starting point for consumers to become more aware and active in their energy use.
- Provision of flexibility by the pilot to DSOs through aggregating district-level assets and intelligent private appliances.

As buildings become increasingly intelligent and active, new challenges arise for energy market actors. Building Energy Management Systems of such Smart/Active buildings take decisions that alter their behaviour (consumption and injection) and state (available flexibility) based on their opportunities and objectives in an unknown manner for external stakeholders. This makes traditional statistical congestion forecasting approaches based on historical data less effective. Furthermore, it makes it harder to judge what flexibility, to mitigate the congestion, can be provided by whom.

The USEF[8] (Universal Smart Energy Foundation) interaction scheme addresses this problem by proposing a DSO-Aggregator-BRP interaction scheme that adds an a priori flex activation check by the DSO. Aggregators are expected to communicate their planned flex activation, which they want to offer to BRPs, to the DSO. Thus, they can check whether the planned flex activations would result in grid congestions and, if they would, restrict the flexibility offered to ensure grid security.

[8] https://www.usef.energy/app/uploads/2021/05/USEF-The-Framework-Explained-update-2021.pdf

The **Flex Trading interaction scheme innovation** in comparison to the USEF interaction scheme consists of the following:

- It intensifies the interaction between the USEF' active customer' and the Aggregator beyond a static traditional Flexibility Purchase Agreement.
- It generalises the Aggregator role to 'Neighbourhood Energy Manager' or 'Local Energy Community Manager.'
- It enriches the interaction between the Aggregator / Neighbourhood Energy Manager / Local Energy Community Manager in two ways:
    - The DSO can provide dynamic grid constraints (power profile).
    - The Aggregator / Neighbourhood Energy Manager / Local Community Energy Manager can inform the DSO about the planned aggregated consumption and aggregated flexibility[9].

This flexibility trading interaction scheme will be **mapped on the SAREF** (and extensions) ontology to make it **semantically interoperable**. Specific focus will be on the **ontological definition of flexibility information exchanges** (i.e., how much flexibility is available when). In addition, the ontology must define a semantic flexibility representation that is (preferably) technology agnostic and easy to aggregate and that allows the determination of an optimal flexibility activation within the available flexibility.

Inducing behavioural changes in energy consumers is one of the biggest challenges of the energy transition, and it is precisely what the service *BE. Green progress bar service* tries to achieve. Energy metering data from the district is used to calculate and display, for example, the share of produced RES, while pilot inhabitants have access to their energy use data. This data allows for tracking the district's progress and can provide incentives for adjusted consumer behaviour. Although several variations of this service are implemented throughout the pilot, the consumer engagement strategy of the student Tower in Antwerp is focused on gamification to attain a change in student energy use behaviour.

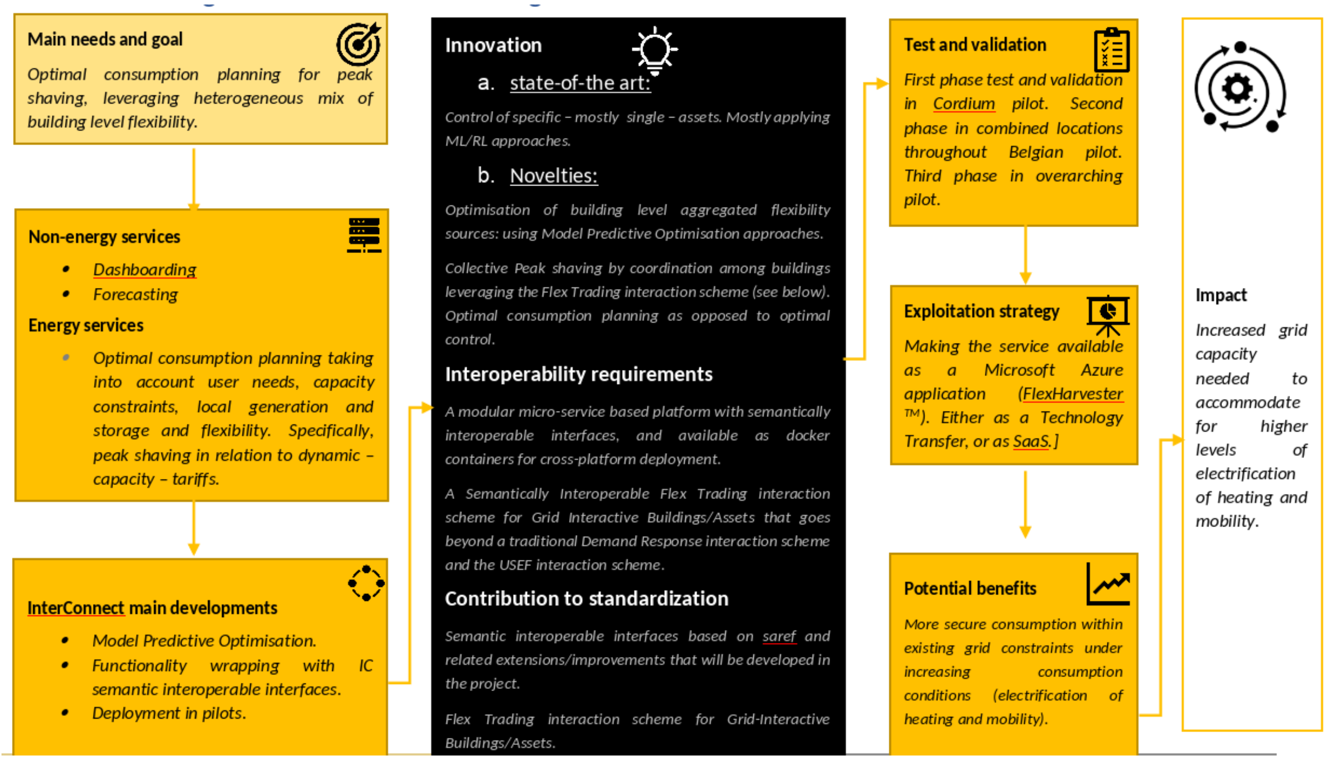


Figure 1: BE. Building level services: Peak shaving

[9] What USEF communicates as 'flexibility' to the DSO is a planned flex activation, i.e., planned – changed – consumption, not flexibility as such.

The extensive data collection at the pilot, both for private users and district-wide applications, allows for accurate forecasting models for heat and electricity demand. In addition, the use of such models can be offered to third parties by using the SAREF protocol.

BE describes the second set of services. *Energy flexibility service with thermal loads for individuals (Figure 2)* in D1.1 focuses on retrofitting (thermal) assets in energy communities. The main innovations are:

- Integration of end-users comfort feedback (one bottleneck from end-users in terms of flexibility potential[10]) with energy efficiency objectives and demand-side flexibility (DSF) monetisation through reduced consumption, self-consumption, and peak shaving optimisation every customer individually;
- The flexibility of retrofitted thermal loads can be complemented with other flexible devices (e.g., heat pumps, PV production, or EV charging points) through the interoperability framework (WP5) and the SAREFization of the service (WP3), which is a significant barrier for the integration of behind-the-meter heterogeneous devices and systems[11].

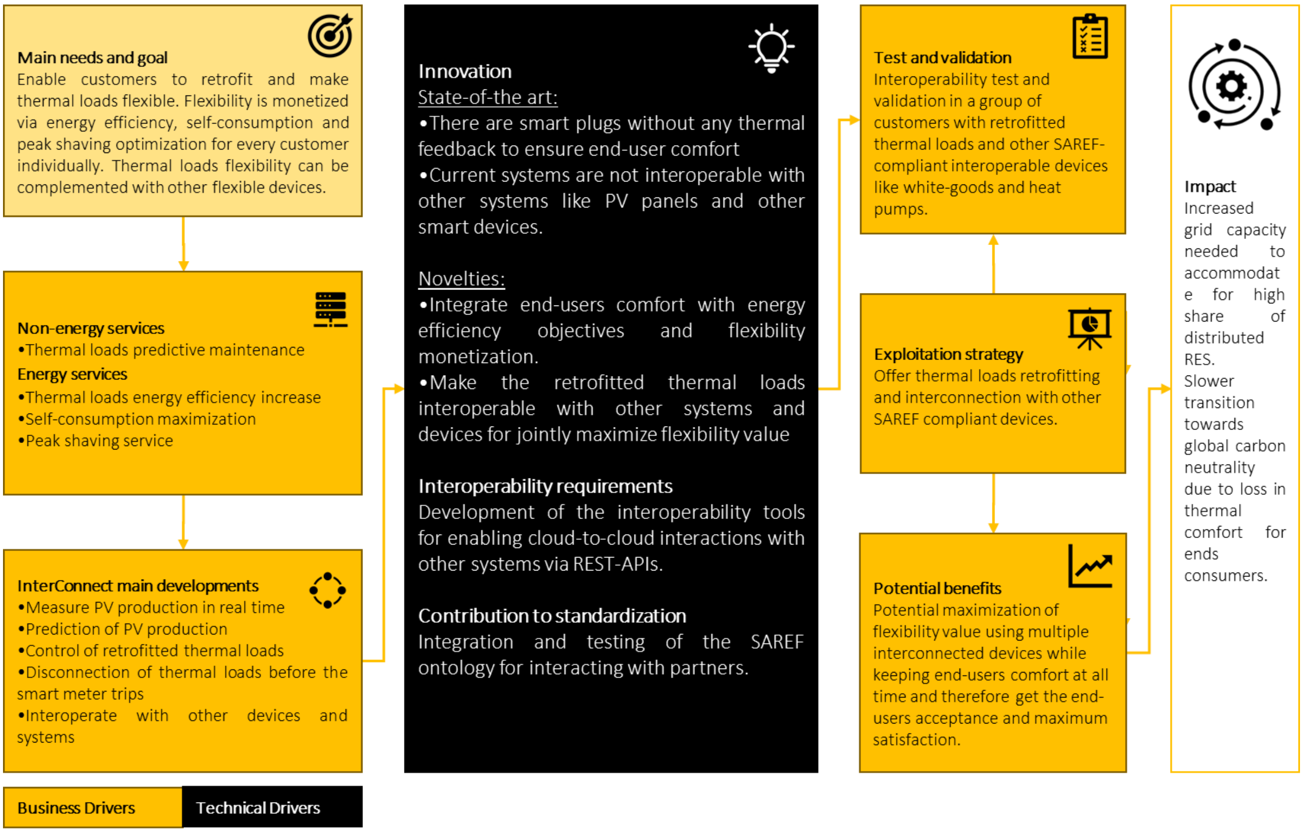


Figure 2: BE. Energy flexibility service with thermal loads for individuals

BE describes the third set of services. *Peak-shaving and self-consumption for local energy communities (Figure 3)* in D1.1. The main characteristics for these services, focused on enabling a P2P marketplace that will work via the Interoperability Layer of InterConnect (WP5) and use a blockchain as a ledger for all the transactions and smart contracts, are:

- This P2P marketplace will use a blockchain as a ledger for all the transactions and smart contracts. In addition, it will allow residential prosumers to trade any excess energy from their RES systems with peers.
- The marketplace should enable homeowners to sell their excess at a higher tariff than the retailers. In return, the buyers would buy energy at a lower tariff than the retailers.

[10] Pfeiffer, C., Puchegger, M., Maier, C., Tomaschitz, I. V., Kremsner, T. P., Gnam, L. (2021). A Case Study of Socially Accepted Potentials for the Use of End User Flexibility by Home Energy Management Systems. Sustainability, 13(1), 132.

[11] Phan, L. A., Kim, T. (2020). Breaking down the compatibility problem in smart homes: A dynamically updatable gateway platform. Sensors, 20(10), 2783.

- As described in BE Date's freedom of choice service, the marketplace will respect consumer data and allow stakeholders to connect and disconnect from the market.

The main innovation delivered in Interconnect is the **SAREFization of existing use cases**. Although peer-to-peer trading is not a new use case, the combination of several energy management systems engaging in a SAREF based peer-to-peer market is innovative. By using the interoperability framework, communities can choose and change the energy management system on a household and district level. More specifically, the marketplace will use the following innovations:

- the use of SAREF to exchange tariffs and energy data between HEMS's peers and the marketplace increases interoperability between systems and platforms;
- use SAREFized services from InterConnect such as demand-side flexibility and consumption and production forecasting to influence the marketplace to increase RES share, lower electricity bills and increase grid stability.

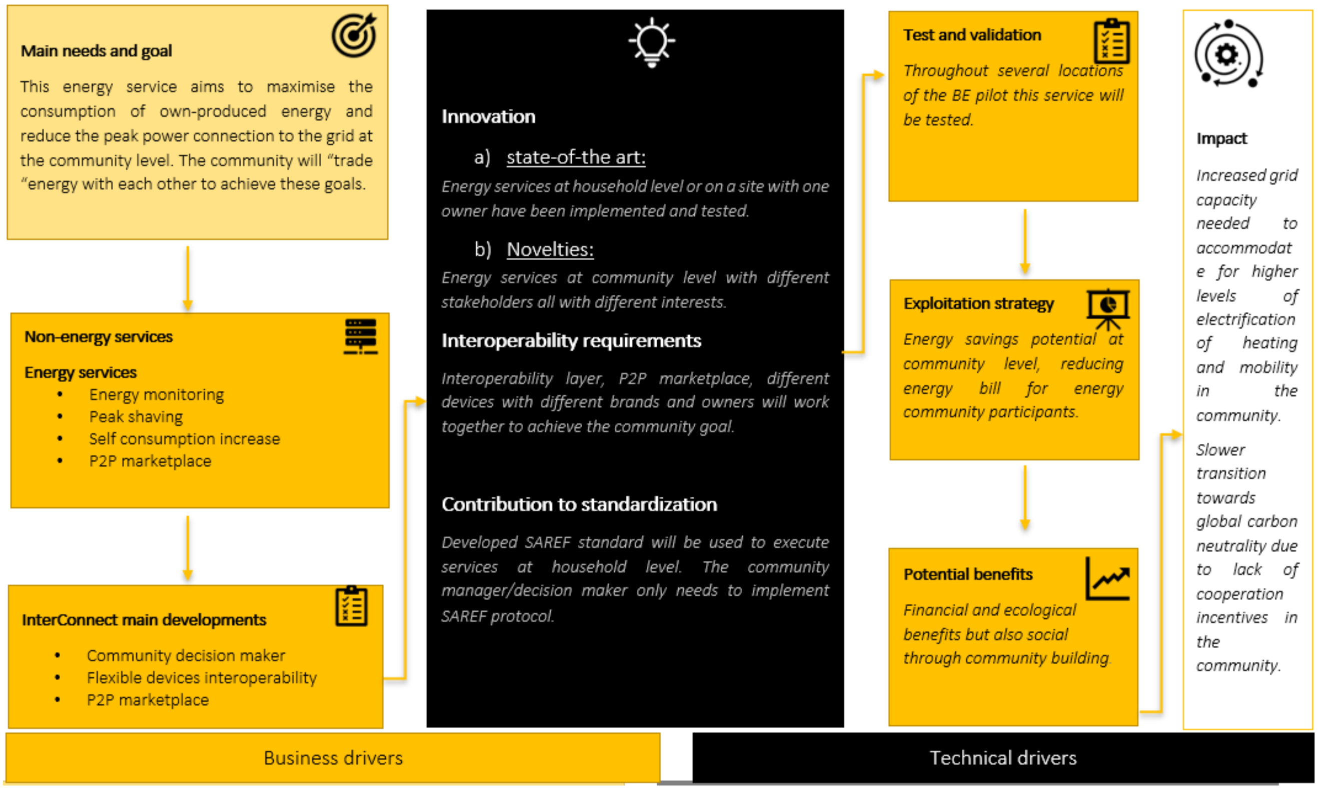


Figure 3: BE. Peak-shaving and self-consumption for local energy communities

SERVICES WP7.3 - DE

German Pilot innovation

The energy supply is becoming more and more decentralised and volatile, while at the same time, mobility and the heating transition are putting a significant load on the grid. The German pilot is focused on balancing RES production and demand by bidirectional end-to-end communication from the grid to the device level. The controllable loads EVs/EVSEs, heat pumps, local PV systems, and classical white goods networked by an energy management system are considered. The solution will be interoperable using EEBUS and SAREF, enabling different manufacturers or technologies to participate and scalable from residential to commercial buildings. For this reason, the German pilot will have a residential installation in Norderstedt with 50 buildings and a commercial facility in Hamburg with five hotels.

The implemented services correspond to the DSO. The customer needs and offers various cross-sector business models such as §9 EnWG (German legislation) conform contract design to provide incentives at times of power limitation and higher connection capacity approvals due to limitation capabilities.

The main innovations from InterConnect are:

a. D1.1-GE-S1[12]; D1.1-GE-S2[13]; D1.1-GE-S3[14]: Full chain standard-based bidirectional end-to-end communication from the distribution system operator (DSO) to interoperable devices in residential and commercial environments via BSI-certified SMGW infrastructure.

b. D1.1-GE-S2; D1.1-GE-S4[15]: Identification of consumption hotspots by DSO through standardised SMGW solution: SMGW meter data up to 1-second metering interval is provided via interoperable EEBUS or SAREFized service (on change, exceeded the limit, ...).

c. D1.1-GE-S2¸ D1.1-GE-S3: Dynamic grid support by power limitation on building or device level: in time reaction by the DSOs to power curtail consumption or local production to avoid overload scenario the grid via interoperable EEBUS or SAREFized service. Especially devices such as EVSEs/EVs or heat pumps are considered power curtailed as grid support. As a result, grid expansion can be avoided or way better planned.

d. D1.1-GE-S1: Grid support by flexible tariffs to use energy-relevant device's flexibility via EEBUS or SAREFized service: adapt power consumption to the availability of RES production through price offers. The flexible tariff service is supposed to work within the power constraints received from the DSO (innovation item c).

e. Incentive-based energy management: Negotiate energy consumption plans with devices with intelligence (EVs or heat pumps) to avoid loss of comfort, inefficiency, or conflicts with internal processes.

f. Dynamic AI-based power management of buildings: Avoid overload and underload by grid quality status. Grid bottlenecks or capacity requirements are calculated by Fraunhofer beeDIP platform.

The German InterConnect pilots will demonstrate an interoperable ecosystem to harmonise RES production and demand. Within the power constraints given by the DSO back-end (Stadtwerke Norderstedt and Energienetze Hamburg), the market may offer energy by flexible tariffs to influence the building's energy behaviour. Today, ecosystems do provide limited networking capabilities in terms of interoperability. The EEBUS and SAFRF standard will enable actual manufacturer and technology interoperability.

The SAREFized EEBUS communication to the building's EMS (from gridX and KEO) is established via BSI conform SMGW infrastructure and added value module (from Theben). The EMS interprets grid commands or tariff information to implement the power consumption or production setpoint or make price offers to the

[12] D1.1-GE-S1: Flexible tariff service

[13] D1.1-GE-S2: Power monitoring at grid connection point

[14] D1.1-GE-S3: Power limitation at grid connection service

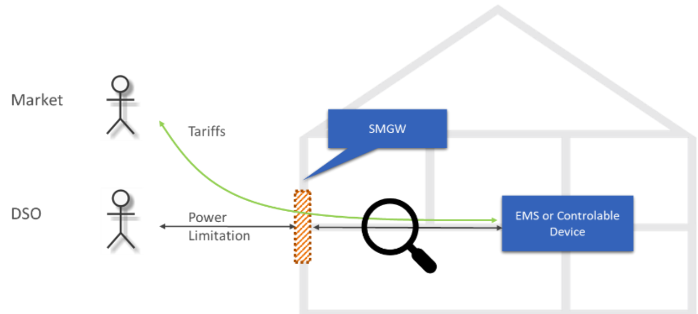
[15] D1.1-GE-S4: Fuse protection service

connected devices by the interoperable EEBUS standard. The devices will determine their charge or consumption plan based on their energy needs, flexibility, and price offer. The EMS may start renegotiating with a specific device (e.g., EVSE from Wirelane, heat pump from Vaillant or Daikin) if the requested energy goes not in line with the DSO's constraints. The device's flexibility of EVs and heat pumps is considered by optimising their operational costs through the incentive table approach. Details see "PUC4 - Time of use Tariff (TOUT)", "PUC 7 - Coordinated EV charging (CEVC)", and "PUC 8 - Incentive table-based power consumption management (PCM)".

A back-end service (beeDIP platform from Fraunhofer Institute) will provide a grid quality status to identify grid bottlenecks or capacity requirements in the commercial pilot.

Significantly the residential pilot will demonstrate an interoperable ecosystem where the DSO and the market will interact even at the same time. The DSO defines the power constraints within which the market, e.g., energy service provider or aggregator, may act.

The DSO will operate with the "power limitation at the grid connection service," The market will perform with the "flexible tariff service." These coexistent solutions are provided through BSI conform SMGW infrastructure, which is the innovation potential that could deliver high value for the following generation energy supply systems.



The innovation path of the "flexible tariff service" is described in Figure 1.

Figure 1 – Innovation path of the service "Flexible tariff"

The innovation path of the "power limitation at the grid connection service" is described in Figure 2.

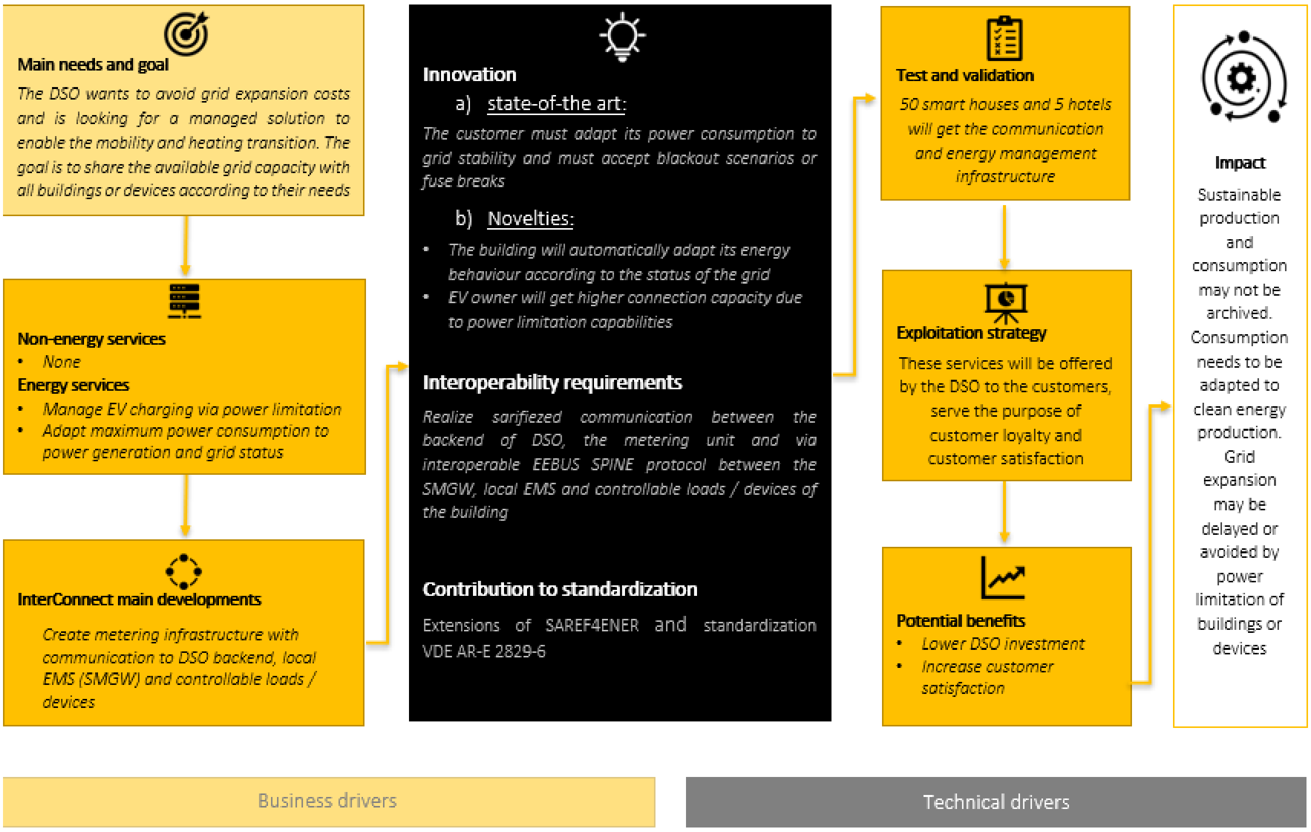


Figure 2 – Innovation path of the service "Power limitation at grid connection"

SERVICES WP7.4 - NL

Dutch Pilot innovation

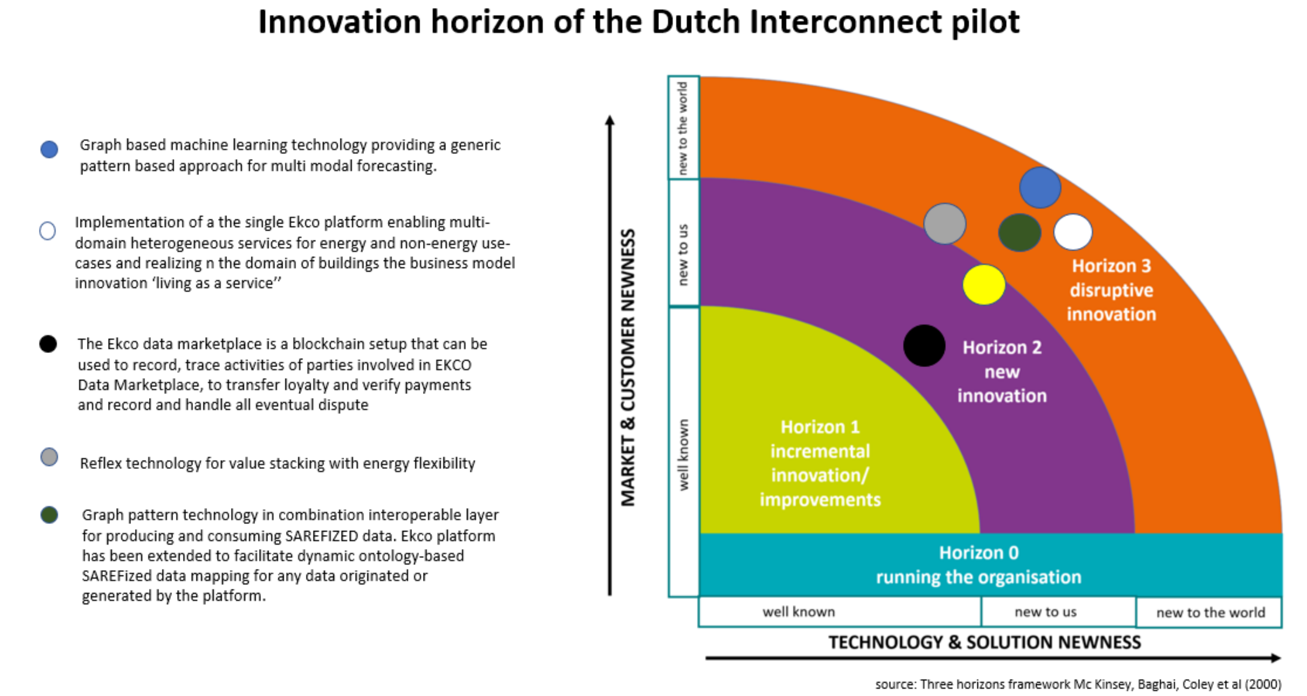
The Dutch pilot is developing a service concept installed in two different buildings, aiming at two distinct target groups: building owners and households. The focus is on reducing grid peak load, optimising RES use, and decreasing energy costs (HLUCs). The pilot approach will add several non-energy services for accessibility, health, safety, and comfort in the building. Moreover, it demonstrates a business model innovation in building, energy, and user-centric interoperable services. Providing the users with a physical and digital interoperable infrastructure boosts DSF from white goods and EVs. The final goal is to offer living-as-a-service, where users can easily connect all types of devices autonomously. With this intelligent infrastructure, the users are ready for the future and seamlessly allow endless scenarios.

The living-as-a service concept we are implemented in the Dutch pilot by offering the following services:

- Safety services: triggers from sensors alarm homeowners when intruders are detected.
- Health services: triggers from sensors inform homeowners about the CO2 levels in the home.
- Comfort services: homeowners can add their sensors to increase comfort in their home (intelligent switching, lighting, and more), and homeowners can get handyman services based on performance data from the installations in the house.
- Sustainability services: homeowners are informed about reducing energy bills and using the home.

To enable this set of services, the Dutch pilot is developing an integrated building and energy management system for the commercial premises and the households in the residential building a building and home platform. This combines hardware (gateway and essential appliances), connectivity, and software (e.g., forecasting, managing, and controlling all sensors, devices, and appliances). The most impactful innovations (depicted in Figure 1) from InterConnect for the Dutch Pilot are:

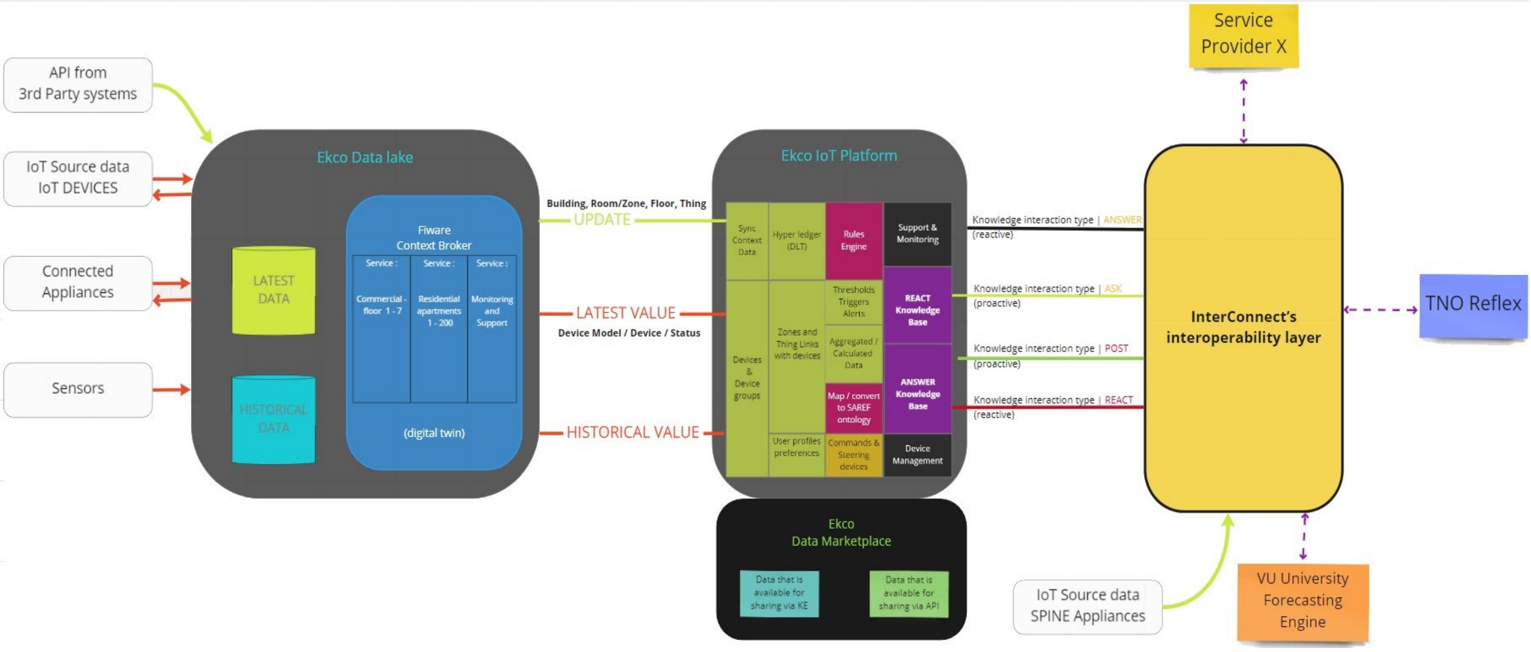
- Automation functionality (convenience), automation functionality (health) and Platform function, user interface, and Dissemination - Monitor and control. Ekco is the IoT technology platform behind these services, which process the data in the Dutch pilot. To extend the Dutch pilot with services, we create new functionality for this platform. Implementation of a single Ekco platform enabling heterogeneous services for above mentioned energy and non-energy use-cases and realising it in the domain of buildings the business model innovation 'living-as-a-service''. This also means households pay a recurring monthly amount for the service instead of selling devices.
- Platform function, user interface, and Dissemination - Monitor and control. The data marketplace behind these services is also a blockchain setup that can record trace data sharing activities of parties, transfer loyalty, verify approval for service-to-service providers, and record this.
- Energy recommendation and automation – Intelligent Building Management System (iBMS) - Monitor and control and Mobility - Green/Smart is charging for mobility. The technology behind these services is REFLEX. This technology enables value stacking across multiple energy markets (congestion management, dynamic tariffs, imbalance prices) with energy flexibility assets in the VideoLab and Next buildings, such as the innovative charge lounge for EV's. (See below for a detailed description). This service will also use the novel Relational Graph Machine Learning methods for forecasting and error detection (developed in Task 3.4). These will make learning over SAREF knowledge graphs that include various types and modalities (sensor values, geo-data, other).
- Platform function, user interface, and Dissemination - Monitor and control and Mobility - Green/Smart is charging for mobility. The innovation behind these services is graph pattern technology (developed in WP5 and WP3) in combination interoperable layer for producing and consuming SAREFIZED data. In addition, the Ekco platform has been extended to facilitate dynamic ontology-based SAREFized data mapping for any data originated or generated by the platform.
- Platform function, user interface, and Dissemination - Monitor and control. Related to the innovation identified in point a), the Ekco platform will enable complete but straightforward control for users over their homes. Furthermore, the service will connect to the novel Relational Graph Machine Learning methods developed in Task 3.4.



The next presents the innovation path of 'The Ekco IoT technology platform for the services automation functionality (convenience), automation functionality (health) and Platform function, user interface, and Dissemination - Monitor and control. This innovation will realise HLUC1 reducing energy costs, PUC6 Building and Home control, and PUC10 Send schedule and control energy device.

Figure 2 presents the innovation path of REFLEX technology for the services Mobility - Green/Smart charging for mobility and Energy recommendation and automation – Intelligent Building Management System (iBMS) - Monitor and control. We will implement HLUC 2 to reduce grid peak load with this innovation. HLUC optimise the reduction of RES, PUC7 Getting Flexible Tariffs, ..., from Energy Provider, PUC8 Getting DSO/Grid Tariffs, ... In addition, DSO and PUC10 Send schedule and control energy devices.

Figure 2 - Innovation path "'Ekco IoT technology platform for the services automation functionality (convenience), automation functionality (health) and Platform function, user interface and Dissemination - Monitor and control''.



The main innovations from InterConnect for the Ekco platform and features are:

- The platform has been extended to facilitate dynamic ontology-based SAREFized data mapping for any data originated or generated by the platform.
- The platform can transform NGSI and NGSI-LD based Smart data models[16] from the FIWARE[17] stack into SAREFized graph patterns.
- At its core, the data lake is a managed FIWARE Orion context broker[18]; this adds another layer of interoperability between highly innovative cities in this project. By having a scalable infrastructure also after this EU project.

The data marketplace is a blockchain setup that can record and trace parties involved in Data Marketplace (structure depicted in Figure 4), transfer loyalty, verify payments, and record and handle eventual disputes.

- The data marketplace allows all marketplace users and or suppliers to have wallets to hold loyalty tokens to transfer value linked to transfer any data through the Interconnect Interoperable framework.
- The platform will also provide data storage, transformations, and marketplace functionalities (off-chain).
- In addition, the data marketplace adds secure blockchain verified authentication and dispute channel to the Interconnect Interoperable framework for the Dutch Pilot use cases, thus allowing a security enhancement to the standard implementation.
- The data marketplaces use DLT (Hyperledger fabric[19]) blockchain technology (for user-data authentication on the market for services.

Exploiting these technology innovations with the critical business partners has uniquely enabled real-world fusion for a new take on a relatively “technology” based business model - “as a service” model. The Dutch pilot partners have applied this model to smart homes, building and IoT technology, and Reflex technology for value stacking with energy flexibility.

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[16] Fiware smart data models. These data models have been harmonized to enable data portability for different applications including, Smart Cities, Smart Agrifood, Smart Environment, Smart Sensoring, Smart Energy, Smart Water, Smart Destination, and Starting Smart Robotics and Smart Manufacturing. Available at and https://github.com/smart-data-models https://smartdatamodels.org/. And https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Data+Models and http://fiware.github.io/specifications/ngsiv2/stable/

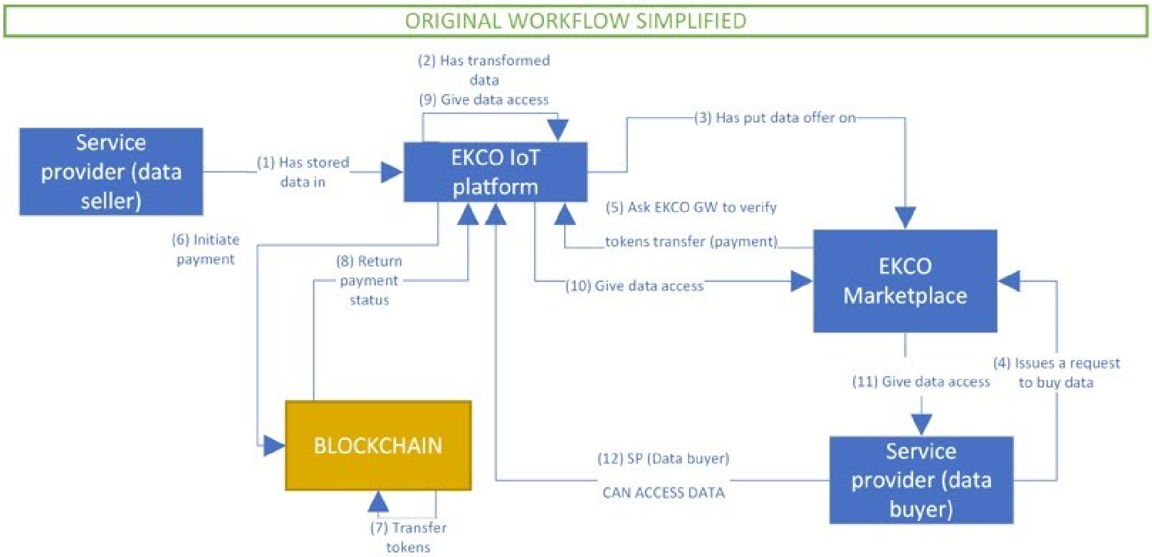
[17] The Open Source platform for our smart digital future - FIWARE - http://fiware.org

[18] Fiware Orion context broker - https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Orion+Context+Broker

[19] Hyperledger Fabric is intended as a foundation for developing applications or solutions with a modular architecture. https://www.hyperledger.org/use/fabric

Within the Dutch pilot, the Ekco IoT technology platform is being used in the following use cases:

- PUC1A BMS (sensors and devices);
- PUC1B EMS (devices);
- PUC1C Smart Meter readings;
- PUC2 EVs (and Charge Lounge);
- PUC3 Battery;
- PUC4 PV cells;
- PUC5 Get user data and feedback;
- PUC6 Building and Home Control (and local technical aggregation if needed);
- PUC10 Send schedule and control energy devices.



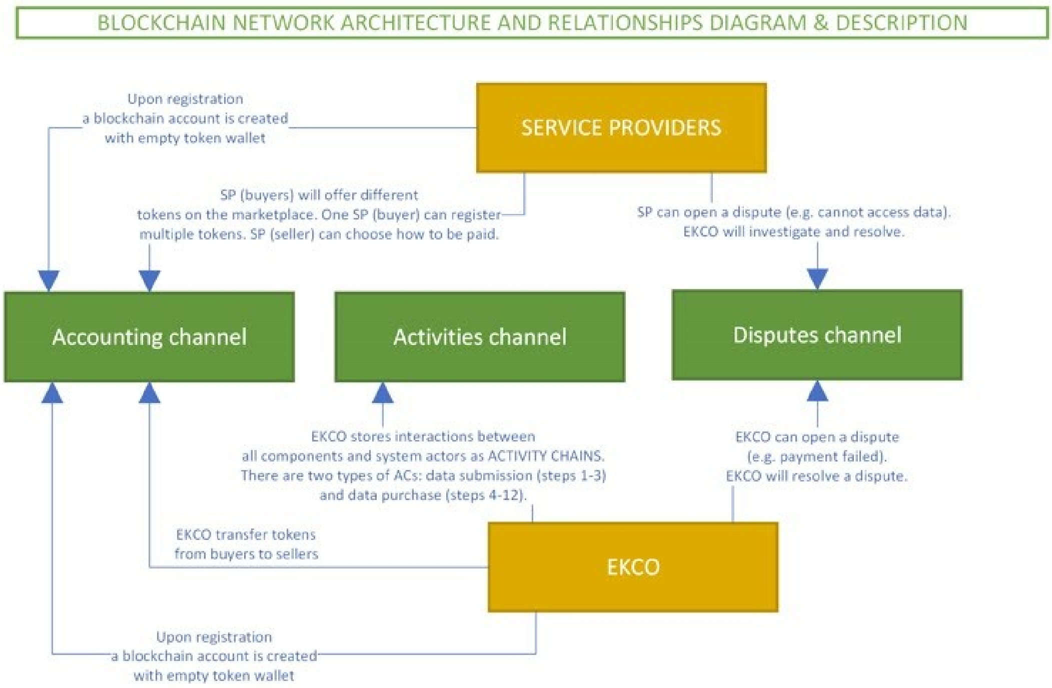


Figure 5 - Innovation path of the reflex technology that enables the services: Energy recommendation and automation – Intelligent Building Management System (iBMS) - Monitor and control and Mobility - Green/Smart charging for mobility.

REFLEX is a platform that aggregators can use to maximise the value of flexible energy assets in their portfolios by value stacking this flexibility across multiple energy markets. The focus of REFLEX lies on assets in the built environment. However, the combined flexibility of assets in the built environment represents a considerable potential that largely remains unused. The main reasons for this are the wide variety of devices (and their proprietary protocols) in the built environment, leading to high integration costs and low flexibility value margins for individual assets.

REFLEX combines the following innovations to tap into the flexibility potential within the built environment:

- The S2 flexibility standard (prEN50491-12-2) provides a uniform and generic way to describe the flexibility of a wide range of assets found in the built environment, such as PV, HVAC systems, EV, stationary batteries, ...
- The merging of S2 flexibility concepts with SPINE/EEBUS flexibility concepts in the SAREF(4ENERGY) ontology.
- Graph Patterns combine with the Interoperability Layer and the ontology to exchange flexible information between REFLEX (aggregator platform) and platforms directly connected to assets such as the Ekco platform described above.
- Planning algorithms that user-value stack to maximise the value of flexible assets. These planning algorithms combine flexible information from the assets with input from multiple markets/energy services such as congestion management, day-ahead trading, intra-day trading, and imbalance prices. The planning algorithm provides detailed insights into how flexibility can best be exploited across the different energy markets. Multiple scenarios can be evaluated to find the best one given the constraints on the various markets.
- An operational algorithm provides instructions to the flexible assets to follow the selected scenario as closely as possible.

Within the Dutch pilot, the REFLEX technology is being used in the following use cases:

- PUC7 Getting Flexible Tariffs .... from Energy Provider;
- PUC8 Getting DSO/Grid Tariffs .... DSO;
- PUC10 Send schedule and control energy devices.

SERVICES WP7.5 - IT

Italian Pilot innovation

The Italian Pilot involves residential social housing that will be provided with a dedicated digital energy management platform to monitor and control IoT-powered white goods. The Social districts where Planet Smart City operates are already supplied with the Planet App, a tech solution for estate and community management to empower people with control and management capabilities over building automation systems, among other features. Scheduling and power profiles will be grouped onto a cloud IoT Hub. Consumer behaviour-centric deep learning algorithms will provide enhanced centralised energy management to accomplish electrical distribution grids requests regarding energy and reactive power, thus enabling more efficient distribution of energy. Furthermore, the proposed centralised approach will postpone grid reinforcements (i.e., upgrading secondary substation power rating and retrofitting cables. Leveraging these resources, the Italian Pilot will pave the way to group and organise residents into local energy communities (LEC) that will boost local flexibility services from white goods, e.g., enable the DSO to request optimisation of load consumption profiles at the district level. In addition to the energy services, social innovation strategies will be tested to increase awareness of energy usage at the end-user level by co-designing or tailoring digital service's design to enhance its acceptance and effectiveness.

The district-level energy management system defined the first set of services, driven to empower end-users in leveraging ICT for energy services.

The main innovations from InterConnect for the proposed services are:

a. Implement modular architecture with a centralised energy management system to enhance optimal grid operations. The algorithm proposed will be empowered with machine learning techniques to profile the prosumers digitally at the district level, promoting a predictive optimisation of energy capability. In terms of innovation, the service will target a digitalisation of energy behaviours at the district level (community-wise), introducing and testing the role of a social aggregator to capillaries inclusion and capability in accessing the emerging market of flexibility services.
b. Use of SAREF to exchange flexible information (availability and activation) between devices and the aggregator permitting a seamless data exchange independently from the infield devices, thus scaling up seamlessly the energy capacity reachable for the flexibility services.
c. Raise the sense of belonging of residents in the neighbourhood and their feeling of contributing to a common goal as a community. This is key to transforming simple energy consumption into energy welfare with a relevant social impact. The community will be deeply engaged by the community managers throughout the Planet App to structure and leverage the app's practical energy flexibility feature. Guidelines for sustainable behaviours (energy-related, among others) will be made available to ensure a common understanding of the hot topic. Promotional awards will be accorded at the community level to reinforce the sense of belongings and subsidiarity in reaching common goals. Rewarding will nudge behavioural changes in making use of energy.

<u>Energy management at the LEC level (social housing)</u>

The Pilot will demonstrate an interoperable architecture of digital monitoring and control IoT platform (from Whirlpool and Planet) that enable exploitation of flexibility from the washing machine at the residential premises, which will be aggregated by a retailing company (which RSE simulates bidding process) for participation in the wholesale electricity market and provision of system services to the DSO (which RSE simulates activation signals). The goal is to optimise smart appliances (washing machines) to avoid congestion in the critical hours of the day and reduce CO_2 emissions, maximising RES usage while promoting a conscious use of electricity.

The innovation of the technical aspects is in the way flexibility will be provided to both aggregator and DSO. In Italy, other pilots on LEC are currently based on flexibility from battery storage systems or EV charging. In

InterConnect, the flexibility will be provided by an intelligent appliance (a washing machine), which is more challenging from both management and a user engagement point of view but has a significantly greater potential catchment area. It is essential to remind that this Pilot targets social housing, and therefore it is more likely to find white goods like washing machines than storage or EV.

As stated before, the challenging part is engaging and especially keeping engaged users. This is the real core of the Pilot as it has a very high impact in managing the potentially available flexibility. The flexibility provided by white goods is not directly controllable by the aggregator or DSO, that is the opposite of the case in which flexibility is provided by battery storage system or EV charging (in Italy, aggregator or DSO can have direct control over them, making it simple to provide flexibility when required).

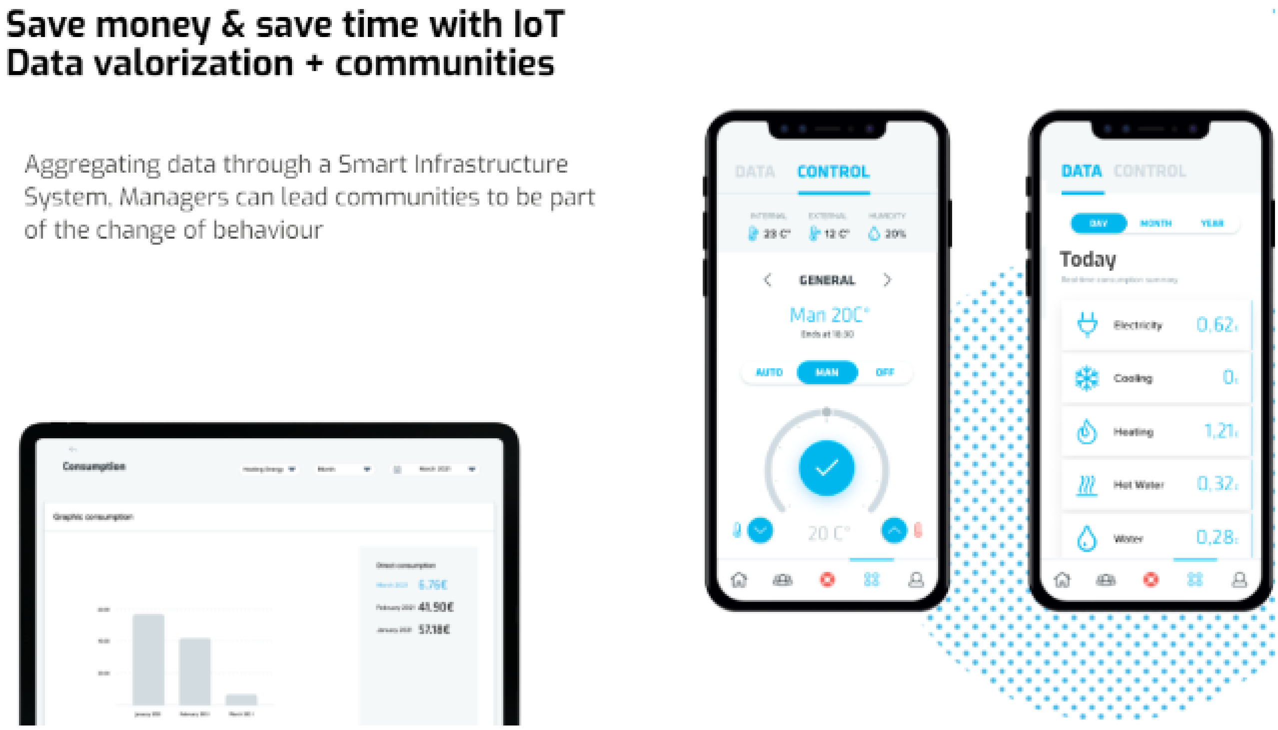
Also, it is crucial to do not to annoy users. For example, shifting the start time of a washing machine's washing cycle impacts users' habits and comfort. So, it is essential to ask users the time slot they accept such a shift. Also, it must be left to the users to perform a washing cycle when they prefer, even if it is not scheduled before. If such precaution does not consider, the risk that the users will relinquish to participate in the flexibility service is not negligible. One way to mitigate such a risk is gamification. For example, organise a challenge between users to establish the most virtuous ones. Another way that represents an innovation brought by the Pilot is to offer the users the possibility to unlock additional features or perks with the continuous use of the app to provide their flexibility, as stated in the service *"Unlock Perks with Use."*

Within the "***digital platform for end-users control and awareness,***" primary use case -***PUC1*** - the functionality of sending notifications to the end-users through the Planet App will be implemented to engage them to be part of a LEC. With an additional gamification add-on, the engagement will be investigated by unlocking benefits and perks whether the end-users rescheduling of electrical loads tips is met.

Figure 1 – Innovation path of the service "digital platform for end-users control and awareness."

End-user receives alerts and notifications about:

- remuneration status for the flexibility granted;
- information about incentives from aggregator and timing;
- status of connected devices;
- load forecasting;
- benchmark based on historical data analysis.



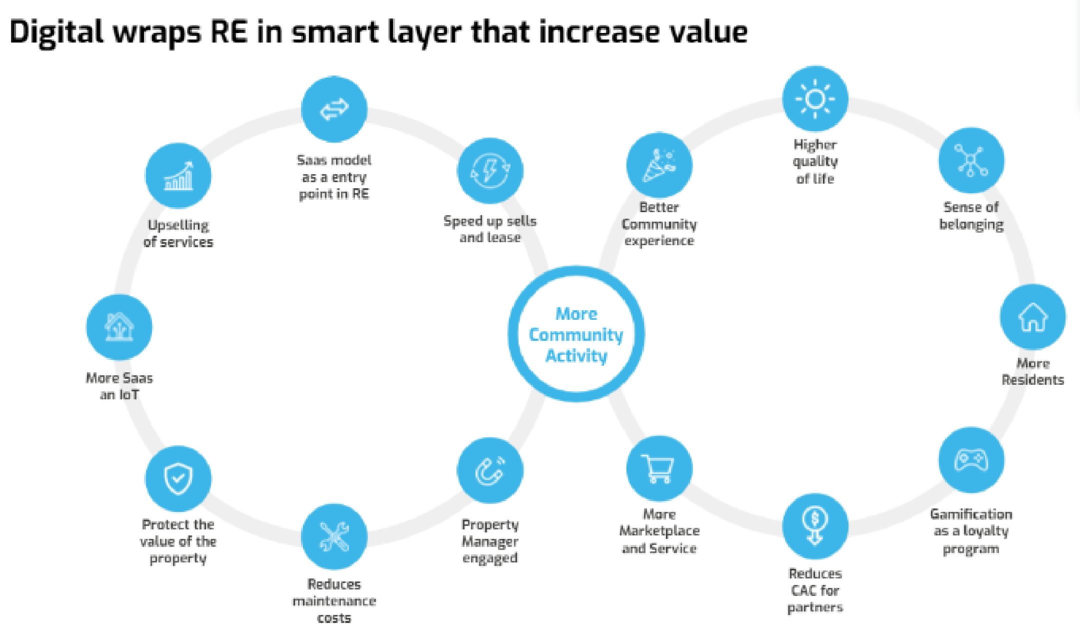
<u>Social Innovation</u>

The InterConnect project is a critical step towards creating an active energy community in the Moneta neighbourhood.

Energy communities are citizen-driven energy actions that pave the way for a clean energy transition and a more significant mobilisation of fellow residents. In the Moneta neighbourhood, the project aims to engage up to 130 families guided and supported from the beginning. They will participate throughout the period by providing feedback and giving their inputs. In addition, the Italian Pilot will empower experimenters with digital capabilities, guiding them in a radical change of common behaviours such as the way they are making use of electrical devices (e.g., the washing machine), shifting the energy consumption from a need to a service they can offer.

By supporting citizen participation in this energy project, we reach several goals related to both energy efficiency and social innovation. The objective is to make the residents feel more aware of energy flexibility and sustainability and more empowered by giving them the chance to contribute actively. The initiative also aims to raise their sense of belonging in the neighbourhood and contribute to a common goal as a community. This is key to transforming simple energy consumption into energy welfare with a relevant social impact.

Therefore, the community will be highly engaged in the project activities, letting them experience a way of living more participated and social thanks to both the community managers in situ activities throughout digital services. The participation in the "virtual" flexibility market will be ideally remunerated with peaks (HLUC Unlock Perks with use) for the benefit of the whole community (toolkits, free gardening, free access to spaces such as cinema, among others), thus amplifying the sense of belongings to the community itself. This process will speed up sales and lease and upsell services, especially digital ones.



In addition to the energy mentioned above and related social innovation, an innovative approach on data sharing procedures to guarantee compliance with regulation has been discussed and defined in the primary use case ***Interoperability and availability of solutions*** where end-users provide consent to the Manufacturer to share data about specific devices with Energy Manager. Device pairing to foster a seamless data flow and collection, thus enabling management and control capability at a granular level.

Leveraging to single DPIA -DPP and cyber security procedures of single stakeholders involved in realising the use case, the service will be empowered with a shared understanding among the companies to pursue a proper, effective, and transparent data flow. The end-user will be asked to agree on terms and conditions with just one stakeholder (Planet App) as a single touchpoint, having met privacy by joint design agreement with all engaged microservice providers.

SERVICES WP7.6 - GR

Greek Pilot innovation

The Greek pilot is focused on providing innovative services targeted towards transforming how household consumers perceive and interact with the energy grid in a new digitalised and democratised energy domain. Services range from ***grid-centric,*** focusing on harnessing consumers' flexibility, to ***human-centric***, involving the more active participation of consumers for improving their energy efficiency, incentivised by environmental and pricing benefits. SAREF acts as the cornerstone of the interoperability capabilities developed within the project, resulting in a set of services that seamlessly combine heterogeneous data sources and APIs. Essentially, SAREF's importance for the Greek pilot is twofold: (a) it enables the six different partners to integrate their services to realise the foreseen use cases; (b) it will allow third parties that will team with InterConnect through WP8 Open Calls to integrate their prototypes or offer their applications, by using SAREF as an SDK on top of the Greek pilot ecosystem. A representative example that highlights SAREF's importance is the integration of a mobile app with three different data providers, which would otherwise require the development of 3 different components by the mobile app to f...h the necessary measurements, instead of just a single SAREF component capable of interacting with all the 3 data providers.

Overall, 9 High-Level Use Cases (HLUCs) and 13 Primary Use Cases (PUC) comprise the four services defined in D1.1. Namely, the following overarching services have been described, highlighting the capabilities of the Greek pilot ecosystem: (S1) "Energy Efficiency" including use cases that enable consumers and grid operators to be more energy efficient; (S2) "User Engagement" including those use cases that aim to familiarise the citizens with novel technologies to their own and the social benefit, while harnessing the power of the crowd; (S3) "Non-Energy Services" including use cases that indirectly relate to energy, aiming at offering home comfort and "peace of mind"; (S4) "Data Analytics Services" including use cases such as modelling and prediction of the end-users consumption behaviour and recommendations for energy efficiency.

The main innovation areas of the services developed in the Greek pilot are the following:

- Design and implement innovative Demand-Side flexibility services based on Machine-Learning algorithms (including Deep Learning techniques). By exploiting historical energy consumption datasets of a household, a service can forecast the consumption within the next 24 hours for the different appliances or equipment. Suppose this predicted consumption (from a single household) is aggregated to others from the same area (e.g., district). In that case, the "flexibility requester" can be informed about the peaks that will occur the day after in a particular area. With this knowledge, the "flexibility requester" can decide: 1) how to avoid specific peaks and hence request the users to change their behaviour; 2) the type of incentive that should provide. One important novelty is that the forecast is generated for each appliance and equipment in the household, considering that the consumption is significant, regardless of the manufacturer. (S1, S2, S4).
- Novel twists in currently existing services that offer personalised recommendations, crucial insights, and educational material to the consumers, based on behavioural analysis of their consumption patterns and characteristics, energy profiling, time-series, and non-time series data clustering, and novel deep learning methods to individually forecast their behaviour with a single global model that learns to distinguish the different consumption patterns and characteristics of different types of consumers.
- Leveraging crowdsourcing mechanisms through offering attractive incentives to the consumers, the more significant impact for the demand response actions and energy savings, in general, can be expected. More specifically, in addition to the novel consumer-level demand forecasting models, the system will also incentivise users to submit their plans/predictions for their household's energy consumption, with multiple benefits: further increase in the individual consumer forecasting accuracy for the provider, less erratic energy consumption by the users (since they will be awarded to do so), higher accuracy the of the predictive AI models. (S1, S2, S4).
- Leveraging information from providing non-energy services (e.g., home comfort, physical security) to residential users for energy efficiency purposes, utilising information gathered from non-energy sensors without compromising the services themselves. (S1, S2, S3).
- Data analytics services for consumption practices recommendation and demand forecasting through Machine-Learning algorithms. The service uses data from various sources as input. It provides analysis of energy consumption either for the home as a whole or for specific devices - depending on the object

that is being monitored and analysed. Innovative algorithms based on Recurrent Neural networks are utilised for providing short or long-term forecasts. (S1, S2, S4).

- Design and implementation of an end-to-end architecture (based on the InterConnect reference architecture) combining the developed SAREF-ized services with existing open-source home automation systems (e.g., OpenHAB, home assistant) offering interoperability across a wide range of commercial sensors (energy and non-energy ones) from different vendors, supporting various access technologies. (S1, S2, S3).

To realise the pilot's objectives, partners will interconnect their IoT infrastructures with the services built in the context of the project for implementing the individual use cases and forming the ground for technical, business, and social innovation is driven by:

- A complex IoT infrastructure comprises 270 households equipped with smart meters, custom IoT gateways, sensors, and smart appliances with rich features for monitoring, remote control, and automation capabilities. A diverse environment with a set of heterogeneous devices (such as smart meters, smart switches/plugs, smart light switches, activity detectors, door/window sensors, temperature/humidity/fire/flood sensors, CO2, thermostats, ACs/HVACs, sirens/strobes, IR hubs, casting devices such as Google home/Alexa/TVs, ...) from different vendors (Aeotec, Fibaro, Blitzwolf, sonoff, shelly, Heiman, inner, aqua, Xiaomi, Google Nest, Amazon, Samsung, Sony, Toyotomi, Mitsubishi, Daikin, ...) and technologies (Wi-Fi, z-wave, Zigbee, BLE, ...), and back-end services (storage, fast data retrieval through open APIs, data processing and visualisation), by three different partners (COSMOTE, GRIDNET, and HERON) who integrate their IoT households and services rendering them SAREF compliant.
- An advanced DR environment (DR-solution by INETUM) where system operators can proactively shift the consumers' appliances load based on consumption forecasts and their offered flexibility, while at the same time reactively responding to unforeseen events in real-time by disabling appliances (for which the user has timely provided permission) through the responsible device manager (EMS) to avoid blackouts.
- Continuous engagement and involvement of consumers in the decision-making process through a mobile app developed by AUEB transforming the Grid-Consumer relation from a linear one-way communication to two-way communication where consumers interact and respond to Grid needs, either manually by following alerts and push notifications or automatically by providing their flexibility preferences and their consumption forecasts in a crowdsourcing manner to improve Grid forecasts. The consumer feedback will be incorporated into the deep learning and recommender system models, continuously re-trained throughout the pilot to provide a more personalised experience to the users and increase the acceptance potential of the proposed energy-saving recommendations.
- Extensive data analysis to process high granularity data from many households, along with a novel behaviour modelling and forecasting approach based on consumer profiling, time-series & non-time-series clustering, and a generalised deep learning architecture (HLUC 7, PUC13) trained on the whole customer base, capable of conducting accurate demand forecasts even for new households with few data available. This approach will enable a novel demonstration where the energy consumption behaviour of many consumers will be modelled and forecasted using a single AI model that is more "intelligent" compared to a setup with a separate model for each household while also being scalable for large-scale utility customers bases and can provide accurate predictions even for new consumers that the AI has never seen before[20].

The essential characteristic of the ecosystem mentioned above is that all services are translated in a common substrate through SAREF, thus minimising the integration efforts needed to realise such complex scenarios. The service components described in the 13 PUCs of the Greek pilot exchange information using SAREF endpoints simplify the development/integration of software service components among the six different partners. Consumers' data (energy and non-energy related), DR signals, load forecasts, and recommendations are translated and communicated with SAREF. An alternative approach that would not use SAREF would require three more software components to integrate with the APIs from the three different data providers.

[20] Spiros Chadoulos, Iordanis Koutsopoulos, and George C. Polyzos. "One model fits all: Individualized household energy demand forecasting with a single deep learning model." Proceedings of the Twelfth ACM International Conference on Future Energy Systems. 2021

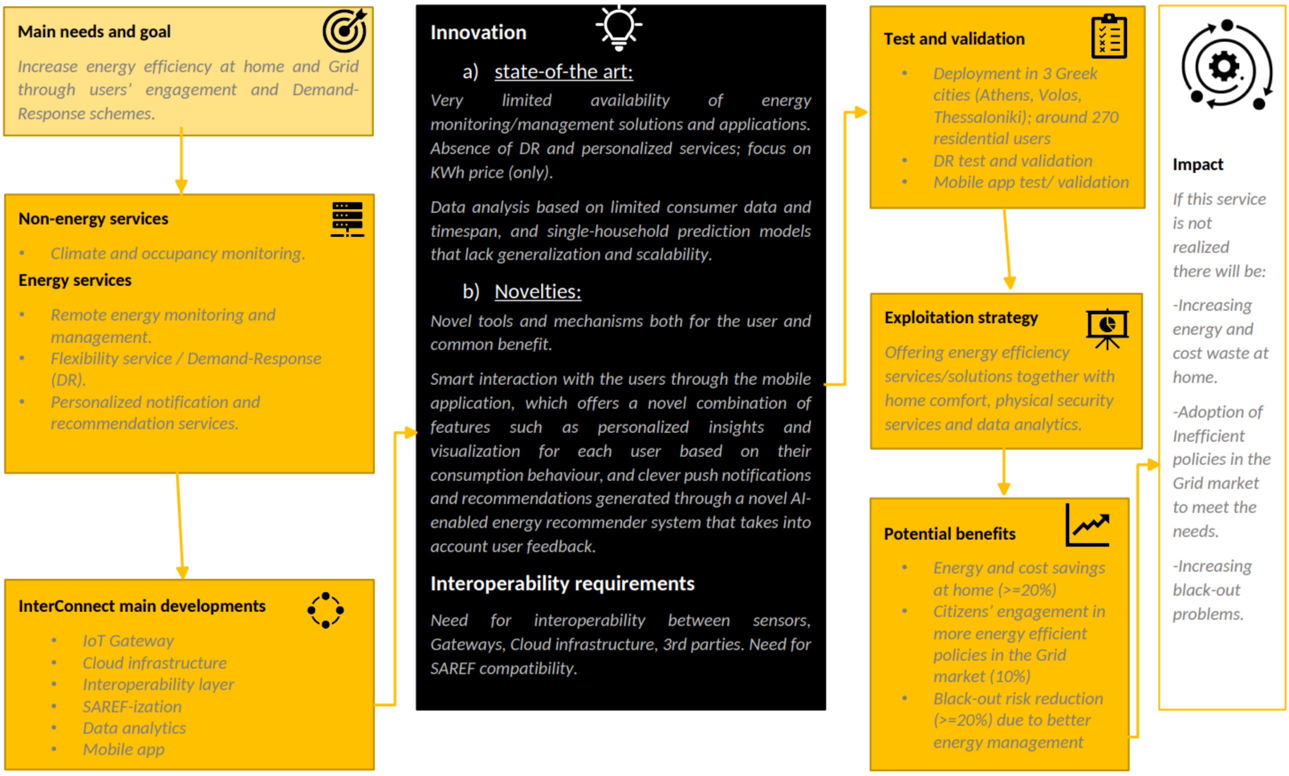


Figure 1 - Innovation path of the service "Energy Efficiency."

The overall goal of "Energy Efficiency," as shown in, is to provide the means and tools to grid operators to protect their assets and increase the energy awareness of society by improving the consumers' behaviour. It should be highlighted that several of the following high-level use cases (see D1.3) are contributing to the overall innovation of that service:

(a) HLUC1 "Energy Monitoring & Management," where technical innovation takes place by interconnecting various devices and appliances by different vendors, offering remote control capabilities in addition to monitoring, while everything is realised through SAREF.
(b) HLUC2 "Home comfort" where occupancy-related information is combined with heating and cooling adjustments (temperature increase/decrease, switch-off).
(a) HLUC3 "Flexibility Provision," where grid operators offer incentives to consumers for the latter to show their flexibility. The incentives will include gamification points which the users can later exchange for rewards. Furthermore, the mobile app incentive mechanism will personalise the incentives sent to consumers to achieve a greater acceptance probability.
(c) HLUC5 "Security services," concerning a novel, innovative physical security solution supporting energy efficiency indirectly, as an add-on, as follows: upon setting the user the alarm on (upon leaving the house), a predefined set of, e.g., light switches, A/C could be switched off automatically. Suppose the user forgets to arm the alarm. In that case, this could be done automatically, based on occupancy-related information, lack of activity, ..., derived from various sensors such as door/window, PIR, mobile phone location/activity.
(d) HLUC6 "Increase CO2 savings and become eco-friendly", where we focus on changing consumption behaviour by providing them real-time feedback and awareness about their impact on the environment.
(e) HLUC8, "Unified User Interface Application," is a mobile application that helps the users better understand their consumption characteristics through a unified interface and notification system, regardless of the manufacturer of their appliances.

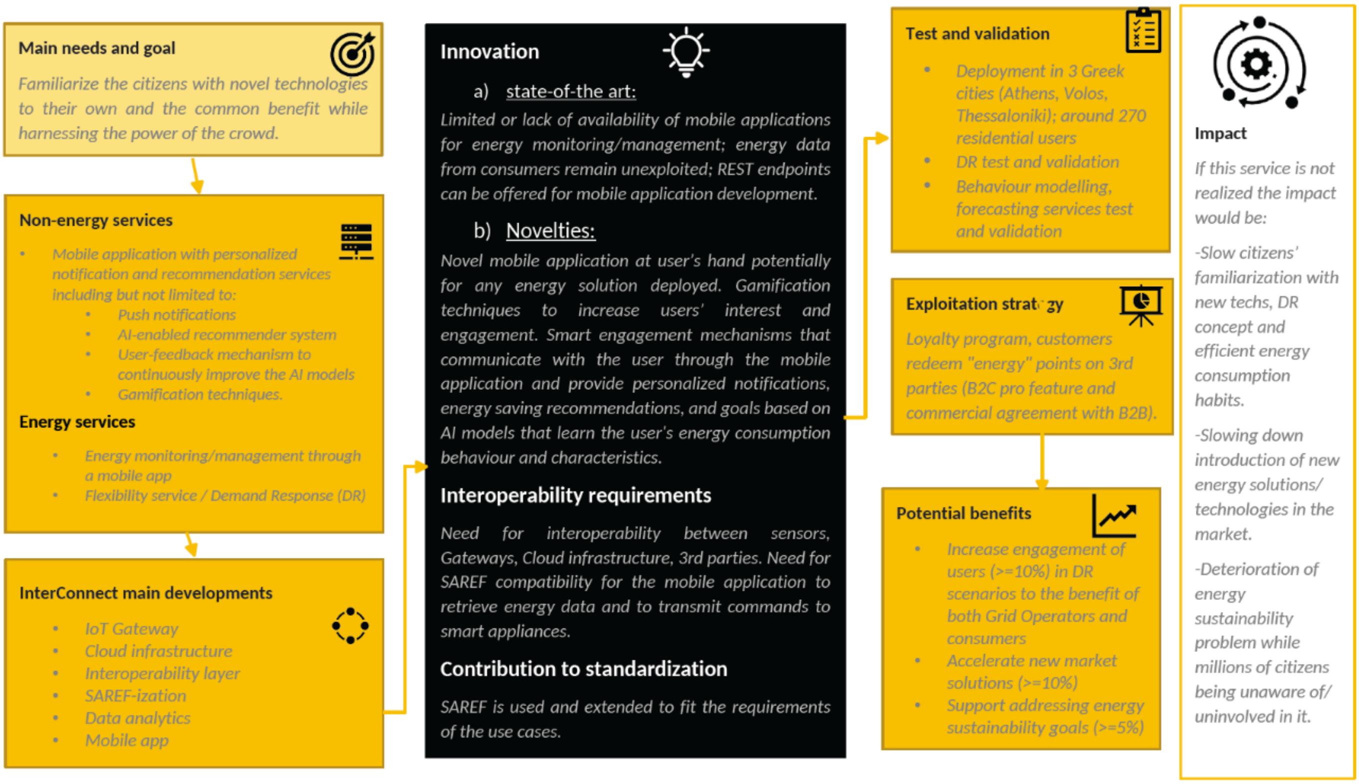


Figure 2 - Innovation path of the service "User engagement."

User engagement in the pilot activities is of paramount importance to achieve all the planned goals in the innovation path depicted. The main drivers that will accelerate the adoption of the new services by the consumers are the availability of real-time data (smart meters, sensors, user feedback) and a unified user interface application (HLUC8). Furthermore, being able to interact with the end-users directly will allow the implementation of gamification techniques (HLUC7 - PUC11), solicitation of flexibility preferences based on the scheduling of the controllable device, provision of notifications/alerts (HLUC3 – PUC6), and more importantly, data analysis (HLUC4) - innovation is explained later in the text-, modelling and prediction of the end-users consumption behaviour (HLUC7 - PUC13), and personalised notifications and recommendations (HLUC7 - PUC12). Combining all these features at the palm of the user's hand is an innovative approach since prior demonstrations incorporated only a subset of these features. In addition, features such as the AI-enabled consumer behavioural modelling, which will provide new insights to the providers regarding their consumer characteristics, are novel themselves, as described earlier.

Leveraging the sheer amount of data from the households will allow us to use machine-learning algorithms to break down consumers' appliance-level behaviour even in combination with non-energy sources and classify consumption and user behaviour patterns. The analytics mentioned above will be accessible by the grid operators to safeguard technical and economic stability while also giving consumers personalised recommendations that will educate them to transition to more energy-efficient habits. Furthermore, Gamification will play a significant role in keeping the users engaged and increasing their interest in participating in the pilot community by providing a feeling of fulfilment and accomplishment with a reward at the end of each challenge, thus creating new habits through their repetitive actions. Furthermore, the recommender system of the mobile application will further contribute to user engagement by sending appropriate personalised notifications (tips or recommendations) on proper time slots, based on machine learning models and energy profiles. Thus, this personalised engagement approach will exploit new aspects of the consumers' energy behaviour through AI, leading to higher user acceptance and energy savings.

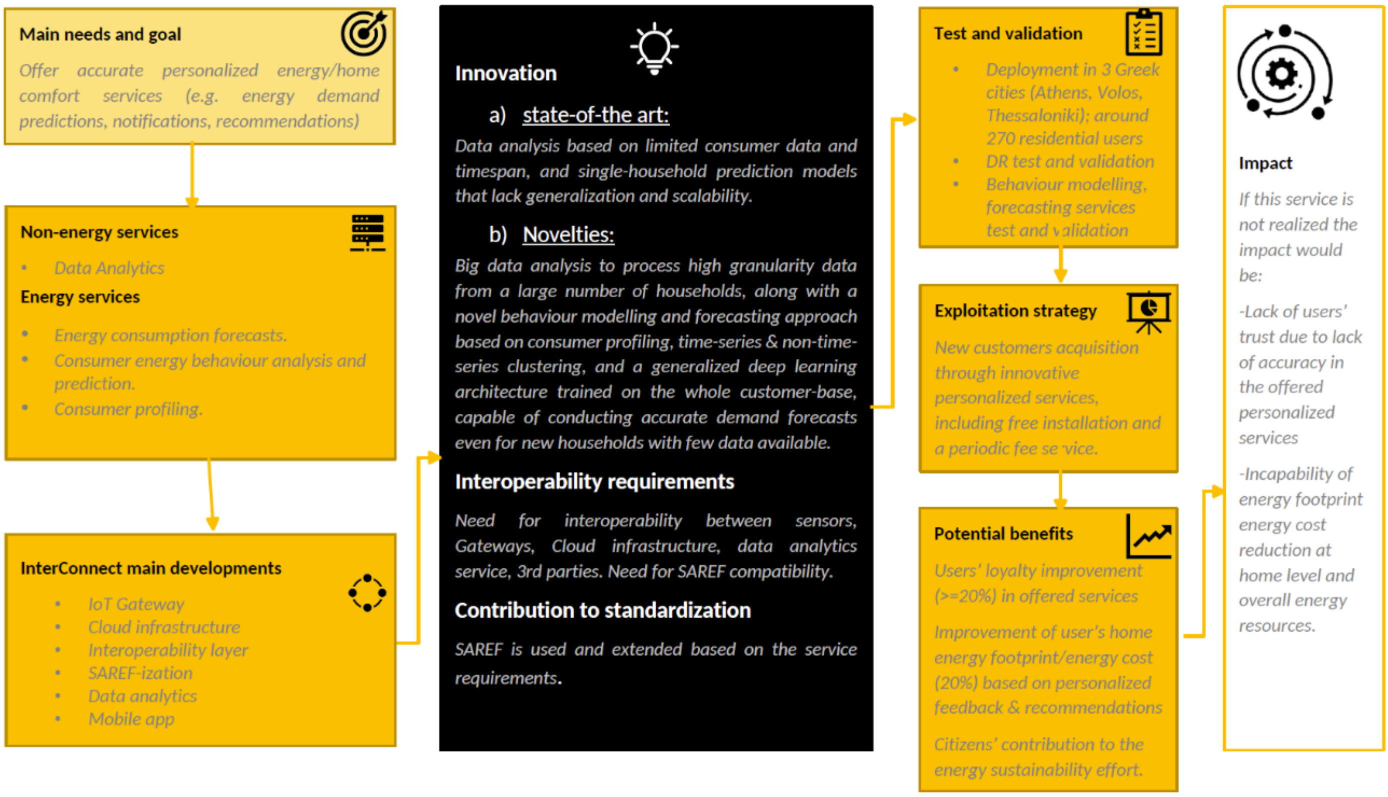


Figure 3 - Innovation path of the service "Home analytics."

As mentioned earlier, data analysis and the availability of data from different sources of IoT sensors, including but not limited to smart meters, will enable data demanding algorithms to provide valuable outputs to realise the innovation path depicted. The following high-level use cases (see D1.3) are leveraging on consumers' data to deliver innovative services:

(a) HLUC4, "Data Analytics Services," where forecasting of various market, system, and user behaviour parameters and recommendations related to eco-friendly energy consumption by maximising the usage of renewable sources are generated based on machine learning techniques. In our case, the eco-friendly recommendation proposes to shift the highest energy-consuming device load to a time interval where the contribution of RES (Renewable Energy Sources) is maximum (% wise). The recommendation applies only to Energy hungry devices whose load can be shifted (i.e., washing machine, water heater, ...) and not continually operating appliances (i.e., Refrigerator).

(b) HLUC6, "Increase CO2 savings and become eco-friendly", where the combination of data from the consumers and the system operators allows identifying the periods within the day where the total system's electricity demand is satisfied by the highest shares of RES generation. Based on system load and RES output forecasts, electricity demand will be curtailed when fossil fuels are estimated to occupy high stakes in electricity production.

(c) HLUC9, "Appliances' energy efficiency," where the comparison of consuming profiles of all the consumers' appliances allows for categorising appliances' efficiency, providing back to consumers feedback regarding the benefits of replacing or adjusting how and when to use a device.

(d) HLUC7, "User Engagement" and specifically PUC13 "Consumer behaviour modelling and prediction," where anonymised energy profiles are constructed for each consumer/user based on the energy/non-energy measurements collected throughout time. Then, novel machine/deep learning techniques utilise these profiles to model and predict their energy consumption behaviour, an approach also published in a conference paper[21] from the team of AUEB.

[21]Relevant publication: Spiros Chadoulos, Iordanis Koutsopoulos, and George C. Polyzos. "One model fits all: Individualized household energy demand forecasting with a single deep learning model." Proceedings of the Twelfth ACM International Conference on Future Energy Systems. 2021

It should be highlighted that Greece's concepts like DSF and intelligent meters are fledgling. While there are some DSM programs in place (e.g., ToU tariffs), there are no provisions for DR in general or for the straightforward operation of DR in the current market framework, which only recently partially aligned with the EU Target Model. While the continuous electricity market reform process, which still lacks critical components such as Capacity Remuneration Mechanism or Interruptible Load auctions, poses significant regulatory barriers in even trialling DR outside a controlled pilot environment, additional systemic challenges exist. Specifically, the significantly congested and ageing low and medium voltage infrastructure has been the cause of an increasing number of controlled and uncontrolled blackouts in 2021, following the unprecedented snowfall during the winter in Athens and the record high temperatures in most of Greece's urban and metropolitan areas during the summer. This has highlighted the need to reform the distribution grid and pushed forward initiatives on intelligent meter deployment as part of the DSO's modernisation process. The enrolment of smart meters from the national DSO is starting gradually[22] and will be finished in 2030.

In this context, the Greek pilot provides a unique opportunity for SMEs and grid stakeholders to develop new technologies, identify business opportunities, and scale up their solutions in a controlled environment acting as a regulation-less bubble. At the same time, consumers familiarise themselves with new concepts that will challenge their preconceptions on electricity consumption and involve a learning curve. This is a critical contribution of InterConnect as it prepares all stakeholders for an upcoming transformation of the electricity sector, which, although foreseen, often manifests in very unpredictable ways.

Pilot GREECE — SERVICE CONCEPT Template

Energy Efficiency

Service Description

Enable users to monitor their energy consumption, receive feedback on CO2 emissions reduction and increase their awareness about energy efficiency. Users need to have installed a smart meter, an IoT GW paired with sensors and devices, and a corresponding mobile App acting as the user interface. The actors involved are consumers/prosumers, technology providers (IoT, smart-meters, app developers), energy suppliers, grid operators and aggregators.

Service Journey

Phase	PRE	PRE	DURING	DURING	DURING	POST	
Step	*Awareness*	*Hardware Installation*	*Real-time consumption info*	*Educate Users about energy efficiency*	*Ask users to be energy efficient*	*Maintenance & Upgrades*	
User's Actions	Learn about the service offering through a demo (video, ad, leaflet).	Installation of a smart-meter by a technician. Installation/Configuration of an IoT GW together with sensors. Installation of the app for smartphone.	Energy consumption visualization with charts through the mobile app. Historical data of his energy consumption.	Receive notifications with tips & tricks about energy efficiency. Educational videos pushed through the mobile app that will teach users about the GRID operations and how their actions can be beneficial to the GRID and to the environment.	Respond to flexibility requests like keeping energy consumption under a certain level during a time-period of the day. Receive info about the impact of his actions by translating it to CO2 emissions reduction.	New versions of the mobile App. Troubleshoot GW firmware updates.	
LINE OF VISIBILITY							
Back-end Actions	Prepare a demo	Initialization of data measurement stream and validation of proper operation and SAREFization.	Data storage, consume data APIs,	Notification service, Video production	Generate flexibility requests, Calculate CO2 emissions reduction	Push updates in mobile App and GW firmware. Health check of GWs devices.	

[22] HEDNO (ΔΕΔΔΗΕ), the Greek DSO, has launched a pilot project to install 200,000 smart meters in Xanthi, Lemnos, Ag. Stratis and selected parts of Athens and Thessaloniki. The project is at a very initial stage with award of the contractor undertaking the supply of the equipment and software of the Remote Reading center and the installation of the new meters pending (https://www.deddie.gr/en/stratigiki-eksugxronismos/stratigika-erga/tilemetrisi-pelaton-xamilis-tasis-pilotiko/).

SERVICES WP7.7 - FR

French Pilot innovation

The French pilot aims to empower consumers to become the main energy transition actors by reducing their electricity consumption, carbon footprint, and bill. Also, the French pilot is focused on integrating DSF from B2C and B2B customers segments in distribution grids and demonstrates a set of data-centric energy and non-energy services for consumers, prosumers, and communities. The pilot shows cross-sector business models and interoperable services by providing banking, municipality, and energy services to the customers or the community. The energy providers offering automatically manage customers' devices remotely.

The first set of services related to *"dynamic tariff and usage management"* has been defined to allow the user to benefit from a lower electricity tariff by acting on his usage to reduce his costs and better understand his use and energy impact. This tariff varies according to its structure, e.g., include information about local RES production, distribution grid usage, critical peak prices, wholesale electricity price, distribution costs. We use dynamic information from DSO and service providers' offers to adapt energy consumption to the current tariff to reduce the bill and the carbon footprint. These services are based on 24 prices per day and the Service Orchestrator's new component. This orchestrator intelligently advises/orders the smart appliances managed by various Energy Management Microservices. One house can potentially host several EMSs synchronised by the orchestrator. The main innovations of InterConnect for control and devices in the dynamic tariff context are:

a. An interoperable framework implements the SAREF ontology to exchange flexibility information, tariff information, and real-time information issue from the customer (instantaneous consumption, power subscriber, max power subscriber reached, …). SAREF will also enable new data-driven services (e.g., connectivity, soft real-time electric measurements, metering data, comfort data)., valorising consumers' data for improving grid observability and aggregators' analytics capabilities.
b. The design and implementation of a Smart Orchestrator (Inetum and YNCREA) allow the intelligent and remote control in the same household of different Energy Management Systems (EMSs) provided by various service providers. E.g., the Smart Orchestrator is intelligently controlled by AI and according to user recommendations from both the Engie/ThermoVault EMS controlling the water heater and the heating and optimises the start-up of whites-goods provided by Whirlpool/Miele/Bosch and the charging of the EV managed by Trialog.[23]
c. Creation of a power limitation service to prevent the smart meter from tripping (and cutting off the electricity supply) because of different appliances being started by different independent EMSs. Power limitation is an interoperable microservice using cloud and edge computing to stop intelligent devices when the electricity consumption exceeds the maximum power. The overpower alert is generated in soft real-time by the smart meter.
d. The smart orchestrator schedules computation. This interoperable microservice provides an electrical consumption schedule at the household level to advise all household EMSs for starting/stopping their smart appliances. The schedule is a function of the user habits analysed by IA and the DSF service provider commitments.

For DSF in the B2C sector, InterConnect will demonstrate an interoperable architecture of digital monitoring and control IoT platforms (from Engie, Inetum, ThermoVault, and Trialog). This solution enables flexibility aggregation from different smart appliances managed by several EMS providers in the same household. The service *"Dynamic tariff and usage management"* is implemented at the customer's premises, which a service provider will aggregate (Engie/ ThermoVault) for participating in the wholesale electricity market (like peak prices shaving) based on customer information provided in soft real-time by the DSO (Enedis). The main goals of this service are to efficiently contribute to grid stabilisation, low electric tariffs, and reduce carbon footprint. The use of aggregated flexibility from different sources (space heaters, water heater, EV charging station, white goods), piloted by its own EMS providers (at the customer premises), was not explored in real-world conditions in France.

[23] S.Barja-Martinez,M.Aragüés-Penalba,Í.Munné-Collado,P.Lloret-Gallego,E.Bullich-Massagué,R.Villafafila-Robles, 2021, 111459

The innovation path of the Dynamic Tariff and Usage Management service deployed in 250 households is depicted in Figure 1. As a result, this InterConnect service will help to empower customers to take responsibility for their energy consumption, educate them to consume less and reduce their carbon footprint, learn from their consumption patterns, and reduce their bills.

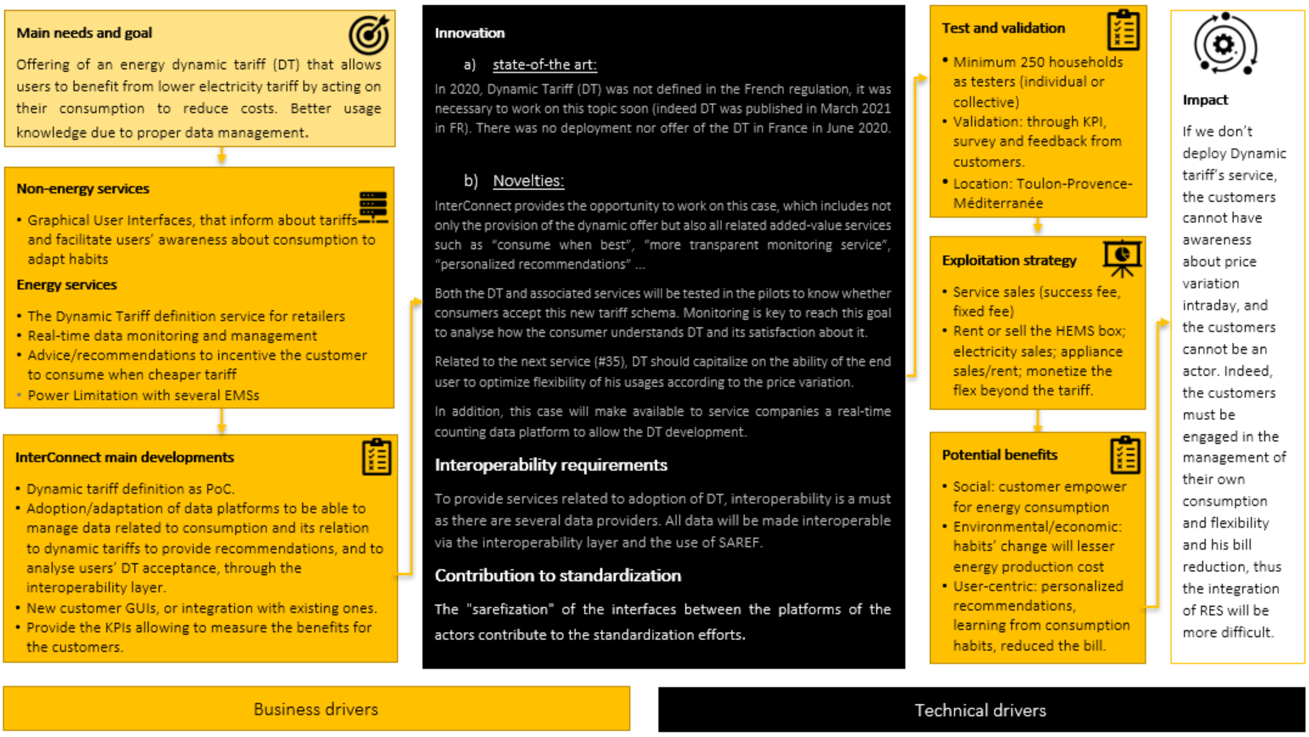


Figure 1 – Innovation path of the service "Dynamic tariff and usage management."

Maximising the use of RES at the local level within a community (*"Maximize the use of local RES"* service) is also at the heart of this pilot. Thus, the actors of this community will be able to generate energy to the grid through PVs production within this community and be rewarded with green coins (managed by blockchain) or consume RES when available. This green coin will allow exchanges within this community, e.g., an electricity consumer like a baker could exchange his products with his customers by using green coins. The primary producer in this community is the municipality of Le Pradet, which equips its municipal building with PV for self-consumption and production. The city would provide the French demonstrator at the local community level with two production sites. This service synchronises consumption with RES production at the local level based on data coming from smart meters. The "dynamic tariff and usage management" service is used when the community does not produce enough energy. The main innovations of InterConnect to maximise the use of local RES in soft real-time are:

a. Using an interoperable framework implementing the SAREF ontology to exchange soft real-time information issues from the customer (smart meter identifier, instantaneous power produced and consumed, smart appliance control).
b. The Smart Orchestrator advises each EMS to consume local renewable energy when available in an interoperable manner. This makes it possible to use/value local production that is not consumed.
c. The end-user is rewarded by "green coins" (local money) proportionally to the level of his investment in the REC. The key innovation is the monetisation of the local energy community through blockchain. Blockchain will be used as a trusted mediator in the payment process.
d. The repartition key for the energy distribution is established when the customer signed in the energy community, leading to ownership and management of energy-related assets. This model allows sharing costs and enables the participants to own assets with lower investment amounts. This effectively

encourages people to unite and act on energy and other socio-economic challenges locally to their community. This is a crucial innovation for community-ownership models.[24]

e. The aggregation in soft real-time of energy produced and consumed inside the community by a microservice. Thanks to the smart meters, these real-time households' data are provided to the smart orchestrator that manages the different EMSs installed in each community household.[25]

Digitalisation is a change for the energy sector, both technical and social. The following use case contributes to decarbonisation, decentralisation, democratisation, and digitalisation, as depicted in figure 2. GTR

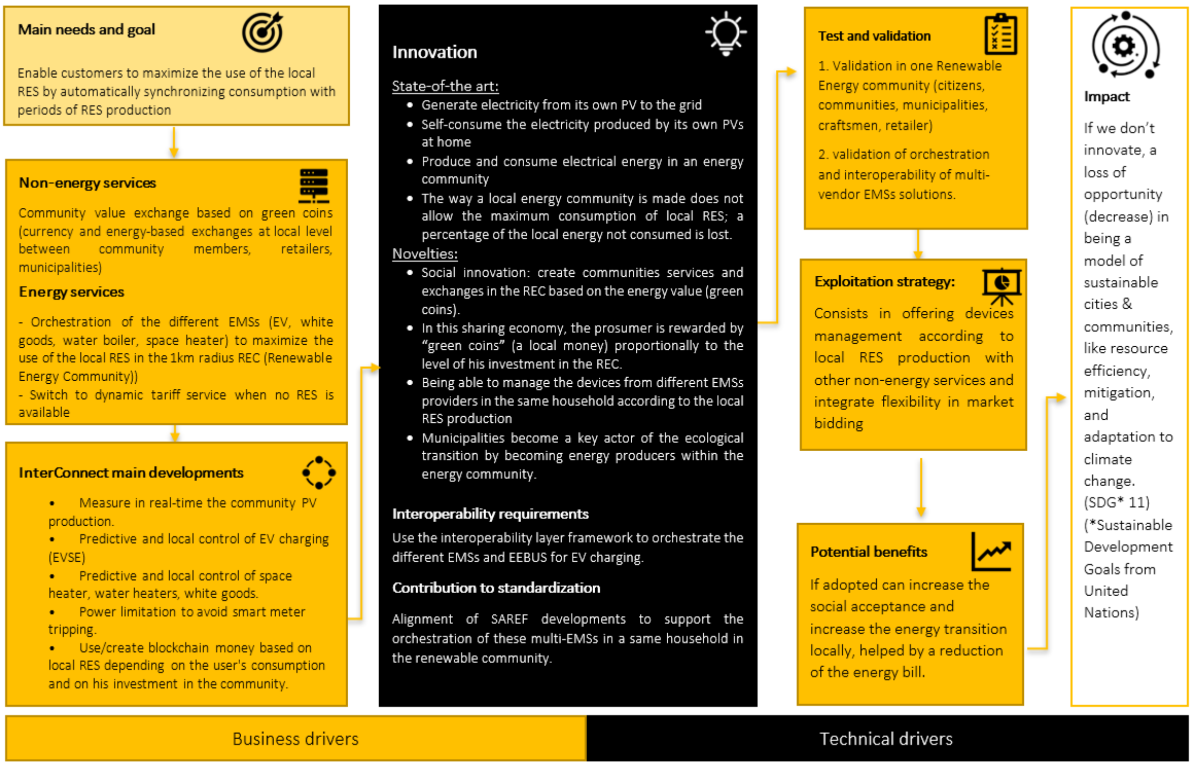


FIGURE 2 – INNOVATION PATH OF THE SERVICE "MAXIMIZE THE USE OF LOCAL RES"

To achieve the objectives set by the French pilot, the HLUC01 *"Maximize the use of RES"* and the HLUC02 *"Dynamic tariff and usage management"* have been translated into PUCs. Among these PUCs, some are directly linked to the business strategy, such as the PUC03 *"Provide a contract to the customer,"* which potentially addresses the rental of EMSs, the sale of electricity, the rewarding of users, the monetisation of flexibility, and the management of private data. Other PUCs allow users to become the main energy transition actors by reducing their electricity consumption, carbon footprint, and bill. Thus, these PUCs provide an optimisation of the energy consumption through the digitalisation (through better management of connected asset and their data PUC 05-"*Smart Orchestrator processing & operations")*, decentralisation (with the Distributed Energy Resources -PUC01-PV Production, the consumer becomes an active participant in the electricity market) and electrification of end-use sectors (which help decarbonise heating/warm water production/… PUC 04- EMS processing & operations).

[24] Innovation Toolbox IRENA 2020, https://www.irena.org/innovation/toolbox

[25] G.Franzl; A.Goranovic; S.Wilker; T.Sauter; A.Treytl, Initiating an IES based Technical Framework on Local Energy Communities, 2020, 9212075

SERVICES WP7.8 CROSS-BORDER

Cross-Border Demonstration innovation

The cross-border demonstration objective highlights the technological and economic advantages of cross-border interoperability. The demonstration's use case aggregates flexibility resources (e.g., loads, RES, DR, and storage) from the country-level pilots to a *simulated* TSO to provide ancillary services. Thus, the local flexibility operator can acquire flexible units and pools. In contrast, a pan-European flexibility platform can supply reliable and efficient (technically and competitively priced) flexibility to the cross-border balancing market (e.g., aFRR, mFRR) to fulfil the TSOs requirements.

The flexibility aggregation platform used in the demonstration, cyberNOC, collects data from the platforms/assets from pilots, i.e., active power and flexibility forecasts. cyberNOC aggregates the flexibility and offers it in bids to the simulated markets. If bids are accepted, the simulated TSO sends continued activation (aFRR) or scheduled activation (mFRR). cyberNOC de-aggregates the activation signals and sends them to the platforms/assets.

The main innovations from InterConnect for the cross-border demonstration high-level use case includes:

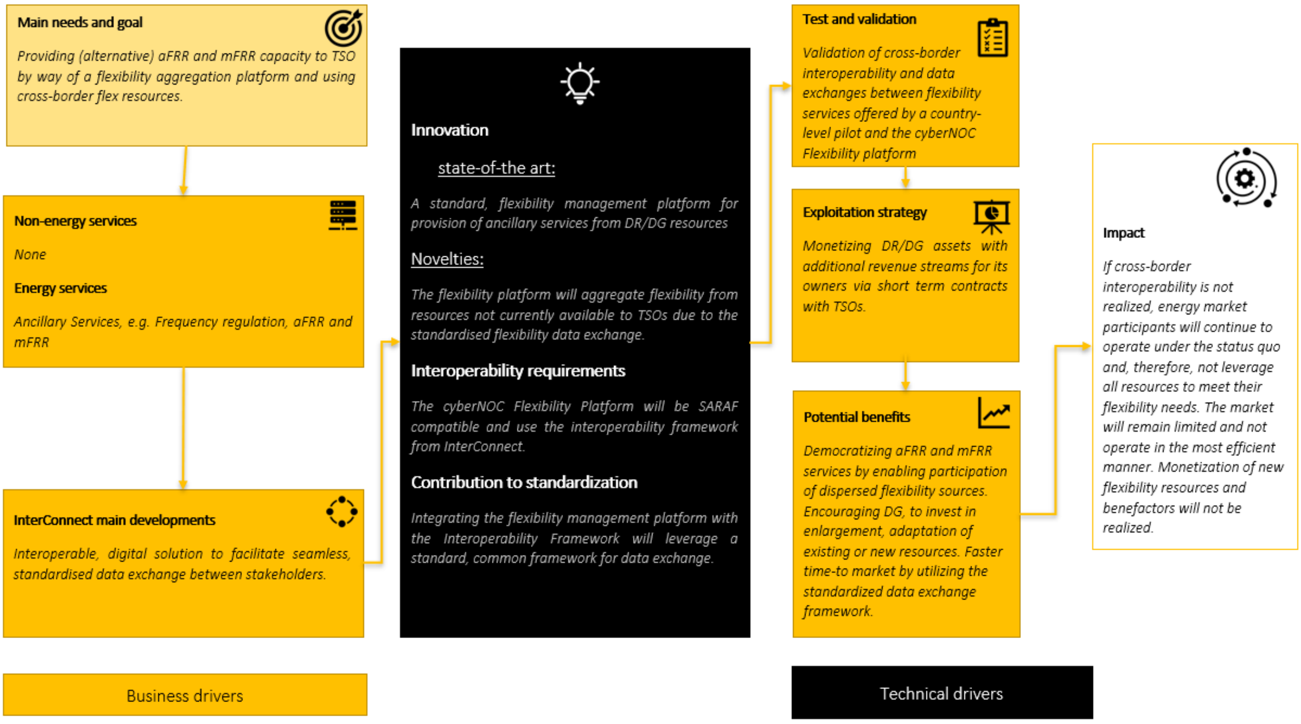
a. Implementing a SAREF-ized flexibility aggregation platform facilitates **cross-border flexibility data exchanges**, creating a *grid-centric* service for TSOs.
b. Leveraging the interoperability framework further expands the flexibility markets to new participants and stakeholders at the LV and MV levels (e.g., residential RE prosumers and local aggregators). This allows different types of flexibility and aggregation platforms across Europe to use SAREF and enables **interoperability between digital platforms by utilising the Interconnect framework**. However, compared with the traditional data exchange standards, they lack the technical details enabling pan-European adoption.
c. Finally, this demonstration has a solid potential to be **replicated** throughout EU members states and the broader European energy markets, given the establishment of a typical data exchange (i.e., SAREF.)

More specifically, several business value propositions can be realised through a typical data exchange for the interoperable use of the various digital platform.

Today, when a flexibility aggregator wants to integrate with the balancing market, it requires a high level of technical effort to integrate its flexibility assets. Moreover, integrating small-scale assets – e.g., HVAC, boilers, residential PV – does not yield a revenue level that justifies the costs for aggregators. The costs of dedicated hardware devices at small-scale flexibility units (small amount of <kW they can provide) and software development for the integration with the assets reflect high costs and low revenue compared with the C&I or BESS, which are usually large-scale flexibility units (>100kW).

The use of standard data exchanges and frameworks in Europe will thus lower the costs of developing the dedicated data exchange interface and use the HW already available at the flexibility unit. Unfortunately, these benefits are *not* considered today, and, therefore, the propositions listed below are not fully realised in the markets.

a. Providing (alternative) flexibility to TSO.
b. Enabling small-sized DR/DGs to participate in balancing markets.
c. Monetizing DR/DG assets with additional revenue streams for its owners.
d. Increasing balancing market liquidity and competition, allowing for reduction of balancing the cost of TSOs, generators, and end consumers, thus increasing social welfare.
e. Enabling reduced capacity for TSO dispatching actions due to providing geographically more evenly dispersed flexible capacity.
f. contributing to breaking of monopolies and creation of free-market competition;
g. democratising balancing services by enabling the participation of dispersed small flexibility sources.
h. Encouraging DG to invest in enlargement, an adaptation of existing or new resources, and.
i. enable faster time to market



Innovation path, cross-border interoperability for flex monetization, ancillary services

Annex II. BUSINESS MODELS

LIST OF BUSINESS MODELS

Country	Number of BM	Business Model Name	Dimensions									
				Cost estimation						Revenue stream		
				Financial				Main cost type				
			Innovation (1: low; to 5: high)	<1 M€	<10 M€	>10 M€	Unknown	IT (SW&HW)	Marketing /Promo	End-user monthly fee	End-user reward such. (incl. EPIC)	3rd Parties fees
PT	1	Monitoring energy consumption	2				1	1		1		
PT	2	Energy as a Service	5				1	1		1		
PT	3	Energy Efficiency as a Service – commercial	5		1			1			1	
PT	4	Convenient Smart EV charging	4				1	1			1	
PT	5	User Energy Data	4				1	1		1		
BE	1	BE1 - Building level services: Peak Shaving	4	1				1		1	1	
BE	2	BE1 - Building level services: RES self-consumption	4	1				1		1	1	
BE	3	BE1 - Building level services: EV smart charging pricing for flexibility use	4		1			1		1	1	
BE	4	BE2 - Community peak shaving and self-consumption controlling thermal loads	4				1	1			1	
BE	5	BE2 - Real-time price energy management	4	1				1		1	1	
BE	6	BE3 - Mobility Service Package for Energy Community	3				1	1			1	
BE	7	BE3 - P2P-Energy Community	3	1				1			1	
BE	8	BE3 - Centralized EMS	3		1			1		1	1	
BE	9	BE4 - Freedom of choice – data management	1		1			1	1			1
BE	10	BE4 - Green progress bar – data management	1		1			1	1			1
BE	11	BE4 - Voluntary (non-) participation in Energy Community	5	1					1			1
BE	12	BE4 - AC - DC Interface for DC grid	5			1		1			1	1
BE	13	BE5 - Community optimisation of efficient heat generation	4	1				1		1	1	
BE	14	BE5 - Peak shaving via direct control of HP	4	1				1		1	1	
BE	15	BE5 - RES self-consumption	4	1				1		1	1	
BE	16	BE5 - Community car sharing	5				1	1	1	1		1
BE	17	BE6 - Asset portfolio optimisation service	5			1		1	1	1	1	
BE	18	BE7 - Flatten energy profile of a student residence	4	1				1			1	
BE	19	BE8 - Sustainable services for Local Energy Communities	5			1		1		1		
DE	1	DE 1 – Flexible tariff	4				1	1	1		1	
DE	2	DE 2 - Power monitoring and grid connection point	3				1	1			1	

	3	DE 3 - Power limitation	1				1	1			1	
	4	DE 4 – 143 Overload protection	4	1				1		1		
	5	DE 5 - Manual power shifting	2		1			1			1	
	6	DE 6 – EV fleet charging	4				1	1			1	1
	7	DE 7 - Coordinated charging of electric vehicles	4	1				1		1	1	
	8	DE 8 - Incentive table-based power consumption management (e.g., HVAC)	5	1				1		1	1	
	9	DE 9 - Flexible start of white good	3	1				1		1	1	
NL	1	Automation functionality (convenience)	5		1			1		1		1
	2	Automation functionality (health)	5			1		1		1		1
	3	Energy recommendation and automation - Intelligent BMS (iBMS)	5	1				1				1
	4	Mobility - Green/Smart charging for mobility	5		1			1		1		1
	5	Platform function, user interface, and dissemination - Monitor and Control	5	1				1	1	1		1
IT	1	Unlock Perks with Use	3	1				1			1	1
	2	Digital Platform for End-User Control and Awareness	3	1				1		1		1
	3	Interoperability and availability of solutions	3	1				1			1	1
	4	Energy & Environmental Performance App	3	1				1		1		
	5	Playing with Technologies	3	1				1			1	
GR	1	Energy efficiency ServiceBiz model	3	1				1		1		
	2	User engagement	4		1			1	1	1		
	3	Smart home energy management system	4	1				1		1		
	4	Data analytics	2	1				1		1		
FR	1	Dynamic tariff	4				1	1	1	1		1
	2	Maximising RES	4				1	1	1	1		1
	3	Bill saving	4				1	1	1	1		1
	4	EV charging, flex, and balancing within communities	5				1	1		1		
TOTAL		**51**		**23**	**9**	**4**	**15**	**50**	**11**	**32**	**27**	**17**

The business models associated with the innovative services presented in Annex I are detailed in the other part of Annex II.

BUSINESS MODELS WP7.1 - PT

Pilot PORTUGAL: BM(3) **Energy Efficiency as a Service – COMMERCIAL** — BUSINESS MODEL Template

Key Partners	Key Activities / Key Resources	Value Proposition	Customer Relationships / Channels	Customer Segments
Equipment + systems suppliers/integrators Technology developer / provider O&M companies (electricians, installers) Retailer / Aggregator Data service provider TSO / DSO	**Key Activities** **Key Resources** Integrated EMS - interoperable ecosystem of devices (BMS + Energy Meters + consumption devices: HVAC, freezing units, lighting, EV chargers, storage + generation devices: PV, emergency generators, storage) - interface / App for monitoring + back-end analytics / computational optimization / decision making + actuation over devices (also with dashboards / KPI's / reporting); Forecast services; iEMS operator / technical support;	**Centralized energy management at tertiary buildings as EE enabler** - Awareness @ store / building / portfolio level through access to data / monitoring / dashboards / KPI's - Integration of diverse technologies for optimal energy management / maximization of RES penetration / cost reduction - Active and remote control over stores/buildings to enable flexibility as a tool for optimal energy management / unbalance mitigation - Flexibility offer to grid market services based on the forecasted energy use/generation energy price	**Customer Relationships** **Channels**	Commercial buildings - Retail stores networks - Shopping malls - Offices - Industry

Cost Structure	Revenue Streams
iEMS operation / technical support team Equipment controllers/reconversion Support services (data, cloud)	- From commercial building owner/operator for iEMS deployment, operation and technical support - Improved energy efficiency led to cost savings - Energy performance contracts (articulate the group objectives with the store/buildings managers) - From DSO / TSO through DSF services

Pilot PORTUGAL: BM(4) **Convenient Smart EV charging** — BUSINESS MODEL Template

Key Partners	Key Activities / Key Resources	Value Proposition	Customer Relationships / Channels	Customer Segments
Equipment suppliers Technology developer / provider O&M companies (electricians, installers) Retailer / Aggregator Data service provider TSO / DSO	**Key Activities** **Key Resources** EV charging infrastructure EV charging integration with CEMs/BMS, if any;	**Convenient EV charging – small impact in daily routine, big benefits.** Take advantage of the ecosystem interoperability to enable smart EV charging (optimization of time slots: maximization of PV generated energy use – happy hours / competitive energy cost/demand-side flexibility needs..). Commercial store /building customers can conveniently charge their EV's with minimal impact in their daily routine while shopping in a store/building.	**Customer Relationships** **Channels**	Commercial buildings parking managers

Cost Structure	Revenue Streams
Technical support; Support services (data, cloud);	- From commercial building parking manager (EV charging integration with CEMS / BMS and technical support); - Improved energy efficiency leads to cost savings; - From EV user; - From DSO/ TSO through DSF services.

BUSINESS MODELS WP7.2 - BE

Pilot Belgium: BM1 Peak shaving

BUSINESS MODEL Template

Key Partners

- Forecast(s) provider
- Electricity supplier
- Building manager
- Manufacturer of controllable devices
  - HP
  - Heating/cooling system
  - EV chargers
- Optimisation expert
- Software developer
- Platform provider
- Provider of BEMS

Key Activities

- Data analysis and optimisation
- Sales
- Customer relations
- Site/building Survey
- Operations
- Partnerships

Key Resources

- Digital platform
- Data analysis and optimisation experts
- Energy experts

Value Proposition

- Minimisation of system services and commodity costs while maintaining comfort through
  - Integration with other energy / non-energy services
  - Better understanding of building dynamics
  - Learning and understanding preferences
  - Sustainability and scalability to the core
- Use available smart meter data and future expected behaviour based on the state of the art forecasting techniques to define energy consumption strategies for controllable devices within the building. These strategies aim to limit the system building consumption when there is a high probability of utilising more than the contracted capacity. Real-time data is used to dynamically adapt a strategy accommodating the changing environment (PV generation deviation, changes in comfort levels, changes in preferences).

Customer Relationships

- Customer feedback via the platform of surveys.

Channels

- Electricity supplier
- Direct contact
- Website

Customer Segments

- Managers of tertiary buildings
  - Office spaces/buildings
  - Hospitals

Cost Structure

- Platform (CAPEX and OPEX)
- Staff: researcher and business developers
- Software development (service)
- ICT (service)IC (service)
- Technical support service)

Revenue Streams

- Building manager (user) : a hybrid model that combines subscription with sharing benefit/penalties; either pay a monthly fee; or according to targets (e.g.:savings) : set periodically : (1) If the target is met, an x% of savings is paid ; (2) If the target is not met, an x% of extra costs above the expected threshold are deducted to the subscription).

Pilot Belgium: Community peak shaving and self-consumption controlling thermal loads

BUSINESS MODEL Template

Key Partners

- Heat pump/ water heater manufacturer
- Software provider (provide controlling algorithm)
- DSO (information about the grid)
- Maintenance companies
- Electricity retailer (Utility companies)
- Flexible asset provider (home battery, EMS ...)
- PV inverter companies
- Battery inverter controllers
- Electric vehicle controllers
- Interconnectivity solution providers
- Legal entities, regulators

Key Activities

- Sales
- End-customer relation
- Operations
- Establishing partnerships

Key Resources

- Digital platform for controlling appliance
- Data analyst to predict consumer behavior
- Legal expert
- Partnerships

Value Proposition

- Cost reduction
- Sustainability increase
- Providing peak shaving for avoiding fines
- Peak shaving for reducing grid congestions
- Providing self-consumption
- Maintaining thermal comfort
- Aggregate individuals in a local energy community
- Consumption and savings insights

Control thermal loads by using IoT devices to disconnect water heaters and heat pumps when a maximum allowed peak consumption is reached or there is a surplus in the PV installation. The service provides an application to simplify the interface with energy providers.
End producer gets a higher price for sharing PV production internally than selling into the grid. Assume: Special tariff for sharing PV surplus within the community

Customer Relationships

- Long term relationship
- Provide support for maintenance (not do the maintenance yourself) by doing fault detection of heat pumps and water heaters
- End user feedback through the smartphone application

Channels

- Maintenance companies
- Website
- Smartphone Application
- Electricity retailer (utility companies)

- Maintenance companies
- Electricity retailer (utility companies)

Customer Segments

- Local energy communities
- Individuals

Cost Structure

- Hardware, IoT
- Cloud maintenance
- Communication setup
- Staff members

Revenue Streams

- End user pays for the service, so he does not need to pay the fines. *Assume: penalty for customers when exceeding peak consumption*
- DSO pays to avoid local congestion. *Assume: DSO wants to prevent congestions*

Pilot BE: Cordium | **Peak shaving via direct control of HP** | BUSINESS MODEL Template

Key Partners

- Forecast(s) provider
- Electricity supplier
- Social housing provider/ manager
- Manufactures of controllable devices
  - HP
  - BTES
- Optimization expert
- Software developer
- Platform provider
- Providers of thermostats
- Provider of BEMS

Key Activities

- Data analysis & optimization
- Sales
- Customer relations
- Site/building survey
- Operations
- Partnerships

Key Resources

- Digital platform
- Data analysis & optimization experts
- Energy experts
- Controllable HP

Value Proposition

- Minimization of system services and commodity costs while maintaining comfort through
  - Integration with other energy/non-energy services
  - Better understanding of HDN dynamics
  - Learning and understanding preferences for heat
  - Sustainability and scalability at the core
- Use available smart meter data and future expected behaviour based on state-of-the-art forecasting techniques to define energy consumption strategies for controllable devices within the HDN. These strategies aim to limit the system's consumption (HDN) when there is a high probability of utilising more than the contracted capacity. Real-time data is used to dynamically adapt a strategy accommodating the changing environment (e.g., RES generation deviations, changes in comfort levels, and preferences).

Customer Relationships

- Customer feedback via platform or surveys

Channels

- Direct contact with social housing operator
- Providers of HDN solutions
- Website

Customer Segments

- Managers/Operators of HDN

Cost Structure

- Platform (CAPEX & OPEX)
- Staff: researchers and business developers
- Software development (service)
- ICT (service)
- Technical support (service)

Revenue Streams

- Social housing manager/operator (user): Hybrid model that combines subscription with sharing benefits/penalties: either (1) user pays a monthly fee (2) or according to targets (e.g., savings); set periodically (A => If the target is met, an x% of savings is paid ; (B) If the target is not met, an x% of extra costs (costs above the expected threshold) are deducted from the subscription.

BUSINESS MODELS WP7.3 - DE

Pilot Germany: Cost optimized operation of devices (Norderstedt/Hamburg) | BUSINESS MODEL Template

Key Partners

- Stadtwerke Norderstedt
- Energienetze Hamburg
- their IT/software branch/partner
- IT service/ customer care
- Manufacturers: EMS (N/H), charging station (N/H), heat pump (N), white goods (N), PV (N)

Key Activities

- Marketing
- Installation
- Maintenance
- Operation

Key Resources

- IoT Assets
- EMP communication
- EMS (N/H), charging station (N/H), heat pump (N), white goods (N), PV (N)
- Metering/Sub-Metering
- APP

Value Proposition

- Operate devices at lowest costs
- Manage overload and underload scenarios
- Enable use of volatile energy resources and the mobility or heating transition

Customer Relationships

- Existing customers
- Needs to be developed

Channels

- Direct contact to customers
- Internet and media channels

Customer Segments

All people that are interested in saving money with high device flexibility (EV, heat pump, white goods)

Personas:
Residential:
- Jean Dupont #2
- Beate Sanders #2

Commercial: TBD

All **DSO/EMP** that are interested in managing overload and underload scenarios

Personas:
TBD

Cost Structure

- Development costs
- Maintenance and service costs
- Marketing costs

Revenue Streams

- Customer: Saved energy costs will amortise the device invest
- DSO: Cheap flexibility at relatively low investment (gateway and infrastructure)

Pilot Germany (Norderstedt/Hamburg) — BUSINESS MODEL Template

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
• Stadtwerke Norderstedt • Energienetze Hamburg • their IT/software branch/partner • IT service/ customer care • Manufacturers: EMS (N/H), charging station (N/H), heat pump (N), white goods (N), PV (N)	• Installation • Maintenance • Operation **Key Resources** • IoT Assets • DSO communication • EMS (N/H), charging station (N/H), heat pump (N), white goods (N), PV (N) • Metering	• Metering in real-time on building level to identify hot spots • Forecast of power consumption as input for energy purchasing (intraday) • Enable mobility or heating transition	• Existing customers **Channels** • Direct contact to customers	All **DSOs** that are interested in the current power consumption Personas: Residential: TBD Commercial: TBD All **end customers** that are interested in their power consumption Personas: Residential: Jean Dupont #2 Commercial: TBD

Cost Structure	Revenue Streams
• Development costs • Maintenance and service costs • Installation costs	• DSO: Savings through non-grid expansions and identification of hot spots • Customer: Offer energy analysis and recommendation of action to optimise energy behaviour or exchange of devices.

BUSINESS MODELS WP7.4 - NL

Pilot NL – automation, comfort 1.1 Automation functionality (convenience) — BUSINESS MODEL Template

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
Appliance manufacturers Device providers (Sensor, gateway, light) (InterConnect) platform provider or operator Cloud/storage provider 3rd party related service providers (Apple, etc.) Energy Service Provider Additional service providers (housekeeping, (parcel)delivery) The service provider could be: • Telco operators ; Building company ; Energy retailers • Independent (SME) provider • Home insurance firms, societies (homeowners, consumers, etc.)	**Key Resources** Data (personal, group, sensor, appliances) Personnel Algorithm/machine learning Hosting User Interface (easy/fun/adjustable(personal)) "Interoperable service" Privacy-maintaining (GDPR) agreements and technical solutions	Freeing up time for the user, reducing the cognitive load, providing trust and peace-of-mind that all is under control. With the option to see remote control/status-view by offering a service collecting user (also building level) behavior data and predicting future needs/preferences in order to adjust the settings and automate (basic) actions. Limited interaction (feedback) is needed. Trust that data sharing is done responsibly.	 **Channels**	1) Consumer (owning house) (B2C) 2) Consumer (as a tenant) (B2C) 3) Building/complex owner (B2B) A) Early adopter (John Comfy) B) Early Majority ("the rest") ...

Cost Structure	Revenue Streams
Device costs, sensor costs, service development costs Communication costs, data storage costs, security Platform provisioning (development AI/ML, operational, maintenance, customer service); Contracting and legal with 3rd parties Ecosystem governance; Marketing/PR; Lobbying (energy legislation, standardisation)	Kickback fee from 3rd party service providers/manufacturers (e.g., for preventive maintenance) Subscription fee from end-users (small segment) Advert/marketing fee from 3rd party service providers Included in subscription to an energy provider or insurance policy Total play telecom subscription

Pilot NL – automation, health | 1.2 Automation functionality (health) | BUSINESS MODEL Template

Key Partners	Key Activities / Key Resources	Value Proposition	Customer Relationships / Channels	Customer Segments
Appliance manufacturers Device providers (Sensor, gateway, light) (InterConnect) platform provider or operator Cloud/storage provider 3rd party related service providers (Home healthcare, etc.)). Additional service providers (housekeeping)	**Key Activities** **Key Resources** Data (personal, group, sensor, appliances) Personnel Algorithm/machine learning Hosting User Interface (easy/adjustable(personal)) "Interoperable service" Privacy-maintaining (GDPR) agreements and technical solutions	**Being able to live alone, self-sufficiently, even when the person's physical and cognitive abilities are impaired. Both in their own home and in automated assisted living accommodation. Difficult tasks are automated, depending on the needs of the user. E.g., managing daily routine, planning treatment/medicine taking, getting meals on time, monitoring social contact.**	**Customer Relationships** **Channels**	1. Seniors. 2. People with chronic healthcare issues limit their abilities to care for themselves. 3. Assisted-living building owners A. Early adopters (Jane Pensio) B. Early majority (the rest)

Cost Structure	Revenue Streams
Device costs, sensor costs Communication costs, data storage costs, security Platform provisioning (development AI/ML, operational, maintenance, customer service) Contracting and legal with 3rd parties; Ecosystem governance ; Marketing & PR ; Lobbying (health legislation, standardisation)	Health insurers pay less for this service than older adults living in sheltered accommodation. Assisted-living building owners, as it makes their work easier Government funding for standard self-sufficient living solution (government supports the platform for health efficient services) "EU Google" digital healthcare platform, monitoring and aimed at prevention, linking to healthcare providers.

Pilot NL | 3. Energy recommendation and automation – Intelligent Building Management System | BUSINESS MODEL Template

Key Partners	Key Activities / Key Resources	Value Proposition	Customer Relationships / Channels	Customer Segments
Main components suppliers: - Heat pump - Thermostat - WKO - HVAC - Light system - Security - Elevator - Access control/intercom	**Key Activities** **Key Resources** IT know-how (people) Interoperable platform Third-party compliant infrastructure Data analyst/ Machine learning specialists	**Value proposition:** saving operational cost (energy & maintenance) and increasing the functionality of the building **Offer:** remote control of the building systems by the integrated system with customised control strategies. Real-time insight in building performance and building status. Predictive maintenance due to data collection and analysis. Adaptive configuration by machine learning	**Customer Relationships** **Channels**	Building investors/owners (private and institutional)

Cost Structure	Revenue Streams
Salaries of consultants Software development (R&D) Service & maintenance of software Branding & sales of solutions	Single software package Consultancy fees for customising solution License fee Kick back from companies Aggregator fee ;Energy trade fee

BUSINESS MODELS WP7.5 - IT

Pilot ITALY: MONITOR & CONTROL - Digital Platform for End-User Control and				BUSINESS MODEL Template
Key Partners	Key Activities / Key Resources	Value Proposition	Customer Relationships / Channels	Customer Segments
Aggregator Energy Service Provider Building Owner	Key Activities: Key Resources: Capability to define the **necessary analyses about users' behaviours** (Data Science) **UX/UI Capability** in App development **Business Logic** embedded in the App for the Energy Manager	Digital Application aimed at enabling easy and effective **control of services and products that consume energy** Digital Application aimed at improving **awareness about economic saving and energy efficiency** Gamified Digital Application aimed at **keeping end users engaged and active**	Customer Relationships: Channels:	**Environmental conscious** people People willing to **save on energy cost** **Residential** users People willing to **use technology** to improve their life People **interested in the contests and challenges** offered by the gamification part

Cost Structure	Revenue Streams
App Maintenance (to Energy Service Provider) Cloud Hosting (to Amazon/IBM/etc.) Data Traffic (to Amazon/IBM/etc.) [Administrative Cost for the Aggregator]	**The flat tariff** paid by **Aggregator** for keeping and maintaining the App with Energy Manager **Fee** paid by **Building Owner** for services provided [**Free subscription** to Energy Flexibility Program by the End User + **Reward** by the Aggregator]

BUSINESS MODELS WP7.6 - GR

Pilot GREECE				BUSINESS MODEL Template
Key Partners	Key Activities / Key Resources	Value Proposition	Customer Relationships / Channels	Customer Segments
• DSO/Aggregator/Energy provider • Technology providers (IoT management system, smart meters, mobile App development) • 3rd party companies that are being promoted through the loyalty program	Key Activities: Key Resources: • Customer engagement tools/tactics • Loyalty program agreements with other companies • Significant customer base • Extensive energy market knowledge • Gamification techniques	• All inclusive (Installation, monitoring, control, single App) • Better tariff plans • Increase consumption efficiency -> Cost savings • Real-time monitoring of his power consumption • IoT home automation • Extra benefits from the loyalty program	Customer Relationships: Channels:	Residential users (Consumers, Prosumers)

Cost Structure	Revenue Streams
• IoT management system and smart meter • Mobile App development • Commercial & Operational costs	• New customers acquisition because of innovation • Free equipment with monthly fee service • Free and paid plan (free and pro features) • Free feature example -> Real-time consumption monitoring • Loyalty program, customers redeem "energy" points on 3rd parties (B2C pro feature and commercial agreement with B2B)

Pilot GREECE — BUSINESS MODEL Template

Key Partners
- DSO/Aggregator
- Technology providers (IoT management system, smart meters, mobile App development)

Key Activities

Key Resources
- Smart meter
- Mobile App
- Extensive energy market knowledge
- Customer engagement tools/tactics

Value Proposition
- Increase consumption efficiency -> Cost savings
- Reduce CO2 emissions, be eco-friendly
- Real-time monitoring of his power consumption
- Increase awareness on how GRID operates

Customer Relationships

Channels

Customer Segments
- Residential users (Consumers, Prosumers)
- Consumers who care about the environment

Cost Structure
- IoT management system and smart meter
- Mobile App development
- Commercial & Operational costs

Revenue Streams
- New customers acquisition because of innovation
- Free equipment with monthly fee service
- Free and paid plan (free and pro features)
- Free feature example -> Real-time consumption monitoring

BUSINESS MODELS WP7.7 - FR

Pilot France - Dynamic tariff & usage management — BUSINESS MODEL Template

Key Partners
- DSO
- Energy provider owners of the business model
- local company for installation and maintenance
- Local company for installation and maintenance branch/partner: service provider; installation/ maintenance partner
- Recruitment partners: city department, Ademe, local sales; data sellers; local authorities; end-user; recruitment of different customers segments, consumers and producers.

Key Activities

Key Resources
- Smart meter
- EMS system
- UI integrating tariff information and consumption
- Data availability
- Electricity sourcing capability
- Maintenance service
- Billing service
- Energy efficient connected electric WH and space heater
- Contracting capabilities
- Enrollment capabilities
- Customer support

Value Proposition

Enable customers to reduce their bill by providing a dynamic tariff, a control system to optimize their behaviour to the tariff and monitoring/information support.

Customer Relationships

Channels

Customer Segments
- Residential energy consumers
- Building energy managers of collective homes, companies and administrative building for the service part differentiated approach between energy and services
- Energy consumers of collective homes, companies and administrative building of the energy part
- Producer (local authorities, home users)
- Condominium
- Electric heating, AC, electric boiler and or EV
- Consumers home, collective home, companies and local authorities
- Consumer who can adapt their consumption

Cost Structure
- Equipment purchase, installation & maintenance
- Customer management: recruiting & contacting; cost to serve; IT systems for invoicing; customer interface dept & management
- Energy sourcing: energy, grid costs, taxes, debt.
- Solution development & administration: dynamic tariff communication; management; offer development

Revenue Streams
- Services sales (success fee, fixed fee)
- Rent or sell the HEMS box
- Electricity sales
- Appliance sales/rent

Pilot France - Maximise use of RES | BUSINESS MODEL Template

Key Partners	Key Activities / Key Resources	Value Proposition	Customer Relationships / Channels	Customer Segments
• DSO • Energy provider, owner of the business model • Service provider • Local company for installation and maintenance: PV installer; service provider; EV seller; battery installer • Recruitment partners • recruitment of different customer segments, prosumers • Customers • Advertiser • Third-parties for funding (bank, total) • City (department, Ademe, Local sales, data sellers) • Local authorities; legal person; Community representative	**Key Activities** **Key Resources** • Smart meter (Linky) • EV, PV • UI information on RES management (consumption, production, ...) • Internet Box, EMS BOX • Battery • billing service, • Maintenance service • data (real-time and forecast) availability • Customer support • Installer • contracting capabilities • enrollment capabilities • electricity sourcing capability • Appliances (boiler, heater, ...)	Enable customers to maximise the use of the local* RES by synchronising automatically consumption with periods of renewable energy production *local: Delimited by the high-level grid connection point	**Customer Relationships** **Channels**	Residential energy prosumers - end-user with battery, PV, boiler - local community - customers: energy community, prosumers, end-user, collectivity, ...

Cost Structure	Revenue Streams
• Equipment purchase, installation & maintenance : PV installation ; battery installation • Energy sourcing: energy, grid costs, taxes, development • Customer management • Solution development & administration: development of platforms (RES, customer)	• Bill of the customer • Electricity sales • Appliance sales/rent • Rent or sell the HEMS box • Third-party financing for its brand image (Total, bank, ...) • Contextual advertising on the user interface • Services sales (success fee, fixed fee) • sell overproduction • Valorize Flexibility when there is no RES production

BUSINESS MODELS WP7.8 – CROSS-BORDER

Pilot Cybergrid | BUSINESS MODEL Template

Key Partners	Key Activities / Key Resources	Value Proposition	Customer Relationships / Channels	Customer Segments
• TSOs • Demand Response (DR) (industrial, commercial, residential) and Distributed Generation (DG) resources (RES and CHP) • Regulatory bodies • DSOs	**Key Activities** • Provision of aFRR and mFRR to TSOs • Aggregation of DR/DGs at the commercial and residential levels • Customer (DR/DG) acquisition • aFRR/mFRR aggregation platform operations • 24/7 control center operation • Field identification of flexible capacity • Systems integration - Technical integration of flexible capacity, including management of subcontractors • Business model and techno-economic analysis • Development of flexible electricity products for DR/DGs • aFRR and mFRR reserves and activation accounting and reporting • Prequalification, compliance • Bidding **Key Resources** • Domain knowledge (power grid, electricity markets, economics, regulatory framework) • Flexibility Management Platform (cyberNOC) for aFRR and mFRR provision (sw tool) • Well established sales channels • Large and firm customer base • Trusted and recognized brand	• Providing (alternative) aFRR and mFRR capacity to TSO • Enabling small-sized DR/DGs to participate in aFRR, mFRR markets • Monetizing DR/DG assets with additional revenue streams for its owners • Increasing aFRR and mFRR market liquidity and competition allowing for reduction of aFRR and mFRR cost of TSOs, generators and end consumers, thus increasing social welfare • Enabling reduction of required capacity for dispatching actions of TSO, due to providing geographically more evenly dispersed flexible capacity • Contributing to the breaking of monopolies and creation of free-market competition • Democratizing aFRR and mFRR services by enabling the participation of dispersed small flexibility sources • Encouraging DG to invest in enlargement, an adaptation of existing or new resources	**Customer Relationships** • TSO: aFRR and mFRR provisioning of short-term contracts • DR/DG resources: flexible electricity generation or consumption provision contracts • In the future: DSO, Communities, BRPs **Channels** • Direct relationship (TSO) • Public tenders • Internally established sales channels • Internally organized customer-oriented marketing events • Fairs, energy sector events	• TSO • DR/DG resources (industrial, commercial, residential, renewable technology sectors) • Aggregators and other platform energy service providers Managers of household-level energy assets and managers of e-mobility-transport

Cost Structure	Revenue Streams
• DR/DG flexible capacity reservation fees, produced energy fees • Flexibility Management Platform infrastructure fixed and recurring cost • Human resources • ICT cost • DSO's metering data provision costs	• (Short-term) contracts with TSO's

Annex III. HIGH-LEVEL USE CASES

Pilot team	HLUC TITLE	HLUC DESCRIPTION
PT	Monitoring energy consumption	This Use Case describes how a user can, throughout technological solutions, such as the Energy Management System (EMS): have convenient access to the data generated from all their appliances to monitor their consumptions of energy; set preferences on AC temperatures (within some activation and limitation conditions); increase energy cost savings (e.g., having best tariffs); offer flexibility (by shift usage in exchange for best tariffs). In addition, set preferences about flexibility on the usage of some appliances, offering flexibility by possible shift loading in time of some defined appliances (washing and dish machines; EV charging); have notifications (according to their preferences) about improvements of their consumption behaviour; have control based on the informed decision (scheduled actions/ autopilot mode).
PT	Subscription of services for domestic energy management	This Use Case describes how the end-user can have the ability to select which (sets/modules) services to subscribe to (ex. Load optimisation for EVs; PV forecasting; Recommendation System) through technological solutions, such as the Energy Management System (EMS) the concept of the "Energy as a Service."
PT	Data sharing via consumer enabled preferences and profiling.	This Use Case describes the enablement of consumer data to be shared while allowing the consumer to choose what data (and metadata) is selected, according to a profile. Data ownership and control should be user-centric and reflect users' preferences. An array of data streams emerge from the domestic realm, exposed to or abstracted by the EMS. The consumer gains awareness for the data streams at their disposal and selects which data streams they allow to be shared.
PT	Prosumer data ingestion for third-party enhanced data-driven services	This Use Case will create new data-driven services that require access to data and awareness of its representativeness, geographical dispersion, and origin profiling. Data-driven services should filter and give rewards to create incentives and engage prosumers.
PT	DSO Open Data 4 New Energy Services	This use case describes the Data interfacing mechanism for exchanging new added-value data for consumers and DSO, creating a bi-directional data interfacing mechanism between DSO and consumers, enabling the exchange of new added-value data for DSO and consumers.
PT	Multi-Level integrated Energy Management System (iEMS) for Commercial Buildings	This use case describes the development of integrated retail shop chain management by combining local and centralized-level energy management.
PT	Flexibility Aggregation of Commercial Buildings	This use case describes the integration of flexible loads for DSF services provision in the wholesale electricity market.
PT	Convenient Smart EV charging at Commercial Buildings	This use case describes the integration of smart EV charging with iEMS for optimal energy management.
PT	Enabling community services via P2P and Blockchain enablers for SAREF services	This use case describes how to make community distributed services available for data-driven services.
PT	Regional Flexibility Portfolio - Distributed Flexibility Management	This use case will describe how the DSO can develop an interfacing mechanism that will enable to perform local and regional congestion management & voltage control based on the interconnection to both commercial and residential flexibility pools rules-based or agreement solutions
PT	Electric Vehicle Smart Charging – Flexibility, management through impactful embedded variable load	This use case will describe how a collaborative flexibility management system can be developed between the DSO and the electric mobility charging operators.

PT	Retrofitting Solutions for Energy Efficiency & DSF 4 DSO	This use case will describe the development of a collaborative mechanism between DSO and a technical platform provider. By deploying retrofitting equipment (water heater, boilers, and heaters) at the household level, an innovative market for DSF for DSO at a local and granular level can be created. This interfacing between DSO and cloud-based solutions at the systems level.
BE	Freedom of data choice	This use case describes how a resident @ Leuven Noord can choose the amount of data visible to companies or researchers. This should also provide a clear overview of the advantages of sharing data (services are impossible when the customer does not want to share this part of their data).
BE	Green Progress Bar	This use case describes a non-energy service for the site of Leuven Noord. The participants of Leuven Noord would get regular updates about how the site (and therefore their actions) is doing towards several ecological KPI's (or estimations of KPI's). This dashboard of KPIs is displayed on strategically placed displays throughout the site where users' traffic is high.
BE	Voluntary (non-) participation in Energy Community	This service allows a pilot to connect and disconnect to the energy community. Users of the pilot will have the option to temporarily not participate in the energy and non-energy services of the site.
BE	DC – AC interface for DC grid	This service provides a DC-AC interface for a DC grid. It aims to simplify the installation and operation of a DC grid within a building or site by providing consultations and the necessary hardware.
BE	Building level services: peak shaving --> reduce electricity invoice	In short, with available data, the energy service provider prepares a prognosis of the system following the day's behaviour (e.g., building) behaviour. The prognosis accounts for expected generation (e.g., PV panels) and consumption assets (e.g., heating/cooling requirements). Based on the prognosis, a set of steps is defined. These steps aim to limit the system's consumption when there is a high probability of utilising more than the contracted capacity. The technical aggregator monitors and sends close to real-time data to the energy service provider. This data is used to update the prognosis also the technical aggregator.
BE	Building level services: RES self-consumption --> reduce electricity invoice	This UC explains how to coordinate energy consumption with local renewable generation. For this UC, the energy service provider forecasts the generation profile of available RES (directly connected to the system in question). Next, this generation profile is matched with the consumption profile of the system. The matching aims at utilising (as much as possible) the energy generated by local sources. Then, the energy service provider calculates the setpoints for consumption assets. Finally, the energy service provider sends the setpoints for deployment to the technical aggregator. The technical aggregator monitors the behaviour of generation and consumption assets and reports it to the energy service provider.
BE	Building level services: EV smart charging pricing for flexibility use	This UC describes how flexibility from a building/parking lot equipped with EV charging stations and PV panels may be traded in a cost-efficient and cost-reflective manner. For this UC, the energy service provider calculates the charging point provider's flexibility costs.
BE	E-mobility services for energy communities --> demand service through EV provision.	Commercial/industrial companies or private entities united in an energy community demand for e-mobility solutions (e.g., to reduce costs during peak hours, make maximum use of surplus energy (sell it during peak hours) and opt for sustainable transport solutions for Employees or by private entities).
BE	Smartifying my Local Energy Community	In this use case, end-users install the IoT solution for smartifying its thermal loads (water heaters, space heaters, and heat pumps) to control them. This control capability is leveraged with the LEC to save money with aggregated peak shaving and self-consumption.
BE	Peer-2-Peer Energy Community	This high-level use case summarises all epics that ask for a value provision created through a P2P trading scheme. The added value of this P2P energy trading is the option to be part of the energy market more actively select the energy sources/producers; it offers financial benefits if the energy is sold above FiT rate and purchased below wholesale/retail price.
BE	Centralised Energy Management System for Community	This service provides a centralised EMS for a community; the value provision is created through a centralised point for controlling, monitoring, and optimising the communities' generation, transmission, consumption, and demand control to save money, time, and effort. In addition, a centralised EMS system enables the communities' demand-side management and can improve its flexibility offer to third parties, e.g., the DSO.
BE	Community optimisation of efficient heat generation	This UC involves managing a cost-efficient device dynamically controlled to comply with an optimal temperature range.
BE	Peak shaving via direct control of HP	This UC explains how manageable loads avoid penalties from brief incursions of local (facility) peak demand above the contracted capacity.
BE	Increase RES for self-consumption	This UC deals with the coordination of energy consumption and local renewable generation. For this UC, the energy service provider forecasts the generation profile of available RES (directly connected to the system in question). This generation profile is matched with the

		consumption profile of the system. The matching aims at utilising (as much as possible) the energy generated by local sources. Electricity generated in excess may be used to power non-energy services provided to the community. The energy service provider calculates the setpoints for consumption assets. The energy service provider sends the setpoints for deployment to the technical aggregator. The technical aggregator monitors the behaviour of generation and consumption assets and reports it to the energy service provider.
BE	Community car sharing	This UC describes how a low-cost e-mobility service can be provided to community members using excess energy from local RES.
BE	Flatten energy profile of a student residence using gamification (PRINCE)	The building operator wants to optimise the building energy consumption by a) reducing the overall consumption and b) flattening the consumption curve to be granted with special tariffs. This flattens curve helps energy providers to sustain constant energy production. To reduce peak loads (peak shaving), the building operator relies on two main approaches: Clever usage of water boilers as thermal batteries. Gamification of the usage of common appliances in the building by students
BE	Energy flexibility service for spot prices electricity tariffs	In this use case, the end-user installs the IoT solution for smartifying its thermal loads (water heaters, space heaters, and heat pumps) to have controllability. This control capability decreases electricity bills by shifting consumption from expensive to cheap.
BE	Asset Portfolio Optimization	Organisations with a building portfolio are constantly searching to minimise the operational cost of their operations. Therefore, they often work with asset managers for investments for operating and energy service companies (ESCOs). Harvesting the complementariness between asset management (by the AM), asset investments (by the ESCO), and asset operations (by a third-party controller) allows to maximally turn an existing building portfolio into a more sustainable version.
BE	Local energy community dashboard	The pilot will develop a real-time visualisation dashboard to measure individual and community level consumption, manage end-user billing (e.g., selling heat and EV-charging services), increase energy awareness, and involve citizens in their energy community.
DE	Cost-optimized operation of devices	This use case enables to manage overload and underload scenarios by flexible tariffs. Energy needs to be consumed when it is available, and consumption needs to be reduced in case of energy shortage which may appear with the change to volatile energy sources and mobility or heating transition at the same time. Therefore, the external market participant will send flexible tariffs to buildings' energy management systems to run devices cost-optimized.
DE	Power monitoring at the grid connection point	This use case enables monitoring of power consumption and consumption forecasts of residential homes or commercial buildings to obtain grid information and identify hot spots.
DE	Power limitation at the grid connection	This use case enables the DSO to manage overload scenarios. The DSO will send a power limitation setpoint or power profile overtime to limit residential and commercial buildings consumption.
DE	Local overload protection	This use case shall avoid local overload scenarios in buildings by enabling the energy management system (EMS) to limit individual power consumption devices.
DE	Indication to start uncontrolled devices when energy is cheap	This use case will relieve the grid of high renewable energy production by manually switching additional loads. The energy supplier/DSO will notify the customer by an APP that energy is cheap.
DE	EV fleet charging	This use case enables commercial buildings or hotels to manage electric vehicles' multiple charging demands and departure times while considering grid constraints.
DE	Coordinated charging of electric vehicles	This use case enables the local energy management system (EMS) to negotiate the charging plan of electric vehicles (EV) according to their specific demands and available energy. The EV submits its departure time and energy demand, the local energy management system answers with the incentive table and maximum power curve over time (=available energy), and the EV creates the charging plan.
DE	Incentive table-based power consumption management	This use case enables a local energy management system (EMS) to make use of the devices' flexibility (e.g., heat pump) through the price of energy (incentive table) to optimise the total power consumption of the building or realise set points received from the grid.
DE	Flexible start of white good	This use case enables the energy management system to start a pre-selected program of a suitable white device. The energy manager determines the timeslot to run the white goods devices at the lowest energy costs between now and the pre-defined end time.
NL	Devices that can be controlled to free up time	Via an easy and safe (private and secure) to use GUI (i.e., app or (touch) screen), I can easily set preferences for me as an individual but also for other persons of my household. By knowing who is at home, the system will automate my household appliances and devices (e.g., robot vacuum cleaner, thermostat) based on set preferences.

NL	Devices that can be controlled to save money	The GUI is to get information on my household's energy and the most significant energy users/appliances. Also, I have information about how my consumption is compared to the average of the other users. The systems also inform the user on why the consumption is high. This does stimulate me to do better. The washing machine and vacuum cleaning robot will start on off-peak (power) moments.
NL	Devices that can be automated to run business	Via the GUI is getting information on systems function and how much energy my room/operation does use. The systems also inform the user on why the consumption is high. This does stimulate me to do better.
NL	Automation methodology without user involvement	The systems also inform the user on why the energy consumption is high. I can personalise the automation and enjoy playing with it.
NL		I can get on with my life as a modern woman, knowing that automation helps me in the background.
NL	Enabling routine daily life for those with impaired abilities (tenant)	So that family members have reduced care responsibilities and so that the person themselves can enjoy their independence for longer. The system knows my patterns and agenda (maybe medicine intake) and will inform my closest family about abnormalities. The systems know when I am sleeping and start appliances to do laundry or maybe start my vacuum robot.
NL	Enabling routine daily life for care home tenants	So that I can help to offer them a high quality of life and increase my building occupancy / increase my building stock.
NL	Enabling routine daily life for patients of home care professionals	So that I can save time and concentrate on the patients with the most needs.
NL	Acute care for those with impaired abilities	The IoT devices in the care home for tenants with impaired abilities signal the tenant's family and caregiver when something dangerous or unusual happens. This way, they can come to help quickly but do not have to be around the tenant all the time to "guard" his safety. This makes it easier for caregivers to be there on time and at the right time when the problem is arriving. It also means they do not have to be around the person who needs care all the time.
NL	Acute care for care home managers	The IoT devices in the care home for tenants with impaired abilities signal the tenant's family and caregiver when something dangerous or unusual happens. This way, they can come to help quickly but do not have to be around the tenant all the time to "guard" his safety. This makes the care home even safer, more efficient (less time of caretakers), and more attractive to potential tenants.
NL	Acute care for patients of home care professionals	The IoT devices in the care home for tenants with impaired abilities signal the tenant's family and caregiver when something dangerous or unusual happens. This way, they can come to help quickly but do not have to be around the tenant all the time to "guard" his safety. This makes it easier for caregivers to be there on time and at the right time when the problem is arriving. It also means they do not have to be around the person who needs care all the time.
NL	Carefree building management	All data is easily visualised through a building management platform (which can be adjusted). Via set KPI's by the user/building owner is informed about the functioning of systems. Information is easily interpretable. Also, the system can detect/signal trends and visualise this, so (predictive) maintenance is easy to foresee and plan to prevent malfunctioning of systems.
NL	Information, control (optimise) sustainability	Data is gathered and analysed (via machine learning) by detecting trends. For example, systems will go to standby mode if an off-peak period arises in a building, I.e., during evenings for the elevator. Turn on lights only when movement is detected or expected. Via monitoring also is detected if some systems compared to earlier moments /comparable season still use the same energy. If not, systems might need maintenance to optimise the energy usage again.
NL	Happy tenants	Via a GUI, I can see if there is a malfunction or maybe planned maintenance of (systems/hardware/service of) the building. Suppose I see something else that is not functioning, or I have another complaint. In that case, I can easily report this issue to the building owner (or the facility management company in charge). Via updates, I am informed about updates. Quick problem fixes give me the feeling that we are essential “guests” of the building.
NL	Couple EV to Renewable Generation (optional V2H)	Smart charging of vehicle with a surplus of home/building energy. Seems most feasible and can be explained to the customer, willing to pay, will satisfy his needs, carbon footprint improvement, and decrease costs. V2H (Vehicle 2 Homeless likely)
NL	Prevent overloading grid connection (contract)	It can be an advantage, likely more for a larger building and multiple cars. Is that available at Strijp?

NL	Optimise EV charging for flexible tariffs (V2G optional)	Issue: flexible tariffs are not standard and only for the energy part (not capacity or taxes).
NL	Use EV charging flexibility by an aggregator (V2G optional)	Aggregator exploits flexibility and releases end-users from tariff structures and options to engage in balancing markets.
NL	Monitor & Control anywhere	Tenant monitors and controls all home appliances from any place.
NL	Monitor & Control to learn	The tenant monitors all home appliances and sensors to obtain new information about the house. He does this out of curiosity and acts on it when needed.
NL	Monitor & Control for efficiency (person+commercial)	Tenant monitors and controls all home appliances anytime to reduce energy and water costs.
NL	Monitor & Control Smart lock	Tenant uses the smart lock to make "key handling" easier. For example, he can order the door to be open or closed from anywhere at any time.
NL	Monitor & Control Kitchen devices	The tenant can control kitchen devices from a distance, saving time.
NL	Monitor & Control Monitor per device	The tenant can monitor the energy usage of individual devices separately. By doing this, he will see the ones using the most energy and can choose to cut back on those if he wants to save energy/money.
IT	Unlock Perks with the use	This Use Case describes how to increase or at least keep the engagement of a residential user related to the Energy Service for DSF by rewarding them for the continuous use of the App and service.
IT	Digital Platform for End-User Control and Awareness	The digital platform for control and awareness satisfies the user needs in terms of economic saving and energy efficiency. From a dedicated App, the user can choose what flexible services he wants to offer and be informed about smart tariffs offered by the service provider in real-time.
IT	Interoperability and availability of solutions	This Use Case describes how to enhance the engagement of end-users by offering a single touchpoint to verify and control the seamless integration of a whole constellation of home devices. Through a single touchpoint, the digital platform will enhance the control capability.
IT	Energy & Environmental Performance App	The Use Case enables transparency and gratification for end-users energy performance. An app reflects the user's energy behaviour and consumption pattern performance. In addition, the app shows their ecological footprint related to energy (e.g., CO_2 emissions steaming from energy consumed).
IT	Playing with Technologies	This Use Case describes how to obtain benefits for both end-users and living service providers, letting end users personalise the platform and have fun coding their functions. Also, sharing these new functionalities with other users can improve the overall platform if the living service provider decides to embed them as core functions.
GR	Provide feedback on CO_2 emissions reduction based on consumer's actions Help consumers to be eco-friendly.y	This use case describes how a DSO/Aggregator can provide feedback to consumers regarding the CO_2 emissions reduction based on their actions. Through a user interface like a web page or a mobile app built by a technology provider, the consumers will monitor their consumption by a smart meter. Based on the output of a DR framework, the system will ask the consumers through the user interface to shift their loads to optimise GRID operations. The consumers will get feedback on CO2 savings through the user interface based on their responses to GRID's requests.
GR	Educate customers about energy efficiency Educate customers about energy efficiency through a personalised recommendation	This Use Case describes how to educate customers through energy tips and enable them to be more energy-efficient and reduce their electricity bills. GRID operators will educate their customers by providing energy efficiency tips and recommendations through a user interface. As a result, consumers will increase their awareness of energy efficiency, and in the end, they will achieve lower energy bills.
GR	Gamification Challenge users to be more energy-efficient than others	This Use Case describes how to pay less through gamification challenges. GRID operators will provide challenges and personal targets through a mobile app developed by a technology provider. As a result, consumers will earn rewards in terms of energy points and ranking among other consumers. In the end, consumers will see their electricity bills reduced by accomplishing the challenges and targets in the context of gamification.
GR	Loyalty Program Award energy-efficient	This Use Case describes how to pay less through benefits redeemed for the consumer's actions. GRID operators will engage in B2B agreements with third parties so that consumers can redeem energy points in various businesses (Shopping, Tickets, Gadgets, ...). In addition,

	users with redeemable energy points	consumers earn energy points for responding to GRID's demand for actions (load shifting, increase/decrease consumption) made through a mobile app (developed by a technology provider).
GR	Direct control of home flexibility service Allow users to have direct control of their appliances and provide flexibility at will.	This Use Case describes how end-users can become more active and participate explicitly in demand response schemes. Through a web-based dashboard or their mobile app, the users will be able to monitor the current state of their home appliances and decide when they will participate in a demand response scheme and how much of their harnessed flexibility will be released in the system. First, various installed smart meters and devices should collect their consumption data to achieve the above goal. Then, the collected data should be analysed and visualised by a technology provider in cooperation with their retailer. As a result, the participating users will know at each point of the day the state of their smart appliances, their capability to provide flexibility, and an estimation of the collected revenues from their participation in demand response schemes, to be able to decide if they want to provide flexibility in the system.
GR	Energy events notification service Help customers detect abnormal energy events and become eco & grid friendly.	This Use Case describes how a technology provider can provide a notification service based on energy events to consumers and how a DSO/Aggregator could benefit from this service. Through a notification service through a mobile app built by a technology provider using data provided by smart meters, smart plugs, and smart devices, users will be notified about energy events to prevent accidents or security breaches. Also, the user will be able to detect devices abnormalities and perform predictive maintenance to prevent device failures. Based on the grid's needs provided by DSO/Aggregator, the system will inform the consumer about energy optimisation based on their energy events to be friendlier to the grid and minimise his\her energy consumption to become more environmentally friendly.
GR	Integrate all smart devices and sensors in one app Help customers view all their data and control their devices from a single app.	This Use Case describes how a technology provider can provide a consumer service to integrate all smart devices in one point. Through a smart gateway capable of interacting with devices from different vendors and a user interface like a web page or mobile app built by a technology provider, the consumers will monitor all their data coming from their sensors. Furthermore, the customers will interact with all their smart devices/appliances through the same point (web page, mobile app) and control them. Finally, using the interface provided by the technology provider, the customers will be able to unveil insights related to their actions, e.g., that the power consumption will be decreased by closing the air condition. However, nevertheless still, at the same time, the temperature will be increased.
GR	Smart Home System remote monitor and control Enable remote monitor and control of smart Home IoT Ecosystem	Using state-of-the-art technologies and secure interfaces, the end-user will be able to monitor every (inter)connected device at his house with the touch of a button through the unified user interface built by the technology providers. Either by laptop, PC, or a mobile device, if there is an internet connection, then streams from indoors and outdoors cameras, energy and power consumption measurements, environmental measurements ...., will be available 24/7, both real-time and historical data. In addition, devices that support control functions/actions such as smart plugs, intelligent white devices, A/C modules .... will be controlled through the unified user interface where everything can be integrated, offering a consistent experience. Furthermore, the built-in notification system will allow the end-user to respond and react to DSO/Aggregator DSF requests (semi-manual DR) without physical presence at the house premises and responding to local events, e.g., abnormal consumption patterns house premises security breaches...
GR	House security breach detection system Alert users when a security breach has been detected in their house.	This Use Case describes how an IoT system can notify a user about a security breach in their house. Taking advantage of cheap IoT devices like motion detection or door/window contact sensors and more advanced devices like IP cameras, users can be notified if a security breach is detected in their houses. An IoT technology company provides and setups all the needed equipment in the user's home, while the latter can enable/disable the alarm through an app on his mobile.
GR	Increased efficiency for consumers/help consumers be eco-friendly, reduce bills and adapt to changing environment.	Analysed data and predictions based on usage patterns can be used to show the potential impact of a user's action on their overall energy footprint and energy bills. End-users/consumers will have the opportunity to check their usage behaviour and decide if it is more efficient to shift the usage of power-hungry appliances to off-peak hours.
GR	Increased efficiency for producers/ energy operators /The producer needs to maximise its revenue.	Analysed data and predictions based on usage patterns of customers can be used to provide valuable insights into demand and schedule supply accordingly. Also, producers/operators can provide tailored-made offers based on their customers' needs and give them bonuses/incentives for shifting loads to off-peak hours.

GR	Increased efficiency for appliances vendors The vendor needs to provide high quality and energy-efficient appliances	Analysed data and predictions based on usage patterns of customers can be used to provide valuable insights into how an appliance is used.
FR	Manage the operation of the devices automatically. Reduce the bill	This use case describes how to manage its devices to reduce the consumer bill automatically. (1) The user has connected a bundle of appliances that the service provider automatically & remotely controls. (2) The appliances are controlled according to the dynamic tariff information from the energy provider/user requirements orders. (3) The requirements coming from the users have priority towards the orders coming from the providers. (4) The back end allows piloting the devices remotely. (5) The data exchanged are secured. The KPI: evolution of the bill/power consumed.
FR	Clear invoice Bring confidence	This use case describes how to provide a clear invoice to the customer. The invoice presents the different consumptions in front of the different tariffs. In addition, on the customer interface, it is possible to check daily: (1) the consumptions; (2) the organisation of the different tariffs. The KPI: Satisfaction is returned from the customer on understanding its bill.
FR	User-friendly interface Access information controls the system.	This use case describes the functionalities of the user interface to manage the equipment control service. The user interface allows users to subscribe to the dynamic tariff service to control their devices. This friendly web interface allows the user to control the equipment. The user interface allows the user to manage its account (profile, subscription). The user interface allows the user to visualise his bill. The user interface shall be ergonomic and user-friendly. The user interface relates to the service backend application. The service back-end application exchanges information with the EMS user and billing information. All data exchanges are secure. The KPI: Number of times the user connects to the system, the number of times he opens his bill, customer satisfaction with the service.
FR	User appliances management the end-user can manage remotely or locally its appliances	This use case describes how to remotely or inactivate appliances remotely or locally. The end-user can connect in a secure mode to its local infrastructure. The service provider gives access to the HEMS. The end-user can manage its appliances to benefit from the dynamic tariff: (1) activate; (2) inactivate; (3) set up its appliances by using a web interface provided by the services provider. The HEMS allows to switch on or off the appliances depending on the dynamic tariff. Thus, the management of the appliances is automatic, but the end-user stays the master of the service. The end-user can impose some predefined mode or appliance's behaviour. The end-user can benefit from the dynamic tariff even if he is not at home. The end-user can manage its comfort and home security. The service provider can manage the consumer's appliances to minimise its bill while the comfort remains the same. The KPI: (1) Satisfaction survey about the ability for the customer to activate, deactivate, or set up the appliances at their convenience, (2) number of actions well performed/number of actions asked to the system.
FR	Online Customer Support Provide support to the customer online	This use case describes online customer support. The user wants to have available and efficient support. The online customer support, the customer, have a web interface: (1) create and fill an online request in a ticketing tool.; (2) the support: (a) analyse the request to identify the root cause; (b) manage secondary support according to the issue (equipment issue, configuration issue, network issue ...); (c) give feedback to the customer through the request ticket; (d) close the ticket when the customer agrees with the solution. The KPI: customer satisfaction rate.
FR	Tariff schedule monitoring Plug the appliances at the right moment	This UC aims at describing how the customer will get the info regarding its tariff schedule. The tariff schedule is changed dynamically by the supplier consistently with the electricity supply contract. The user can choose to be notified or not. The customer can get this info on its customer interface. The customer can program its appliances according to the schedule. The HEMS allows to switch on or off the appliances depending on the dynamic tariff. The KPI: (1) the number of times the customer checks its tariff schedule/ year ;(2) customer satisfaction rate.
FR	Start/stop my appliances and EV at the right time. use my appliance and charge my EV battery during the REX production	This use case describes how to use the customer appliances or recharge their EV at the right time. The end-user is informed of the period of the RES production. The end-user can manage its appliances remotely/locally. The end-user shall be able to activate, inactivate or set up its appliances using a web interface provided by the services provider. The service provider gives access to the HEMS. The HEMS allows to switch on or off the appliances. The management of the appliances is automatic. The end-user stays the master of the service. The end-user can impose some predefined mode or appliances behaviour. Outside of the renewable energy production period, the dynamic tariff service could manage the consumption of these

		appliances. All data exchanges are secured. The KPI: (1) the number of times the appliances were managed remotely; (2) The % of additional PV consumption.
FR	Reduce your bill by consuming renewable energy consume my RES energy	This use case describes how to synchronise the consumption of its appliances with the period of energy production. First, the service provider is informed of the period of the RES production. Then, the service provider can activate the client's appliances accordingly to the customer's settings. The service provider can recharge the EV according to user needs. The needs are validated initially via the client's platform. The HEMS allows to switch on or off the appliances. All data exchanges are secure. The KPI: (1) number of times the service provider activates the appliances; (2) Number of times he recharges the EV; (3) number of needs /months validated by the customer on the platform; (4) % of energy locally consumed and increase in comparison with a baseline.
FR	Reduce my bill by automatic management of my EV's charge use the PV energy store in the battery	The charging of an electric vehicle must be done at the right time for the end customer. The charging should be done when the energy: (1) is the lowest carbonated; (2) it is the cheapest: modulation overtime must be possible. The customer does not need systematically to cover a full-power charge. The charging power can be modulated automatically by taking the remaining power at home, thus preventing the customer from increasing the maximum contractual power. We are also considering the level of renewable production to charge the EV first. All data exchanges are secure. The KPI: (1) Number of times the charging was done when the energy was the lowest carbon; (2) number of times when it was the cheapest.
FR	Store the overproduction of the res Energy the end-user can manage remotely or locally their appliances	This use case describes how to store the overproduction of the RES energy and use it at the right time. First, the service provider is informed of the period of the RES production. Then the service provider compares the RES production and the real-time user consumption. Finally, the service provider activates the storage of the remaining energy by the EMS box, When the user wants to consume the battery's energy, he can switch on the device using the client platform. Moreover, all data exchanges are secure. The KPI: (1) number of times the service provider uses to recharge the battery ;(2) total power/year recharged in the battery.
FR	Maximise my battery's charge with renewable energy; consume energy battery when needed.	This use case describes how to maximise the battery charge with renewable energy. The user accesses the service with a secure web interface. The user can prioritise the battery charge during the production of renewable energy. The user uses the energy from the battery when necessary (especially outside the period of production of renewable energy). All data exchanges are secure. KPI: (1) percentage of renewable energy used to charge the battery per day; (2) the percentage of renewable energy used to charge the battery per month; (3) number of kWh used to come from the battery; (4) number of RES kWh used to charge the battery.
FR	I want to consume renewable energy from the community. reduce my bill and consume greener energy	The user needs to schedule a defined task. The user opens a UI that shows him the actual and forecasted renewable production. The UI proposes the best period to schedule the defined task. The HEMS allows to switch on or off the appliances. The user chooses when to do his task depending on the availability of the functionality: (1) manually on the appliance via the interface. (2) all data exchanges are secured. The KPI: the user quickly understands the best moment to program his task and choose another moment.
FR	Prioritise the consumption of my appliances optimise the use of my renewable energy	This use case describes how to optimise the use of renewable energy. The end-user shall connect in a secured mode to its local infrastructure. The end-customer can manage its appliances. He can activate, deactivate, or set up his appliances by using a web interface provided by the services provider. The service provider gives access to HEMS. The HEMS allows to switch on or off the appliances. The management of the appliances is automatic. The end-user stays the master of the service despite the automation. He can :(1) prioritise the consumption of its appliances; (2) select some predefined mode of usage of its renewable energy. All data exchanges are secured. KPI: (1) the percentage of renewable energy use by each appliance; (2) consumption in kWh of each appliance per month.
FR	Sign the contract benefit from the "maximise RES" offer	The Customer signs the contract with the service provider. The service provider provides an interface to the customer to configure all the appliances to connect. The service provider collects user consent for data acquisition, "Linky", and GDPR. The service provider requests access to consumption data from Linky to the DSO. The HEMS allows to switch on or off the appliances. All data exchanges are secure. KPI: The system is up and ready to run.

FR	Consumption adjustment Maximise RES consumption	The use case describes how to adjust its consumption to maximise the consumption on RES and minimise the consumption of non-RES. The system: (1) maximise the consumption of RES energy; (2) notify the customer of the availability of the electricity issue by RES. For some appliances, like a hot water tank, a battery of the EV...., the control is automatic if the customer allows it. The HEMS allows to switch on or off the appliances. The user can choose to be notified or not. The customer can get this info on its customer interface. The user can see the consumption of RES versus non-RES in one simple and understandable graph. The customer can program its appliances according to the RES production. All data exchanges are secure. The KPI: % of RES used in the consumption
FR	User-friendly interface Check the efficiency of the service.	This use case describes the function of the user interface. The user interface allows (1) the user to view his consumption/production; (2) the user to manage his bill (check); (3) the user to check the efficiency of the service; (4) the user to act on the control of the equipment. In addition, the user interface allows the user to manage its account (profile, subscription). The user interface shall be the ergonomic and friendly user. All data exchanges are secure. The KPI: (1) number of times that the user interacts with its equipment, (2) number of times the user connects to the system, (3) number of times that he opens his bill.
FR	Stop/start my appliances automatically when leaving home. Reduce my bill	This use case describes reducing the bill by automatically stopping/Starting my appliances (tv, video games) when leaving home. First, the consumer wants to install an intelligent system that can turn off/on the devices. In addition, the system can control the devices automatically. Then, the user selects the devices to manage. The user selects their arrival/ departure times on the platform. The devices will be activated and deactivated according to user schedules. If the user does not respect his programmed schedules, the consumer can activate his devices remotely via the platform. Then, the user selects the devices to manage by using its GUI/mobile app. After this setting, the system could know if the consumers are no longer in the house. Finally, the system cuts off all the previously configured standby elements. When one of the consumers is back home, all the devices are restarted automatically. The consumer can activate his devices remotely via the platform. The HEMS allows to switch on or off the appliances. The KPI: (1) number of times that the appliances are switched on/off, (2) Number of times that the customer spends on the interface.
FR	know the consumption gain due to the smart management of my appliances Monitor efficiency of the service	This use case describes how the user will be aware of the gains obtained by the subscribed service. This information needs to be identified in a recurring electricity energy bill report. If an appliance is re-programmed to work on a low tariff slot, the system should compare the actual and original prices without re-programming. The HEMS allows to switch on or off the appliances. The KPI: actual consumption vs consumption without the service.
FR	Automatic activation service end-user can enable or disable the automatic control of their appliances	This use case describes how the user can disengage the automatic control of their appliances. The end-user has access to a stop button (mechanical button or web app button TBD) at home to deactivate/activate the service. If the button is pressed, the service is deactivated; if the button is released, the service is activated. The service might be automatically re-engaged the next day. The HEMS allows to switch on or off the appliances even without the service. The KPI: (1) number of disengagements; (2) duration during which the service has been off since the launch of the service; (3) duration of the of service on last month; (4) timestamp of activation/inactivation of automatic appliances control.
FR	Manage my appliances automatically. reduce the bill	This use case describes how to manage its devices automatically to (1) reduce the bill by using dynamic tariff; (2) reduce my energy consumption; (3) maximise the use of my local renewable energy (optional). The user has connected a bundle of appliances which the service provider automatically & remotely controls according to customers settings. The HEMS allows to switch on or off the appliances: (1) based on dynamic tariff information coming from the energy provider; (2) based on user requirements orders; (3) based on local renewable energy availability (optional). The requirements coming from the users have priority towards the orders coming from the providers. Moreover, the back-end allows piloting the devices remotely. The data exchanged are secured. The KPI: evolution of the bill/ power consumed.
FR	Ensure EV energy level (potentially based on a predictive system) Be sure that there will be enough energy in my EV for my future transportation.	1. The EV owner plugs his vehicle into the system to charge it and make the flexibility potential (battery) available to the community needs (load management, for instance). 2. With a predictive algorithm such as A.I., the system ensures that enough energy will be available in the EV battery according to (1) next trips scheduled; (2) the required autonomy, (3) vehicle usage habits (considering the day of the week, the week/month of the year) and the temperature forecast that could reduce the autonomy. 3. The system provides its charging/loading computed schedule to the user for confirmation. 4. The user can force the system to keep the EV battery fully charged at its convenience. Useful KPIs could be: (1)vehicle plug-in duration per day; (2)flexibility potential of the battery (computed by the predictive system); (3)% of flexibility consented by the user for the community

		load management; (4)battery capacity charge and discharge according to the temperature by trip forecast; (5) occurrences for keeping the battery fully charged. Note 1: The customer pays to access more elaborated predictions (taking weather forecasts or complex information into account). Note 2: Being efficient on one's prediction/commitment could grant bonus points to lower the global bill (and partially pay off the predictive service).
FR	Manage the use of the EV battery Ensure that the V2G service does not wear out the battery	1. The owner plugs his EV battery into the system. 2. The system analyses the wear-out level of the battery. 3. According to this information, to statistics originating from the carmaker to the cost of the use/wear out (especially if it is a rented battery), the system can compute a use cost of the battery as an energy supplier for the grid. 4. If the cost is too high (higher than an arbitrary/varying level), the system can decide not to use the battery as an energy source. 5. The user can choose to bypass the system's decision by making the battery usable as an energy source or not. The KPI is the curve of wear out the evolution of the battery.
FR	Provide flexibility (ancillary services, for example) Valorise flexibility from EV or other devices	1. The EV-EMS retrieves local flexibility resources forecast, including building PVs and EV battery resources according to the self-consumption requirements (appliances power needs & EV charging + next trips) 2. The EV-EMS sends (the remaining) flexibility capabilities to the aggregator 3. The aggregator includes the flexibility into its portfolio and arbitrates the flexibility amongst several value pools, including markets and services for TSO and DSO (including congestion management). 4. The aggregator sends flexibility offers while considering its commitment toward TSO or other stakeholders 5. Bids are processed separately by the markets, the TSO, and the DSO. The aggregator is informed if its offers have been accepted by one or another 6. The aggregator activates flexibility capabilities by dispatching the flexibility available in its portfolio, including the community's flexibility. The dispatching considers economic and geographic aspects (it provides adequate power). Useful KPIs could be: (1)occurrences of local network congestion; (2)occurrences of local voltage imbalance and deepness; (3) % of local reactive power used to counterbalance local voltage imbalance; (4)number of local voltage balancing success; (5) occurrences of local frequency imbalance and deepness; (6)% of local active power used to counterbalance local frequency imbalance; (7)number of local frequency balancing success; (8)value earned by the flexibility provider (community prosumer); (9)value earned by the balancing resources provider (community prosumer)
FR	Provide flexibility & ancillary services – release Valorise flexibility from EV or other building appliances	The retailer provides electricity to the consumer with a dynamic tariff and provides a service to optimise the customer's consumption according to the tariff levels. The retailer reshapes the load curve of its customer to minimise the sourcing cost and reduce its capacity obligation. As a flexible service provider, the retailer monetises the consumer flexibility toward the TSO as an ancillary service (FCR). The retailer installs devices to remotely control and command flexible appliances consumption such as EV, heaters, HVAC, hot water tanks). The retailer collects the data in real-time (every 10s) from its devices and the head meter. The retailer forecasts the available flexibility and arbitrates every day between the different value pools. According to the results of its biddings, the retailer dispatches flexible orders. Both DSO and TSO perform the settlement according to the data collected by the head meter and the submetering devices installed by the retailer. The TSO compensates the retailer for the delivered service. The retailer compensates the consumer according to its contract. Useful KPIs could be: (1) the value created by the flexibility; (2) bill increases before compensation by the retailer; (3) number of activation (not considering ancillary service activation).
FR	Personal data and privacy protect personal data and the privacy of the subscriber.	The subscriber trusts the service because he signs a clear and transparent contract concerning his data and privacy. The service is compliant with the General Data Protection Regulation (EU GDPR). All data exchanges are secure. KPI: compliance with GDPR (1 or 0).
FR	Secure service adds security mechanisms to avoid piracy.	All data exchanged between the subscriber and the technical components making up the backend are encrypted. In addition, access to the client's HEMS is protected by a multi-factor authentication mechanism. The subscriber is informed by email and SMS of all actions performed on their system. All the actions are traced to the application backend. All data exchanges are secure.
FR	Reliable service Increase end-user confidence in service and satisfaction	This use case describes how the service is reliable. The service is scalable horizontally and vertically. The service can adapt automatically to (1) the number of users; (2) the number of appliances to manage; (3) the service is robust to the malfunction of one of these components. The end-users setting and data are stored/backup on the cloud. The HEMS allows to switch on or off the appliances. All data exchanges are secure. The KPI: high availability rate per month